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**Southwestern
Region**

Forest Products Specialist Report

Apache-Sitgreaves National Forests

Forest Plan Revision EIS

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Introduction

This report evaluates and discloses the potential environmental and social consequences to the forest, piñon-juniper woodland, and great basin grassland resources, with respect to lands suitable for timber production (hereafter referred to as “suitable timberlands”), vegetation management practices, and potential wood and tree products contributing to the local communities, which may result with the adoption of a revised land management plan. It examines, in detail, four different alternatives for revising the 1987 Apache-Sitgreaves NFs land management plan (1987 forest plan).

Relevant Laws, Regulations, and Policy that Apply to Silvicultural Actions

Federal Statutes

A Federal statute, or law, is an act or bill which has become part of the legal code through passage by Congress and approval by the President (or via congressional override). Although not specified below, many of these laws have been amended.

Anderson-Mansfield Reforestation and Revegetation Act of October 11, 1949 - Provides for the reforestation and revegetation of National Forest System lands and other lands under the administration or control of the Forest Service.

Federal Land Policy and Management Act of October 21, 1976 - Requires that public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use. Also states that the United States shall receive fair market value of the use of the public lands and their resources unless otherwise provided for by law.

Forest and Rangeland Renewable Resources Planning Act of August 17, 1974, as amended by the National Forest Management Act (NFMA) of October 22, 1976 - The National Forest Management Act reorganized, expanded, and otherwise amended the Forest and Rangeland Renewable Resources Planning Act of 1974, which called for the management of renewable resources on National Forest System lands. The National Forest Management Act requires the Secretary of Agriculture to assess forest lands, develop a management program based on multiple-use, sustained-yield principles, and implement a resource management plan for each unit of the National Forest System. It is the primary statute governing the administration of National Forests.

Healthy Forests Restoration Act (HFRA) of 2003 (H.R. 1904)- Purposes are to reduce wildfire risk to communities and municipal water supplies through collaborative hazardous fuels reduction projects; to assess and reduce the risk of catastrophic fire or insect or disease infestation; to enhance efforts to protect watersheds and address threats to forest and rangeland health (including wildfire) across the landscape; to protect, restore, and enhance forest ecosystem components such as biological diversity, threatened/endangered species habitats, enhanced productivity.

Knutson-Vandenberg Act of June 9, 1930 - Authorizes the Secretary of Agriculture to establish forest tree nurseries; to deposit monies from timber sale purchasers to cover the costs of planting young trees, sowing seed, removing undesirable trees or other growth, and protecting and improving the future productivity of the land; and to furnish seedlings and/or young trees for the replanting of burned-over areas in any National Park.

Multiple-Use Sustained-Yield Act (MUSY) of June 12, 1960 -States that it is the policy of Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes, and authorizes and directs the Secretary of Agriculture to develop and administer the renewable surface resources of the national forests for the multiple-use and sustained-yield of products and services.

National Environmental Policy Act of January 1, 1970 - Directs all Federal agencies to consider and report the potential environmental impacts of proposed Federal actions, and established the Council on Environmental Quality.

Organic Administration Act of June 4, 1897 - Authorizes the President to modify or revoke any instrument creating a national forest; states that no national forest may be established except to improve and protect the forest within its boundaries, for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States. Authorizes the Secretary of Agriculture to promulgate rules and regulations to regulate the use and occupancy of the national forests.

Supplemental National Forest Reforestation Fund Act of September 18, 1972 - Directs the Secretary of Agriculture to establish a supplemental national reforestation fund, and states that money transferred to this fund shall be available to the Secretary for the purpose of supplementing programs of tree planting and seeding on National Forest System lands determined by the Secretary to be in need of reforestation.

Stewardship End Result Contracting Projects (16 U.S.C. 2104) - Grants the Bureau of Land Management and the Forest Service ten-year authority to enter into stewardship contracts or agreements to achieve agency land management objectives and meet community needs.

Sustained Yield Forest Management Act of March 29, 1944 - Authorizes the Secretaries of Agriculture and the Interior to establish by formal declaration cooperative sustained-yield units which shall consist of federally owned or administered forest land under their jurisdiction and, in addition thereto, land which reasonably may be expected to be made the subject of one or more of the cooperative agreements with private landowners authorized by section 2 of the Act in order to promote the stability of forest industries, of employment, of communities, and of taxable forest wealth through continuous supplies of timber and forest products; and in order to secure the benefits of forests in the maintenance of water supply, regulation of stream flow, prevention of soil erosion, amelioration of climate, and preservation of wildlife.

Timber Export Act of March 4, 1917 - Permits the Secretary of Agriculture to allow timber or other forest products to be cut or removed from a national forest and exported from the state or territory in which that national forest is situated.

Timber Exportation Act of April 12, 1926 - Authorizes the exportation of lawfully cut timber from the state or territory where grown if the supply of timber for local use will not be endangered, and authorizes the Secretary to issue rules and regulations to carry out the provisions of the Act.

Tribal Forest Protection Act of 2004 - Authorizes the Secretary of Agriculture and the Secretary of the Interior to enter into an agreement or contract with Indian tribes meeting certain criteria to carry out projects to protect Indian forest land or rangeland, including a project to restore Federal land that borders on or is adjacent to Indian forest land or rangeland.

Twenty-Five Percent Fund Act of May 23, 1908 - Provides that twenty-five percent of all monies received from the sale of timber or other forest products shall be paid to the state in which such forest is located to be expended as the state may prescribe for the benefit of public schools and roads.

Wood Residue Utilization Act December 19, 1980 - Enacted to develop, demonstrate, and make available information on feasible methods that have the potential for commercial application to increase and improve utilization in residential, commercial, and industrial or power plant applications of wood residues resulting from timber harvesting and forest protection and management activities occurring on public and private forest lands, and from the manufacture of forest products, including wood pulp.

Regulations

Below is a partial listing of relevant regulations. Federal executive departments and administrative agencies write regulations to implement laws. Regulations are secondary to law. However, both laws and regulations are enforceable.

36 CFR 221 Timber Management Planning - Sets forth the requirements for management plans for National Forest timber resources.

36 CFR 223 Sale and Disposal of National Forest System Timber - Sets forth the requirements relating to the sale and disposal of National Forest System timber.

Forest Service Directives

The Forest Service Manual (FSM) and Forest Service Handbooks (FSH) contains legal authorities, goals, objectives, policies, responsibilities, instructions, and the necessary guidance to plan and execute assigned programs and activities.

FSM 2000 National Forest Resource Management

- **FSM 2020** Ecological Restoration and Resilience
- **FSM 2070** Biological Diversity
    - FSM 2070.3 Vegetation Ecology (use of native plants in re-vegetation, rehabilitation, and restoration)

FSM 2400 Timber Management, Southwestern Region and Apache-Sitgreaves NFs supplements

- **FSM 2430** Commercial Timber Sales, Southwestern Region and Apache-Sitgreaves NFs supplements, Small Sales and Commercial/Personal Use Permits of Timber, Fuelwood, and other forest products
- **FSM 2470** Silvicultural Practices
- **FSH 2409.13** Timber Resource Planning Handbook, Ch. 30 – Timber Sale Scheduling, WO Amendment 2409.13-92-1, Effective 8/3/92. Provides optional agency direction as recommended guidance.

Programmatic Agreements

Memorandum of Understanding among the Arizona Game and Fish Department, New Mexico Game and Fish Department, U.S.D.A. Animal and Plant Health Inspection Service/Wildlife Services, U.S.D.A Forest Service, U.S. Fish and Wildlife Service, White Mountain Apache Tribe, Arizona Counties of Graham, Greenlee, and Navajo, New Mexico Counties of Catron and Sierra, and the New Mexico Department of Agriculture

Glossary

Terms and Abbreviations Used Throughout This Report and Appendices:

ASNFs – Apache-Sitgreaves National Forests

ASQ – Allowable Sale Quantity

BA – Basal Area. A unit of stand/forest density measure, using the cross-sectional area of all tree boles standing in a given land area. Expressed as square feet per acre.

Bole - The cylindrical portion of a tree trunk.

CF – Cubic feet of wood volume (used as a per-acre unit measure).

CCF - 100 Cubic Feet of wood volume (used as a total unit measure across all acres treated).

CWPP - Community Wildfire Protection Plan.

DBH – Diameter Breast Height (tree bole measurement at 4.5 feet above ground).

GIS - Geographical Information System.

FIA - Forest Inventory and Analysis, permanently located plots across National Forest Service system lands.

FFE - Fire-Fuels Extension of the FVS model.

FVS - Forest Vegetation Simulator Model (and all its submodels and extensions).

Gross growth – Ingrowth plus accretion. A measurable increase in wood volume due to the addition of new trees per acre added or grown into size classes which count toward total stand volume (ingrowth), plus added increases in tree diameter increment and height of trees already existing in those same size classes (accretion).

LTSYC – Long Term Sustained Yield Capacity

MA - Management Area (in the forest plan).

NEPA - National Environmental Policy Act.

Net growth - Gross growth in forest wood volume minus natural (non-cut) mortality volume.

Non-declining even flow (of ASQ volume) – Concept of long-term sustained yield which legally prohibits the ASQ volumes harvested from suitable timberlands from declining from one decade to the next (see additional handbook defintions below).

MMBF - Million Board Feet (of timber)

Planning period –Length of time (15 years) the revised plan is expected to be in effect.

PNVT - Potential Natural Vegetation Type (see Vegetation Specialist report)

Regulated (forest) – A balanced progression of age/size classes are present at consistent growth rates to ensure a regular harvest of relatively similar volume each entry, for long-term sustained yield.

TIM – Timber Information Manager (wood/tree product sales program and database)

TPA - Trees per Acre.

VDDT - Vegetation Dynamic Development Tool model.

WMSP - White Mountain Stewardship Project

In context of provisions of the 1982 planning rule, a number of key terms and definitions are presented and explained here. They are not necessarily arranged here in alphabetical order, but intentionally flow in a logical process to enable the reader to digest the concepts. Certain key words are emphasized in italics here for the reader's benefit. (Source: report Appendix A1 contains all definitions provided in the 1992 WO amendment to FSH 2409.13, zero code.)

Suitable Timberland and Allowable Sale Quantity Definitions:

Timber production is strictly defined as "the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees for cutting into logs, bolts, or other round sections for industrial or consumer use. For purposes of forest planning, timber production does not include *fuelwood* or harvests from *unsuitable lands*." (FSM 1900)

Fuelwood is strictly defined as "wood that is round, split, or sawn and/or otherwise generally refuse material cut into short lengths or chipped for burning."

Unsuitable lands are defined as "forest land not managed for *timber production* because: (a) Congress, the Secretary, or the Chief has withdrawn it; (b) it is not producing or capable of producing crops of *industrial wood*; (c) technology is not available to prevent irreversible damage to soils productivity, or watershed conditions; (d) there is no reasonable assurance based on existing technology and knowledge, that it is possible to restock lands within 5 years after final harvest, as reflected in current research and experience; (e) there is, at present, a lack of adequate information about responses to timber management activities; or (f) timber management is inconsistent with or not cost efficient in meeting the management requirements and multiple-use objectives specified in the forest plan.

Tentatively suitable is defined as "forest land that is producing or is capable of producing crops of *industrial* wood and: (a) has not been withdrawn by Congress, the Secretary, or the Chief; (b) existing technology and knowledge is available to ensure timber production without irreversible damage to soils productivity, or watershed conditions; (c) existing technology and knowledge, as reflected in current research and experience, provides reasonable assurance that it is possible to restock adequately within 5 years after final harvest; and (d) adequate information is available to project responses to timber management activities." This is essentially the same definition also used for "commercial forest land."

Industrial wood is strictly defined as "all commercial *roundwood products*, except *fuelwood*."

Roundwood products are strictly defined as "logs, bolts, or other round sections cut from trees."

Suitable forest land is defined as "land to be managed for *timber production* on a regulated basis." Throughout this document, is referred to as "suitable timberlands".

Allowable Sale Quantity (ASQ) Definitions:

Allowable sale quantity (ASQ) - The quantity of timber that may be sold from the area of suitable land covered by the forest plan for a time period specified by the plan. This allowable sale quantity (ASQ) is usually expressed on an annual basis as the "average annual allowable sale quantity." For timber resource planning purposes, the allowable sale quantity applies to each decade over the planning horizon and includes only *chargeable volume*. Consistent with the definition of timber production, do not include fuelwood or other nonindustrial wood in the allowable sale quantity.

Chargeable volume - All volume included in the growth and yield projections for the selected management prescriptions used to arrive at the allowable sale quantity, based on regional utilization standards. Consistent with the definition of timber production, planned production of fuelwood is not included in the allowable sale quantity and therefore is nonchargeable.

Base sale schedule - A timber sale schedule formulated on the basis that the quantity of timber planned for sale and harvest for any future decade is equal to or greater than the planned sale and harvest for the preceding decade and that this planned sale and harvest for any decade is not greater than the *long-term sustained-yield capacity.* This definition expresses the *principle of non-declining flow*.

Long-term sustained yield capacity (LTSYC) - The highest uniform wood yield from lands being managed for *timber production* that may be sustained, under specified management intensity, consistent with multiple-use objectives.

Non-declining flow - is defined in the regulations by the statement "see base sale schedule."

Sale schedule is further defined as "the quantity of timber planned for sale by time period from the area of suitable land covered by a forest plan. The first period, usually a decade, of the selected sale schedule provides the allowable sale quantity. Future periods are shown to establish that long-term sustained yield will be achieved and maintained. For timber resource planning purposes, consider the sale schedule and allowable sale quantity to be synonymous for all periods or decades over the planning horizon."

Departure - A sale schedule that deviates from the *principle of non-declining flow* by exhibiting a planned decrease in the sale schedule at any time during the planning horizon. A departure is characterized by a temporary increase, usually in the beginning decade(s) of the planning horizon, over the base sale schedule originally established. This increase does not impair the future attainment of the *long-term sustained yield capacity*.

Also see report Appendices A2 and F for more explanation of how these terms and other directives are pertinent to this analysis.

Methodology and Analysis Process

Beyond this section, brief disclosure of analysis data and methodology are also provided where appropriate in the affected environment and environmental consequences sections, to assist the reader with concepts and conclusions discussed therein. Several appendices were created to help describe and demonstrate methods of analysis. Due to the size and nature of the appendices, they are all available in the Plan set of documents as separate electronic files. They are listed at the end of this report as an index, and are referenced throughout this report when needed.

This report examines how the plan alternatives contribute to local communities through the availability of wood and tree products. It provides an estimate of how much land (acreage) is available for timber production, cutting levels (CCF per acre) in relation to long-term sustained yield, and allowable sale quantity (CCF) for the first decade. And finally, it estimates the volumes (CCF) of wood products that could be removed from both lands suitable and not suitable for timber production. CCF of sawtimber/pulpwood/poles, CCF of fuelwood/posts, and tons of biomass (converted to CCF) are the only units of wood volume measure analyzed here for a meaningful basis to compare alternatives.

This report only addresses the effects of managing those potential natural vegetation types, (PNVTs) which currently have trees on them, and were modeled in VDDT with cut volume estimates. These PNVTs are:

- Ponderosa pine forested PNVT (includes both the ponderosa pine bunchgrass and ponderosa pine-Gambel oak types);
- Dry mixed conifer forested PNVT (frequent fire regime mixed conifer forest);
- Wet mixed conifer forest with aspen PNVT (infrequent fire regime mixed conifer forest type);
- Spruce-fir forested PNVT (low elevation spruce-fir mixed forest type);
- Piñon-juniper woodland PNVT (piñon-juniper grass woodland). This type is mostly savanna with some persistent woodland; and
- Great Basin grassland PNVT(which is occupied with tree encroachment).

Existing vegetation classification of forest, woodland, and riparian PNVTs and amounts of VDDT structural states were originally mapped using mid-scale technology in 2005-2006. This classification was reassessed with a 2011 (post-Wallow wildfire) update of mid-scale mapping. This update did not address changes in vegetation structure since 2006 due to recent fuels reduction treatments, prescribed burns, tree planting, and other smaller wildfires outside of the Wallow fire. However, it is assumed that it does generally reflect current forest-wide conditions including the major impacts of the 2002 Rodeo-Chediski and 2011 Wallow wildfires. (See further details in the Vegetation Specialist Report.)

The 1987 forest plan mapped forest and woodlands using the outdated cover type classification, which is based on the visibly dominant tree or plant species at the time of mapping. This analysis uses potential natural vegetation types (PNVTs), which may not be the currently dominant vegetation. For example, what appears to be wet mixed conifer forest (infrequent fire type) may actually be dry mixed conifer (frequent fire type) where shade-tolerant species have become established in the absence of frequent fires. Alternatives B, C, and D are based on a large body of research (see US Forest Service, 2008-ESR; Reynolds et al., 2013; and supporting Vegetation Specialist's analyses and bibliographies) that shows the need to reclassify our lands as PNVTs. These types are based on the concept of what vegetation species should be dominating there if all natural processes and disturbances were functioning normally. Without this concept, determining the correct tree species composition and forest structure is not possible for true ecological restoration. This concept is developed further in Reynolds et al., 2013 with a science-based framework for restoration of southwestern frequent-fire forest types (aka the Ponderosa pine and dry mixed conifer types discussed as PNVTs in this analysis for forest plan revision.) Also see Evans et al., 2011 for further explanation of this concept which is similar to using the LANDFIRE biophysical settings descriptions.

Total forest cover type acres used for alternative A (current plan) were re-calculated to match the PNVT acreages for the action alternatives, in order to provide a fair basis for comparison.

This report relies heavily on results from modeling conducted for this analysis. Two models were used to estimate volumes of wood cut under each alternative: the Vegetation Dynamic Development Tool (VDDT), and the Forest Vegetation Simulator (FVS). FVS gives per-acre averages, while VDDT can handle as many acres as the analysis area contains in any given PNVT. A major limitation of the FVS and VDDT models is that neither one is a spatial model. Both are dynamic, density- and time-dependent, and each reacts in its own way to changes in existing condition parameters as a result of natural growth and disturbances, including management actions. VDDT simulations were run out for fifty years.

This report utilizes and summarizes the VDDT model results to compare estimated cutting volumes produced from various treatments. The VDDT model only addresses vegetation development (structural) states for each PNVT based on various combinations of three structural attributes: predominant tree bole diameter range (seedling/sapling, small, medium, very large); canopy closure (open, closed); and number of canopy layers (single-storied, multi-storied). See Appendix B3 to this report, and the Vegetation Specialist Report for detailed explanation of the VDDT model, most of its limitations, and methodology for its use in forest planning analysis.

To calibrate VDDT for volumes of wood cut by various treatments, as well as calibrations for post-treatment progression to other VDDT structural states in key PNVTs, the FVS model and FVS sub-models were used extensively in 2010-2011 by the USFS Region 3 Timber Calculations Working Group. See White Papers O and A. (Weisz et al., 2012; and Weisz and Vandendriesche, 2014).

Appendices B1 through B5, C, E1, and E2 for this report demonstrate how the VDDT model was calibrated by Region-3 and used by the Apache-Sitgreaves NFs to simulate the different mixtures of prescribed tree cutting, tree planting, and prescribed burning treatments designed to reflect the emphasis of each Apache-Sitgreaves planning alternative for comparative analysis. Silviculture cutting methods and intensities of prescribed burns were modeled in FVS to simulate a range of possible treatments designed to move forests and woodlands toward the desired conditions. (For details of fire simulations conducted in FVS, see Weisz et al., 2012, and the ASNFs Fire Specialist Report.)

Within each alternative, relatively the same mix of cutting methods were modeled in VDDT for suitable and non-suitable forested PNVTs, where cutting can be implemented, because both land classifications have the same vegetative and forested desired conditions. In an attempt to move acres of vegetation structural states toward desired conditions for each PNVT, all cutting methods were examined with respect to how well they can reduce percentages of the landscape currently in surplus of the desired amount for that structural state. Similarly, how well each cutting method can create extra acres of those desired states currently in deficit from the desired percentages was examined (see report Appendix B3 for an example). Regionally-derived structural state transitions from the FVS model provide this information by percentages (see report Appendices B1 and B4). Each alternative model run in VDDT then uses a different mix of those cutting methods to simulate the alternative’s different management emphasis (see report Appendices B2 and B5). Then different acreage mixtures (based on the high and low range of treatment objectives) for various prescribed cutting and prescribed burning treatments were input into the VDDT model (report Appendices C and B5), to approximate just one of several plausible treatment schemes commensurate with the vegetation management emphasis of each alternative.

Product demands (or lack thereof) did not influence methods of cuts used to model alternatives; nor should certain treatments be chosen to implement primarily because they will give the greatest dollar return or the greatest output of timber (NFMA, Sec. 219.27 (a)(12)(b)(3)).

Live green tree total wood volumes cut for restoration treatments by PNVT in each alternative, for decades 1 through 5, were taken directly from VDDT model outputs sorted by industrial species, non-industrial species, size and product classes, measured in CCF, and tons. They were added together for all forested PNVTs in additional spreadsheets. (See Appendices D1 and D2).

Additionally, the total allowable sale quantity (ASQ) volumes from VDDT were adjusted to include conservative average estimates of annual pole permit sales, and of routine small salvage sales that have become a part of the annual forest management program (removals of roadside hazard and developed recreation site hazard trees for public safety, new construction and/or maintenance of power-line clearings, road realignment and right-of-way clearings), as well as more frequent insect outbreaks and increasing numbers of small wildfires occurring in a warmer/dryer climate. They do not include additional salvage volumes resulting from unanticipated large scale wildfire events.

ASQ volume estimates only include chargeable volumes of industrial wood. The ASQ calculation includes restoration green tree cutting volumes from the VDDT model which vary by alternative; plus extra small sales and permits sold for live and/or dead poles and miscellaneous salvage timber which are considered to be a constant addition across all alternatives.

Apache-Sitgreaves NFs average annual dead fuelwood sales sold the public, were added to the live green fuelwood volumes cut in VDDT for restoration treatments, to provide total fuelwood volumes estimates that could be offered.

These total ASQ volumes, as well as total fuelwood and biomass volumes, for Decade 1 (see report Appendix D2) were provided to the economics specialist for further analysis in the SocioEconomic Report.

Also not included in the wood volume estimates are the additional dead tree volumes indirectly created by intentionally using moderate-intensity fire as a tree-thinning tool (both planned and unplanned ignitions). Only volumes of live trees cut in VDDT were modeled for this analysis, with incidental salvage volumes of small wildfire-killed trees added manually from salvage sale cruise records. The VDDT model was not calibrated to provide volumes of fire-killed snags. If salvage volumes of prescribed fire-killed trees were included, then Alternatives B and D might possibly approach Alternative C, for total wood products available to offer, at least in the first few decades. The Regional FVS-FFE prescribed fire model runs do report numbers of tree per acre and size classes killed by the fire intensity/severity. However, FFE does not calculate the wood volumes of those fire-killed trees. If desired, estimates of this extra prescribed fire-created wood volume would require further analysis of the R3 FVS-FFE fire simulation results.

Regional average long-term sustained yield calculations were derived in FVS by Region 3 for plan revision analysis. See report Appendix F (Youtz and Vandedriesche, Sept. 2012); and also see assumptions below.

Wood products resulting from restoration treatments on riparian/broadleaf hardwood and grasslands other than Great Basin PNVTs are not available because they lack adequate tree data to run timber growth and yield models to obtain cutting volumes. Also, a wide range of existing conditions and different restoration treatments may be needed, which vary greatly with respect to conifer trees or other species to be removed to meet the desired conditions for these PNVTs. Thus, estimating volumes requires too much conjecture for reliable comparisons. Any volumes resulting from cuts in these PNVTs would not affect ASQ estimates.

The consequences between using different cutting methods emphasized in the alternatives were also considered, as well as the different emphases on using prescribed fire between the alternatives. Those implementation differences were included in VDDT modeling, and are summarized in Appendices B2, B5, E1 and E2. In general, Alternatives A, B, and C would use a wide variety of mechanical treatment methods to meet ecological needs. Alternative B, within the ponderosa pine type, would emphasize the retention of more large/old trees than Alternative C would; therefore some cutting methods would be limited. Alternative D would retain all large/old trees practically everywhere, so that cutting options under this alternative would be much more limited than those under the other alternatives.

Regional average natural regeneration rates are designed to automatically occur in each VDDT model run, depending on the amounts of appropriate structural states present. Additionally, artificial reforestation efforts were modeled in the VDDT simulations for those structural states that need tree cover replaced as a desired condition. Annual acres of tree planting were assigned commensurate with each alternative's overall management emphasis, and were kept within realistic levels possible according to current workforce and funding capabilities. Successful plantation establishment was assumed.

The annual planned cutting acres input into VDDT in year 1 were found to not always be the same acreage treated internally within the model. This is due to the dynamic nature of this model, which continually is tracking acreage transitions of structural states to acres of other states. Some acres, or portions of acres, may fit a particular cutting prescription at a certain point in time, while others may not. This is realistic in the sense that any given project area will propose to treat a certain number of acres, but the number of acres on which trees are actually cut varies a bit when implemented on the ground.

The total acres of suitable timberlands for each PNVT used in all VDDT model runs do not necessarily match the final acres classified as suitable. This is because VDDT modeling was given higher priority in the analysis schedule than completion of the cost-efficiency step for timberland suitability classification. Therefore, the acres removed from suitability due to cost-inefficiency are included in the total suitable acreage programmed in each VDDT model run. However, this total number turns out to be inconsequential because only the prescribed annual cutting acres on suitable lands were used to provide the resulting volumes and ecological trends provided by VDDT. Likewise, this same modeling inconsistency exists across all alternatives equally, so it makes no difference for the decision-maker in choosing between alternatives.

In the case of this analysis, neither model was used to simulate changes in methods of cut from one treatment entry to the next on the same acre. Treatments can be turned off in VDDT, using the "time-since-disturbance" feature, as was done for single-entry clearcuts done on grasslands and cuts implemented in Alternative D. But in cases where several cutting entries are expected on the same land, like on forested acres in Alternatives A, B, and C, the exact same prescribed cutting method (or prescribed burn severity) input into VDDT to implement for year 1 is repeatedly implemented again every time the same acre is due for another treatment some number of years later.

So a logical sequence of different silvicultural treatments that would normally be prescribed for any piece of ground over time was not modeled in our use of VDDT. For example, if an intermediate thinning cut was input for a certain number of acres in Entry1, that same thinning method and target basal area was replicated in VDDT for those same acres again in each subsequent entry. No future regeneration cut or conversion to the group selection cutting method was possible for those same acres in the model runs.

Alternatives A and C were found to comply with the non-declining even-flow legal requirement by continuing the same treatment strategy each decade as was used in the initial level of VDDT modeling. In the case of alternative B however, the initial VDDT model runs which repeated the same treatment strategy in subsequent decades after this planning period produced ASQ volumes that consistently declined each decade, while staying below the long term sustained yield capacity (LTSYC). Therefore, additional analysis at a more refined level of VDDT modeling revealed that treatment strategy would need to change after the 15-year planning period for alternative B.

In order to sustain a non-declining even flow of ASQ volumes on suitable timberlands in alternative B, additional VDDT modeling revealed that the restoration strategy for decades 2 through 5 (years 16 through 50) would need to do the following: Increase treatment acreages in closed canopy transition vegetation states in the ponderosa pine and dry mixed conifer PNVTs; and shift to using only low-severity prescribed fire as a maintenance tool which just thins the seedling/sapling sizes.

It makes sense to constrain the model this way by targeting more aggressive treatments in the closed-canopy states on suitable timberland acres in decades 2-5, because they will need the most restoration at that point in time. Decade 1 focuses partly on the community forest intermix and wildland urban interface areas, and acres already treated recently. Past/recent treatments and the Rodeo-Chediski/Wallow fires have created more open-canopy acres in these PNVTs. By decade 2 the untreated and more-dense portions of treated/burned areas left dense will need heavier and/or more frequent thinning to open them up. This focus on closed-canopy states is additional rationale for meeting the requirement to keep ASQ non-declining. Further discussions of the modeling methodology adjustments made are addressed in the “Environmental Consequences – LTSYC” and the “Relationship of Short-term Management to Long-term Productivity” sections, where explanations are more logical for the reader.

A few other model constraint scenarios were also studied for alternative B to maintain non-declining ASQ such as: (A) Target cutting all states more heavily/more often in decades 2-5, rather than just targeting the closed-canopy states. (B) Keeping some moderate-severity prescribed burn acres in decades 2-5. Both scenarios resulted in considerably more additional cutting acres needed annually beyond the minimum needed to meet the NFMA law, and possibly beyond the maximum treatment acreage objective set for Alternative B. They also shift the alternative B mix of cutting to burning from about a 50/50 mix, more toward the Alternative C mix of 70% cutting/30% burning which deviates too much from the alternative B management theme (i.e. we didn’t need another alternative that ends up being so similar to an alternative that we’ve already analyzed).

Such a logical treatment sequence shift was not simulated in VDDT for Alternatives A and C. See additional modeling methodology explanations in the following two sections on LTSYC in this report.

Therefore given these various limitations of our VDDT modeling, the results are less reliable when enough decades have passed to expect the next re-entry onto the same acres. That timeframe varies by alternative, but generally occurs at about year 30. Thus, beyond the third decade, this specialist is skeptical about the VDDT model’s reliability with respect to precisely measured outputs. General trends beyond the third decade are still assumed to be reasonably reliable outcomes at the programmatic level.

Assumptions

In the analysis for this resource, the following assumptions have been made:

- All four alternatives share the same desired conditions for the resources of the Apache-Sitgreaves NFs.

- Volumes of wood products potentially available from the Apache-Sitgreaves NFs are considered the by-products of treatments that move vegetation towards desired conditions. Management of all PNVTs would be needed to meet desired conditions.
- The revised plan is intended to be more strategic rather than prescriptive. The cuts and volumes presented in this report are estimates, and are not intended to dictate actual project-level treatment methods. According to the proposed plan objectives, it is assumed that work targets will be driven more by acres treated for restoration, rather than by maximized volume harvests.
- For estimating the consequences of alternatives at the programmatic forest plan level, the assumption has been made that the kinds of resource management activities allowed under the prescriptions will in fact occur to the extent necessary to achieve the goals and objectives of each alternative toward reaching the desired conditions. It is assumed the budgets and workforce needed to implement the specific activities will be available. However, the actual locations, design, and extent of such activities are generally not known at this time. That will be a site-specific (project-by-project) decision. Thus, the discussions here refer to the potential for consequences to occur, realizing that in many cases, these are only estimates.
- Southwestern regional FVS modeling is assumed to be representative of PNVTs on the Apache-Sitgreaves NFs. The ASNFs FIA plots were included in the Region-3 modeling data set.
- The VDDT model results are assumed to be reliable for the existing conditions and resulting conditions at year 15 to represent reasonable estimates for comparison of alternatives for this planning period. Longer-term VDDT results may not be as reliable, due to numerous model limitations.
- Appropriate cutting methods and other forms of treatments to be used are many, and vary by the site-specific objectives and existing condition. Decisions about which treatment methods to use, and on which acres, are project-level determinations that will be made by the project silviculturist after site-level field diagnosis, then working in cooperation with a full interdisciplinary team for NEPA analysis, line officer approval, and implementation.
- At the time of FVS and VDDT modeling done for this analysis, the 1995 Mexican Spotted Owl (MSO) Recovery Plan was in effect (USDI-FWS, 1995) and thus the habitat definitions and criteria for management requirements in the Upper Gila Mountains Recovery Unit were the best available predictors of future forest management compliance needs. It was assumed at the time that the forthcoming First Revision of the MSO Recovery Plan (USDI-FWS, 2012) would be similar with respect to the habitat management requirements in the forested PNVTs of the ASNFs. POST-SCRIPT-2013: Comparison review of both USDI documents indicates that the determinations made in this analysis for classification of suitable timberlands with respect to MSO "Protected" habitat are still valid; and VDDT modeling done to represent percentages of landscapes managed for "Restricted habitat target/threshold conditions" (1995 terminology) is reasonably consistent with the minimum desired conditions for "Recovery nesting/roosting habitat" in mixed conifer forest (2012 terminology).
- Harvest volumes from VDDT model runs reflect cutting intensities and acres which have incorporated the multiple-use objectives of each alternative. Model results include fairly realistic estimates of mixtures of approved vegetation management practices, for at least the first one to two decades. The particular silvicultural systems and cutting methods used in modeling for this analysis do not indicate which treatments would actually be applied at the project-level. A full range of all silvicultural treatment systems and

methods would be available for project-level planning and decision making. See the standard silvicultural vegetation treatment options table provided in report Appendix B1, which is also an appendix in the plan.

- USFS Region 3 FVS modeling indicates that to maintain the desired open-canopy structure on average site conditions, thinning re-entries onto the same forested acres sooner than 30 years after the prior cut typically may not enable tree growth rates adequate to provide an economical harvest. (Youtz and Vandendriesche, 2010, 2012; Weisz, et.al., 2012). Because site productivity is not directly used by the VDDT model for growth rates of structural state transitions, it is assumed that treatments using cuts on suitable timberlands would need to occur at about a 30-year re-entry cutting cycle, on average, to agree with harvest volumes calibrated into VDDT model treatments by regional FVS modeling.
- USFS Region 3 FVS modeling assumed that treatments using cuts to maintain piñon-juniper woodlands would need to occur at about a 50-year cutting cycle, on average due to slower growing species usually located on dryer and poorer sites than suitable timberlands. (Youtz and Vandendriesche, 2010; Weisz, et.al., 2012).
- "Industrial" (ASQ) timber 9+" DBH and pulp 5 to 9" DBH species would include: ponderosa pine, Douglas-fir, white fir, southwestern white pine, blue spruce, Engelmann spruce, corkbark fir, when cut from suitable lands. Although not included as "industrial" products under the provisions of the 1982 planning rule, the < 5" DBH sized materials, including tops and limbs, cut from these trees may be utilized as non-ASQ biomass.
- "Non-industrial" (non-ASQ) species include all sizes of: aspen, all junipers, all piñon pines, Chihuahua pine, all oaks cut from any lands; and any "industrial" species when cut from non-suitable timberlands. Wood cut from this category may be utilized as fuelwood and/or biomass.
- Markets would exist for all cut materials. At least 5 percent of cut materials may remain on the ground as broken logs and limbs, and/or debris left for soil stability, productivity, and wildlife needs. About 95 percent of the cut materials would be offered for removal from the site. The adjusted removal volumes constitute the amounts provided for the Economics Specialist Report analysis, as actual product volumes that could be made available for the local economy.
- Whatever future levels of increasing public and small market demands might be for fuelwood and incidental miscellaneous permits and small salvage sales of sawlogs/posts/poles/novelty woods/pulp volumes, they are assumed to be relatively similar for all alternatives. Current sale volumes (averaged TIM records for the 6 year period of 2005 to 2010) of timber salvage, fuelwood, poles and posts contribute to the local economy in measurable amounts and are itemized in the SocioEconomic specialist report (see Appendix D2 of this report, and the Plan set of documents).
- Increasing public and small market demands for fuelwood and small salvage sales of sawlogs, posts, poles, and/or pulp volumes would be similar under all alternatives. Incidental tree products like Christmas trees, wildings, seed cones, novelty woods, and other miscellaneous items would continue to be made available to meet public demand, and would be constant across all alternatives.
- In order to meet desired conditions, some form of management would be needed to meet desired conditions, regardless of whether lands are classified as suitable timberlands or not. Timber harvesting, salvage sales, and tree cutting may be conducted on non-suitable timberlands as needed to move those lands toward desired conditions for multiple resource objectives. The National Forest Management Act (NFMA) Section 6. (k) states (bold emphasis added):

- *In developing land management plans pursuant to this Act, the Secretary shall identify lands within the management area which are not suited for timber production, considering physical, economic, and other pertinent factors to the extent feasible, as determined by the Secretary, and shall assure that,* ***except for salvage sales or sales necessitated to protect other multiple-use values****, no timber harvesting shall occur on such lands for a period of 10 years.* ***Lands once identified as unsuitable for timber production shall continue to be treated for reforestation purposes, particularly with regard to the protection of other multiple-use values.***

- Long-term sustained yield capacity (LTSYC) calculations include Region 3 FVS modeling that simulates treatments to move toward desired conditions. It uses data with the currently available tree growth and mortality rates, and incorporates maximum size limits of openings (in the group selection method), and minimum utilization standards with Region 3 average defects, into the determination of the annual sustained yield volume available to cut on a non-declining even-flow basis from suitable timberlands. These regional results are assumed adequate for the Apache-Sitgreaves NFs to establish a base sale offering schedule, using the projected future regulated inventory volume that could establish perpetual timber harvest.
- Numerous assumptions were made in the USFS Region 3 FVS Timber Calculations Modeling process to calibrate VDDT for cutting volumes and post-cut vegetation structural destination states. All methodology, assumptions, and rationale are documented in the Region 3 Timber Calculations Working Group series of White Papers - see White Papers A and O for an overview (Weisz et al., 2012; and Weisz and Vandendriesche, 2014). Some methodology is summarized in appendices of this report to assist the reader with understanding the basic procedural assumptions, silvicultural rationale, and modeling shortcomings (weaknesses/inconsistencies) of merging FVS model results into the VDDT modeling approaches used. For more detailed explanation of the VDDT model (including limitations), see the Vegetation Specialist Report.
- The allowable sale quantity (ASQ) cutting volume displayed by alternative would establish the sale offering schedule, as the average cut planned annually from suitable timberlands in the first decade.
- Because prescribed fire is now proposed in the action alternatives as a silvicultural thinning tool to intentionally kill trees of various sizes, it is addressed in this report. It is assumed that such use of fire would affect available amounts of green wood and dead wood harvest volumes and market values.
- Low severity fire (both planned and unplanned ignitions) on suitable timberlands would be used to reduce ground fuels and remove slash, and it would be used to maintain or move towards desired conditions (i.e., the age class distributions desired for uneven-aged structure, regulated forest, and sustained volume yields).
- The use of fire (e.g., moderate and high severity burns, planned and unplanned ignitions) as a thinning tool on suitable timberlands may occur when necessary to meet resource objectives. Moderate and/or high severity fire may not achieve the age class distributions desired for uneven-aged structure, regulated forest, and sustained volume yields.
- Due to fire's unpredictable nature under moderate burning conditions, it is assumed that moderate severity fire used for thinning trees over 5 inches diameter has far less control and assurance than tree cutting to achieve precise age class distributions for creating uneven-aged structure, regulated forest, and sustained volume yields.
- Due to fire's unpredictable nature under low burning conditions, it is assumed that low severity fire used for thinning reforestation (seedlings/sapling size class under 5"

diameter) has less control and assurance than tree cutting to achieve precise tree stocking levels for creating uneven-aged structure, regulated forest, and sustained volume yields.

- Prescribed fire as a silvicultural tool will only be used under carefully prepared burn prescriptions developed by USFS certified fire/fuels specialists working in cooperation with USFS Region-3 certified Silviculturists (Bartuska and Croft 2001; Rasure and Harbor 2011); and fire would only be applied when the burning conditions fit the prescription to meet site-specific burn objectives toward meeting land management plan desired conditions.
- Because acres of topsoil loss and/or reduced site productivity due to recent uncharacteristic severe wildfire and subsequent erosion are not yet known, all lands classified as suitable for timber production remain in the suitable timberland base for this analysis.
- Currently deforested acres would not need thinning during this planning period.
- Funding will be available to collect needed amounts of green tree seed and to plant acres proposed for artificial reforestation.

Revision Topics Addressed in this Analysis

This report analyzes consequences of the alternatives for the listed revision topic and issues, using the following indicators and units of measure for a meaningful basis to compare alternatives:

Revision Topic 3: Community-Forest Interaction

Issue: Contribution to Local Communities

1. Suitable Timberlands and Allowable Sale Quantity
    - Lands suitable for timber harvest (in Acres)
    - Allowable sale quantity (ASQ) of timber (in CCF/Year)
    - Long-term sustained yield capacity (LTSYC, in CCF/Acre)

2. Potentially Available Wood Products From Suitable and Non-suitable Timberlands
    - Timber cut volumes (in CCF)
    - Fuelwood cut volumes (in CCF)
    - Biomass cut volumes (both in Tons and converted to CCF)
    - Total woody products (all in CCF)

Summary of Alternatives

A summary of alternatives, including the key differences among alternatives, is outlined in the Environmental Impact Statement, Chapter 2. Relative proportions of treatment methods modeled according to the emphasis and management approach of each alternative are shown in this report's Appendices B2, B5, C, E1, and E2.

Affected Environment

This section describes existing conditions. Of the total national forest land area managed by the Apache-Sitgreaves, approximately 945,753 acres (47%) are classified as vegetation PNVTs in which coniferous tree species should dominate. Riparian hardwood deciduous forest, woody shrub types, and most grassland PNVTs are addressed in the Riparian and Vegetation Specialist reports. The great basin grassland is only addressed in this report because so many acres are encroached with trees that need mechanical reduction (fire alone will not accomplish this objective).

Table 1. PNVTs and Acreages addressed in this report.

PNVT	Total GIS Acres	Approximate Percent of Coniferous Forest PNVT Acres
Ponderos pine (about 30% has Gambel oak as a co-dominant species)	602,206	63%
Dry Mixed Conifer (frequent fire type)	147,885	16 %
Wet Mixed Conifer with Aspen (infrequent fire type)	177,995	19 %
Mixed Spruce–Fir (low elevation mixed species type)	17,667	2 %
Pinyon-Juniper (Grassland savanna and persistent woodland)	222,166	NA
Great Basin grassland	185,523	NA

Past forest growth and mortality, previous active and passive management, and disturbance patterns have produced the current forest tree species composition, sizes, densities, and conditions, which affect the species and volumes of wood and other tree products available for cutting treatments now and in the future.

Across the Apache-Sitgreaves NFs, the annual net and gross forest growth have has far exceeded cutting levels. Rogers (2003) and O'Brien (2002) both illustrate this condition with Forest Inventory Analysis (FIA) plots. Rogers shows that annual gross growth in Apache-Sigreaves NFs ponderosa pine non-reserved lands has been as much as 12 times the annual mortality. For local Douglas-fir stands, growth has exceeded mortality by at least 8 times. O'Brien shows that mortality and cutting levels combined are far below gross growth rates for trees inventoried in Arizona national forests non-reserved timberlands. In other words, cutting rates have been far less than net growth rates (please see Glossary).

In the past 30 years, an average of about 720 cubic feet (CF) of volume per acre has generally been added as surplus net growth, in addition to the desired sustainable volume. This surplus needs to be removed each entry to maintain desired conditions. Every three decades that pass without treatment, a backlog of overgrowth continues to be added. On the Apache-Sitgreaves NFs, several acres of suitable forest land have not been thinned in over 40 to 50 years, leaving a current surplus of over 1,000 CF on some acres. Acres which have this backlog suffer from conditions which contribute to the departure from desired conditions. These areas are at risk of accelerated stand mortality due to intense tree competition, weakened tree vigor, disease intensification and spread, epidemic insect attacks, and/or uncharacteristic wildfire.

This forest growth has outpaced all mortality (including natural mortality and by cutting) for many years, resulting in an extreme imbalance, which is not sustainable. Normal disturbance regimes which used to act as natural thinning agents have been altered (primarily characteristic wildfire), giving rise to overgrown conditions. Abnormal disturbances (like uncharacteristic wildfire and unprecedented insect/disease outbreaks) have produced undesirable stand-replacement conditions across large areas (US Forest Service, Dec.2008-ESR; Lynch et al., 2010) Noticeable (non-fire) losses of large/old trees have been seen recently in all forested PNVTs

(Boehning, 1982-2014 professional field observations validated with FIA plot data, see report Appendix H), especially due to competition in overgrown stands. Overgrowth increases competition among trees for nutrients, water, and growing space, which in turn reduces individual tree and forest stand growth, vigor, and the ability to endure bark beetle attacks and drought years (Korb et.al., 2012; Covington et al. 1997; Friederici, 2006b).

Two very different existing condition categories now occur across the forested PNVTs of the Apache-Sitgreaves NFs (see below and table 2):

- **Forested/Overgrown[1] -** Approximately 71 percent of the current forested types have tree stocking and growth levels which require some degree of tree thinning to restore and/or maintain desired conditions. Without additional severe disturbances accelerating immediate and complete tree mortality, these areas can contribute industrial cutting volumes in the first decade and beyond.
- **Deforested/Early Development -** Conversely, an average of about 29 percent of the current forest type vegetation structural states are now temporarily in deforested[2] states (22 percent) or early developmental[3] states (7 percent) that require reforestation and growth for restoration to desired conditions. This condition is primarily attributed to the 2011 Wallow Fire, the 2002 Rodeo-Chediski Fire, and other fires that caused tree mortality that exceeded or eliminated net growth. These areas cannot provide industrial cutting volumes in the next one to three decades.

Footnotes:

[1] "Forested/Overgrown" acres are all remaining structural states not identified as deforested/early development acres.

[2] "Deforested acres" are those in excess of desired condition percentages for the following PNVTs: Ponderosa pine and dry mixed conifer structural states A and N; wet mixed conifer and spruce-fir structural states A and K.

[3] "Early developmental" acres are those in the seedling/sapling (<5" diameter) structural states, which for some forest type PNVTs also include the small size class (5-9" diameter).

Table 2. Acres and percent by forest type PNVT in forested/overgrown or deforested/early development condition

Forest Type (PNVT)	Forested/Overgrown Acres (Percent)	Deforested/Early Development Acres (Percent)
Ponderosa Pine	475,743 (79%)	126,463 (21%)
Dry Mixed Conifer	100,562 (68%)	47,323 (32%)
Wet Mixed Conifer	89,005 (50%)	88,998 (50%)
Spruce-Fir	8,127 (46%)	9,540 (54%)
TOTAL	**673,437 (71%)**	**272,316 (29%)**

On the forested/overgrown lands, net growth is expected to outpace natural (non-fire) mortality, such that regular thinning (prescribed cutting and/or burning) will be necessary to reduce overgrowth, develop desired uneven-aged forest structure, and/or prevent growth stagnation and movement away from desired conditions. Where moderate-severity fire has occurred on these lands, natural mortality levels are expected to continue to remain high for approximately the next six years, due to fire-related tree stress, sudden exposure to weather extremes, weakened roots, greater exposure to lightning and/or prevailing winds, and greater susceptibility to insect/disease attack. Once surviving trees have stabilized, they are expected to again need thinning for maintenance of desired forested conditions.

For now, deforested lands remain in the suitable timberland base; but without natural regeneration or artificial reforestation, they may not return to timber productivity for many years. Limestone soils are common across the Sitgreaves NF, while basalt soils are more common on the Apache NF (ASNFs TES, Laing et al.,1987). Natural conifer regeneration rates and numbers on limestone soils across northern Arizona are known to survive better than on basalt soils (Puhlick et al. 2012, Richardson 2012; Boehning, 1982-2014). Natural aspen root-sucker regeneration occurs quickly after fire events where aspen roots exist in good health. Natural aspen seedling establishment can also occur in burned areas where aspen roots do not pre-exist. Successful establishment and long-term survival of aspen regeneration will mostly depend on the amount of domestic and wild ungulate herbivory damage that occurs within the first 2-6 years post-burn (Shepperd and Fairweather, 1994; Rogers, 2008 and 2011; Lynch et al, 2010).

A large portion of the natural regeneration acres, especially in the wet mixed conifer and spruce-fir PNVTs, now have prolific aspen root-sucker regeneration occurring in response to fire stimulation. Those young, aspen-dominated acres will temporarily provide no industrial harvest volumes until suitable conifer regeneration becomes established and grows to commercial size. New aspen stands which survive to maturity may begin to provide some fuelwood or biomass products in about 20+ years.

However, a portion of those acres in need of reforestation may not return to a productive forested condition. A body of research in the southwestern ponderosa pine forest type has shown that, on average, approximately 50% of severely burned acres tend to convert to grass/forb/shrub/rock lands that can take a very long time to return to forest, possibly centuries, if ever (Roccaforte et al., 2012; ERI, 2011; Savage and Mast, 2005; Strom and Fule, 2007). Artificial reforestation is needed to reduce that percentage (Higgins, 2008; ERI, 2012b). This tendency is noted for mixed conifer by Jones, 1974. Climax spruce-fir and upper elevation (wet) mixed conifer forests have been documented as also undergoing very long-term type conversions to grass/forb/shrubland following severe fire (Alexander 1974).

Thus, the deforested lands (approximately 203,378 acres) can be further divided into three categories:

- Lands which can be expected to successfully regenerate native tree species naturally (estimated at approximately 54 percent or 110,629 acres) at low management cost. This is approximately 12 percent of all forest type PNVT acres.

- Lands which would need artificial tree planting to restore forest cover (estimated at approximately 19 percent or 37,695 acres) at high management cost. This is approximately 4 percent of all forest type PNVT acre.

- Lands which are likely to undergo site conversions to long-term grass/forb/shrub/rock cover rather than return to tree cover (estimated at approximately 27 percent or 55,054 acres) at the expense of lost forest/timber production acres. This is approximately 6 percent of all forest type PNVT acres. Artificial tree planting can help mitigate this condition by accelerating post-fire succession back to desired tree cover.

Newly established conifer stands (both natural and planted) will require regular thinning entries once they are past the seedling state, to promote tree vigor and facilitate maximum growth for faster return to desired forest conditions.

Lands Tentatively Suitable for Timber Production

Timber production is defined as the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees for cutting into logs, bolts, or other round sections for industrial or consumer use. Timber production does not include fuelwood or products harvested from unsuitable lands. Suitable timberland does not dictate tree cutting. It means that all cutting treatments done on suitable lands would be subject to the annual ASQ volume as a control to prevent over-cutting.

Lands are identified as suitable or not suitable for timber production (referred to as suitable and non-suitable timberlands) during the plan revision process. Appendix A2 of this report details the steps used in the suitability determination. The first step of the suitability determination is to identify those lands that are tentatively suitable for timber production.

Table 3 displays the criteria used to identify lands as tentatively suitable timberlands. The Apache-Sitgreaves NFs have approximately 808,368 acres considered tentatively suitable. Suitable timberland does not dictate tree cutting. It means that all cutting treatments done on suitable lands would be limited by the ASQ volume (see following section on Allowable Sale Quantity).

Table 3. Criteria used to determine tentatively suitable timberlands in all alternatives

Criteria	Acres	Total Acres
TOTAL Apache-Sitgreaves NFs		**2,110,196**
Non-NFS Land	94,844	
Total NFS Lands		**2,015,352**
Non-forest Lands		**1,039,258**
Areas not defined as forest land[1]	4,250	
quarry, urban/agriculture, water		
Grasslands	344,033	
Great Basin, montane/subalpine, semi-desert		
Woodlands	617,094	
Madrean pine-oak, piñon-Juniper		
Interior chaparral	55,981	
Wetland/cienega	17,900	
Forested lands withdrawn from timber production[2]		**87,190**
Designated Wilderness	20,628	
Bear Wallow, Escudilla, Mount Baldy		

Criteria	Acres	Total Acres
Blue Range Primitive Area	43,258	
Research Natural Area	219	
Eligible or suitable wild and scenic river corridors or areas classified as wild	23,085	
Irreversible resource damage likely		**23,952**
Unsuited/unstable soils (sensitive and unstable)	23,952	
Inadequate restocking		**56,584**
Low reforestation potential based on soil properties	56,584	
LANDS Tentatively Suitable for Timber Production		**808,368**[3]

[1]Forest land is defined as having greater that 10 percent overstory canopy cover at stand maturity
[2] Some categories overlap areas already withdrawn in non-forest lands
[3] The tentatively suitable lands in alternative A equal 807,289 acres. There are more acres in research natural area (1,882 acres)

The above table reflects the same step 1 common to all action alternatives.

Acres of "unsuited/unstable soils" and "low reforestation potential" were derived from the Apache-Sitgreaves NFs Terrestrial Ecosystem Survey as "inadequate for restocking". They were not modified after the 2011 Wallow Fire, because the Forest Soil Scientist believes it is too early (less than 5-10 years post-burn) to determine accurate estimates of soil productivity losses due to fire consumption of the organic layers and/or subsequent erosion of topsoil. The fire area soils, watersheds, and ground cover have not yet stabilized post-burn. This is a site-specific determination that will need to be made at the project-level and based on soils monitoring over time. Any estimates made of possible site conversion from forested PNVTs to grass/rock/shrubland in the Forest Products Specialist report for this analysis are purely estimates based on a search of relevant literature, which will also require on-site monitoring for local validation.

Adjustments to the suitable timberland acreage within the Wallow Fire and other high-severity fire areas may be appropriate in the next 10 years during the scheduled review and update of the forest suitability classification process, with input from soils monitoring efforts.

Allowable Sale Quantity (ASQ)

The allowable sale quantity volume control concept enacted by law (National Forest Management Act of 1976) was intended to prevent excessive tree losses due to over-cutting beyond sustainable forest levels on suitable timberlands. The ASQ is the quantity of timber that may be sold from suitable timberland within the Apache-Sitgreaves NFs for a time period specified by the plan. ASQ volume is expressed as the average annual allowable sale quantity. For timber resource planning purposes, the allowable sale quantity applies to each decade during the planning horizon period and includes only chargeable volume. ASQ volume does not include fuelwood or other nonindustrial wood.

ASQ volume estimates only include chargeable volumes[1] of industrial wood[2]. The ASQ calculation includes estimated green tree cutting volumes from the VDDT model which vary by alternative; extra small sales and permits sold for live and/or dead poles; and miscellaneous salvage timber. Small sales, permits, and miscellaneous salvage are considered to be a constant addition across all alternatives.

ASQ and a timber base sale schedule were published with the original 1987 forest plan, along with the timber suitability determination. They were specific and prescriptive. The original ASQ volume of 119 million board feet (MMBF) was subsequently reduced to an interim ASQ of 99 MMBF (198,000 CCF[3]) of sawtimber per year in response to a plan settlement agreement and through forest plan amendment one. That ASQ and related sale offering schedule were never modified again after plan amendment number 4, issued in 1991. During that reanalysis of the ASQ for the settlement agreement, the Forest Silviculturist documented additional ecosystem management concerns beyond the ASQ debate at that time (Shafer, 1993). His concerns are still valid today.

The ASQ volume for alternative A has been recalculated in this analysis for consistency across all alternatives, and is based on current vegetation conditions.

During the planning period (next 15 years) on-going monitoring would evaluate cutting levels compared to the ASQ. According to law and policy, the suitable timberland classification would be updated as conditions and/or management emphasis/strategies change.

Long-Term Sustained-Yield Capacity (LTSYC)

Long-term sustained yield (LTSY) is the calculated annual volume of wood per acre that can be harvested from suitable timberlands, which does not exceed annual net growth volume per acre after desired conditions have been met for multiple resource objectives. LTSY multiplied by the total suitable timberland acreage derives the long-term sustained-yield capacity (LTSYC). This concept is one means of measuring forest sustainability, consistent with ecological desired conditions as well as sustainable harvest volumes for society.

On a per-acre basis, the true problem today on many forested acres in fact is not over-cutting, but rather a backlog of overgrowth that has consistently been undercut annually. In a regulated forest, annual cut equals annual net growth, such that the entire forest never becomes completely overgrown or stagnant for very long. Historically, regular fire intervals were one of nature’s methods for removing excess growth. On suitable timberlands, management actions like tree cutting and fire-use may be used to achieve the same purpose.

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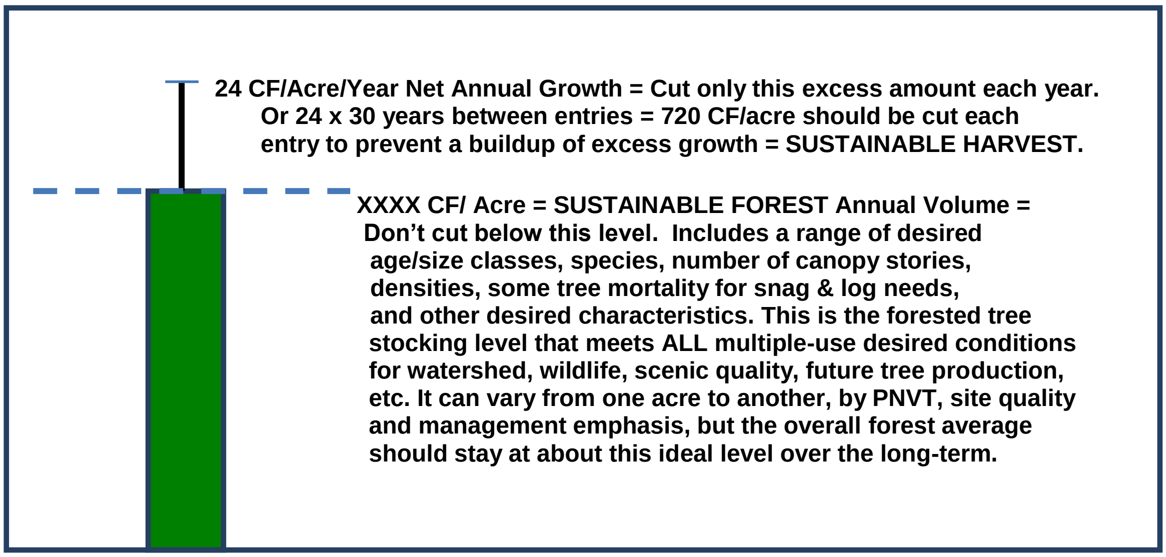
[1] Chargeable volume of industrial wood is from tree species that are saleable as sawtimber logs, pulpwood bolts, poles, or other roundwood sections (excluding fuelwood) based on regional utilization standards and cut from suitable timberlands.

[2] Industrial timber species (5 inches and greater) include ponderosa pine, Douglas-fir, white fir, southwestern white pine, blue spruce, Engelmann spruce, and corkbark fir.

[3] CCF = one hundred cubic feet.

From Youtz and Vandendriesche's September 2012 regional work, an average of 24 cubic feet (CF) per acre per year is used to represent the net growth across all acres of forested PNVTs on the ASNFs that are suitable for timber production. This net per-acre average accounts for annual gross growth after annual mortality is deducted, based on regional average growth and mortality rates calibrated in the Forest Vegetation Simulator (FVS) model. The following simplified figure (not drawn to any scale) conceptually demonstrates this problem.

Figure 1. Conceptual diagram of ideal cutting level for a sustainable forest and sustainable harvests (i.e. "regulated forest")



Because uneven-aged forest structure is an important part of the ecological desired conditions, Youtz and Vandendreische (2012) emphasized it in their modeling to determine regional average CF per-acre-per-year LTSY values for timber-producing PNVTs. Their LTSYC analyses which used the 6-age group 30-yr. cutting cycle prescription for ponderosa pine, dry and wet mixed conifer is the only one of their silviculture scenarios that was used by the Southwestern Region to also model FVS Group Selection cuts for calibrating uneven-aged cutting volumes in the VDDT model. Therefore, the values used in this report's analysis are taken from their 30-year cutting cycle scenarios, and it is assumed here that a return cutting entry of about 30 years is needed on average under the Group Selection system for uneven-aged management to maintain a regulated sustainable forest for desired conditions (Youtz and Vandendriesche, 2010).

A weighted average long-term sustained yield (LTSY) has been calculated as 24 cubic feet (CF) per acre per year for all Apache-Sitgreaves NFs forested PNVTs in suitable timberlands based on current regional data (see Youtz and Vandendriesche, 2012 in report Appendix F). This is slightly higher than the 20 CF per acre per year capacity identified in the 1987 plan. This preliminary LTSY was one criterion used in the determination of tentatively suitable timberlands, based on local soil productivity ratings (see report Appendix A2).

For simplification of analysis, the long-term sustained yield of 24 cubic feet per acre per year used is a rounded, weighted average value for all suitable timberlands, using the regional model run results for each PNVT, based on the proportional acres of each forested PNVT present on the Apache–Sitgreaves NFs suitable land base. Only the Southwestern Region's high-site model run for the ponderosa pine/grass type was used in this calculation, because soils not capable of producing at least 20 cubic feet/acre/year (approximately site index of 70 or greater) were eliminated from the tentatively suitable land base with the Apache-Sitgreaves NFs' soils assessment (see report Appendix A2). Because acres of suitable timberland vary by PNVT, a weighted average was used to verify the correct average to be used for all analyses of all PNVTs combined. Table 4 below shows how this average was derived mathematically.

Table 4. Average LTSY calculation for all suitable timberland PNVTs on the Apache-Sitgreaves NFs by alternative

PNVT	Suitable Acres in Alternative A[3]	LTSY in cubic feet/acre/year[1]	Multiplication Product
Ponderosa pine[2]	503,412	23.6	11,880,523
Dry Mixed Conifer	108,208	22.9	2,477,963
Wet Mixed Conifer	148,072	24.7	3,657,378
Spruce-Fir	5,180	0	0
Totals	764,872	71.2	18,015,864
Alternative A Weighted Average: 18,015,864 / 764,872= 23.6, rounded to **24 cubic feet/acre/year**			
PNVT	**Suitable Acres in Alternative B[3]**	**LTSY in cubic feet/acre/year[1]**	**Multiplication Product**
Ponderosa pine[2]	445,440	23.6	10,512,384
Dry Mixed Conifer	65,086	22.9	1,490,469
Wet Mixed Conifer	86,217	24.7	2,129,560
Spruce-Fir	0	0	0
Totals	596,743	71.2	14,132,413
Alternative B Weighted Average: 14,132,413 / 596,743 = 23.7, rounded to **24 cubic feet/acre/year**			
PNVT	**Suitable Acres in Alternative C[3]**	**LTSY in cubic feet/acre/year[1]**	**Multiplication Product**
Ponderosa pine[2]	451,179	23.6	10,647,824
Dry Mixed Conifer	65,778	22.9	1,506,316
Wet Mixed Conifer	87,789	24.7	2,168,388
Spruce-Fir	0	0	0
Totals	604,746	71.2	14,322,528
Alternative C Weighted Average: 14,322,528 / 604,746 = 23.7, rounded to **24 cubic feet/acre/year**			
[1] From Youtz and Vandendriesche, 2012. [2] Only the regional ponderosa pine/grass type high site index LTSY model result was used. [3] See Forest Products Specialist Report Appendix A-2 for additional information.			

Because this net growth average of 24 cubic feet per acre per year does not vary by alternative, it was used in all LYSTC calculations for all alternatives. This LTSYC level becomes a baseline for comparison of estimated short-term wood product cutting levels by alternative, as presented later in this report.

LTSY multiplied by the total suitable timberland acreage derives the long-term sustained-yield capacity (LTSYC). This concept is one means of measuring forest sustainability, consistent with ecological desired conditions. Ideally, ASQ volume should equal or fall just short of the LTSYC once desired conditions are met. After desired conditions are achieved, management on suitable timberlands would need to be consistent with the LTSYC level (no cutting departure above the LTSYC); annual cutting levels would not exceed annual net growth rates. On suitable timberland acres, the LTSYC is a way to further incorporate the social and economic desired condition of providing a long-term, dependable source of wood products, while maintaining desired multiple-use objectives.

So after every 30 years of net growth 720 CF of volume is added which needs to be removed each entry. Every entry that passes by untreated continues to add to a backlog of overgrowth. On the ASNFs, several acres of forestland have not been thinned in over 40-50 years (personal knowledge and district records), leaving an excess backlog of over 1,000 CF on some acres. Acres which have this backlog suffer from conditions that contribute to an ecological imbalance which must be corrected. If accelerated cutting is not done to correct that imbalance, then nature will correct it by means of extreme stand mortality due to weakened tree vigor, disease intensification and spread, epidemic insect attacks, and/or uncharacteristic wildfire. This understanding of overgrowth backlog applies to both suitable and non-suitable timberlands, although LTSYC and forest regulation are only formally applied to suitable timberlands.

Moreover, to comply with legal requirements of the National Forest Management Act (NFMA) and Multiple Use Sustained Yield Act (MUSYA), long-term sustained yield also means that ASQ volumes harvested from suitable timberlands cannot decline from one decade to the next. More explanation of the non-declining ASQ concept is presented later in the Environmental Effects section of this report.

Wood and Tree Products Availability

Wood products can be provided from both suitable and non-suitable timberlands. The most common wood products (e.g., industrial[4] and non-industrial[5], live and dead wood) on the Apache-Sitgreaves NFs include sales and permits for:

- Ponderosa pine, Douglas-fir, southwestern white pine, white fir, blue spruce, Engelmann spruce, and corkbark fir
    - Sawtimber and house logs (9 inches or greater diameter)
    - Pulpwood or Roundwood (5 to 8.9 inch diameter)
    - Poles, posts, vigas, latillas, rails
    - Laminated beams
    - Paneling and trim moulding
    - Fuelwood
    - Biomass (chips)
    - Furniture
- Piñon pine and all juniper species
    - Poles, posts, vigas, latillas, rails
    - Fuelwood
    - Biomass
    - Furniture and novelty wood
- Aspen, Gambel-oak, and other oak species
    - Fuelwood

[4] The less than 5 inch diameter size materials, including tops and limbs from timber species may be utilized as non-ASQ biomass.

[5] Non-industrial (non-ASQ) species include aspen, junipers, piñon pines, Chihuahua pine, oaks, and any industrial species cut from non-suitable timberlands. Wood cut as non-industrial may be used as fuelwood and/or biomass.

- Furniture and novelty wood
- Poles, posts, rails
- Interior paneling
- Evaporative cooler pad excelsior
- Livestock bedding

Major non-wood tree products of various species have also been made available for the following other uses: Christmas trees, live seedling/wilding transplants, green seed cones for nurseries, green holiday decorative boughs and wreaths, and piñon nuts. Ceremonial wood, tee-pee poles, and other native American items have also been provided only to tribal members by special request.

Within the life of the 1987 plan, annual harvest volumes have varied from 5,000 to 100,000 thousand board feet (MBF) with annual treatment acreages ranging from 2,500 to 30,000 with an average of 9,400 acres (US Forest Service, Dec. 2008-CER). Harvest volumes have stayed under the original 1987 plan ASQ of 119,000 MBF (or 119 MMBF). The 100,000 MBF maximum harvest level achieved converts to 200,000 CCF. Annual acreages treated under the White Mountain Stewardship project (2004 to present) are slightly more than the prior average at approximately 12,182 acres used to represent the current trend under the existing land management plan (Drury, February 2012).

A brief summary of vegetation management pertaining to past cutting practices follows.

With the implementation of the 1987 plan, vegetation management of forest types emphasized even-aged cutting methods: seed cuts, final overstory removals, intermediate thinnings, and a few clearcuts/seedling plantations. Sanitation/salvage cuts have also been used. The concept of "integrated stand management" promoted the policy to leave numerous timber stands untreated as "deferrals" intermixed between treated stands across all projects for creating diversity, and leaving dense key wildlife habitat and un-thinned old growth. Most vegetation management was accomplished through timber sales that focused on cutting trees over 9 inch diameter (or over 12 inch diameter in some cases). Multi-product sales (sales which offer both sawtimber and pulp sizes) targeted trees in the 5- to 9-inch class as well as larger trees, but the lack of markets for the smaller size resulted in many projects not being completed (defaulted sales).

When the 1987 plan was amended in 1996 to specifically address management for Mexican spotted owl, Northern goshawk, and old growth, it initiated direction to emphasize uneven-aged cutting methods (e.g., group selection, individual tree selection). But implementation was met with varying degrees of success, due to various factors. Only thinning of marketable size trees (usually 9 inch diameter and larger) was successfully implemented. Thus many acres became further over-grown with trees under 9 inch diameter which can act as understory ladder fuels.

Uncharacteristic wildfires in the early 2000s highlighted the need for fuels reduction projects. Treatment of all vegetation types, regardless of timberland suitability, became a priority near communities, private lands, and developed recreation areas. The treatment emphasis on removing understory ladder fuels led to the use of a diameter cap (an upper cutting size limit) as the way to focus on removing the over-abundant, small diameter trees.

The Healthy Forests Restoration Act of 2003 fostered the development of community wildfire protection plans that incorporated programmatic and widespread use of diameter caps (limiting cuts to smaller diameter trees) (Logan Simpson Design, 2004a, 2004b, 2005). Meanwhile, the Stewardship End Result Contracting Projects statute (16 U.S.C 2104) opened a new era of cutting small trees to reduce wildfire hazards under 10-year long stewardship service contracts. On the Apache-Sitgreaves NFs, this meant that most wood volume was no longer removed through timber sales. Service contractors were paid in the White Mountain Stewardship Project from 2004 to 2014 to cut and remove the vast majority of resulting wood volume; a government strategy used to reduce fuels near communities until local small-tree markets are established and small tree wood value offsets treatment cost (ERI, 2007; Sitko and Hurteau, 2010).

Major local markets cannot afford the current gasoline and transportation costs to move raw cut materials much over a maximum of 70 miles to their processing plants (Drury, 2011). Raw wood values are so low that very little of the cut volume is sold to purchasers (ERI, 2007). Where haul distances are too far or transportation costs too high, a portion of the cut volume is left on-forest as waste material that must be disposed of at additional cost to the government (Hunt, 2012; Sitko and Hurteau, 2010; Drury, 2011).

Many of the most easily operable, accessible, and shortest haul distance acres have already been thinned with numerous fuels reduction projects. Most wildland urban interface (WUI) areas have already been treated in the past 10 years under contract with White Mountain Stewardship Project using existing approved NEPA decisions. Many of the acres left to be treated during this next 15 year planning period are more difficult ground operationally, and/or have longer haul distances to markets (Drury, 2011).

Black, fire-charred wood has been rejected by some local markets, like pulpwood for paper manufacturing and the wood heating stove pellet industry. Even though other markets like commercial firewood, shipping pallets, lumber sawmills, and bio-electric energy plants will take this material, the majority of fire-salvaged logs and poles have been sold at minimum base rates ($1.00 per CCF for all species). High haul distance costs continue to be the deciding factor for the demand and value of this raw material (Drury, May 2012). Fire-charred wood could tend to stay at a very low market value, even if green wood values improve. The SocioEconomic Specialist Report summarizes more local/regional wood product economic, market, and workforce conditions.

Using even-aged cutting methods and diameter caps has resulted in a longer timeframe to produce uneven-aged forests and woodlands. In areas where even-aged management or removal of small diameter trees have occurred, the next treatment (cutting entry) may be limited to large trees (16 inch and greater diameter) (Triepke et al., 2011). The effects of stand-replacement fire result in essentially even-aged regeneration areas for at least 60 years after new tree establishment. In all cases, subsequent entries could provide variable harvest volumes and product types; while conversion from even-aged to uneven-aged structure proceeds over time.

Although this report focuses on wood products provided for society, proper forest restoration and management provide many equally or more important benefits, such as: improved forest resiliency to survive uncharacteristic wildfires (Waltz et al., 2014; Fiedler et al., 2010) and insect/disease outbreaks; reduced risk of topsoil and site productivity losses; reduced monetary costs of wildfire suppression and post-fire recovery efforts (Combrink et al., 2013; Snider et al., 2006; Donovan and Brown, 2008; ERI, Sept. 2011; Lynch, 2001); homes, infrastructure, and communities saved from wildfire destruction (Bostwick et al., 2011); reduced risk of watershed stability loss and flooding damage; reduced risk of wildlife habitat and old growth losses; continued recreation and visual qualities; possible retention of carbon storage function in sustainable forests (Hurteau et al., 2010; Ryan et al., 2010). No one benefit should be considered independently of the others, as they all contribute to the value of our forests and woodlands.

Environmental Consequences of Alternatives

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions) there can be no direct effects. However, there may be implications, or longer term environmental consequences, of managing the forests under this programmatic framework.

All alternatives would propose various mixtures of three basic vegetation treatments during the 15-year planning period to move toward desired conditions. These include:

- Tree cutting on some forested/overgrown areas, followed by low severity fire to reduce ground fuels and/or thinning-created slash.
- Moderate and/or high severity burning to thin other forested/overgrown areas and reduce ground fuels
- Tree planting on some deforested areas.

All three forms of treatment indirectly impact the amount and availability of sustainable wood products. The number of total annual cutting and burning treatment acreages by alternative (regardless of timber suitability classification) were analyzed in the table below.

Table 5. Annual cutting and burning treatment acres for all PNVTs, suitable and non-suitable timberlands, by alternative

Alternative	High Treatment Acres		Low Treatment Acres		Average Treatment Acres		
	Cutting Treatment	Burning Treatment	Cutting Treatment	Burning Treatment	Cutting Treatment	Burning Treatment	Total Cutting and Burning
A	-	-	-	-	12,182	6,844	19,026
B	30,327	43,771	8,852	14,087	19,591	28,930	48,521
C	42,651	22,586	5,342	3,124	23,997	12,857	36,854
D	25,440	78,772	6,465	19,079	15,954	48,927	64,881

Under any alternative, regular tree cutting on suitable timberlands would be necessary to move the forests toward an uneven-aged (regulated) balance of age classes, and then maintain this condition once it is achieved. It also is very costly. Increasing use of prescribed fire to intentionally kill excess trees is expected to become necessary for treating additional acres as a more cost-effective thinning tool.

The following table displays the relative amounts of prescribed fire severity modeled for each alternative, by PNVT. While these amounts do not in any way dictate that these levels would be used on any given project, they do reveal the general concept for emphasizing more fire as part of the overall restoration activity focus, especially during the planning period. Sources of this data are Appendices E1 and E2 of this report.

Table 6. Annual prescribed burning average objective acres modeled by forest type PNVT (suitable and non-suitable timberlands) and by burn severity, for each alternative

Forest PNVT	Alternative A Burn Severity		Alternative B Burn Severity		Alternative C Burn Severity		Alternative D Burn Severity	
	Low	Moderate &/or High	Low	Moderate &/or High	Low	Moderate &/or High	Low	Moderate &/or High
Ponderosa Pine	2,836	316	2,205	4,095	1,965	3,649	4,438	8,242
Dry Mixed Conifer	720	80	396	1,268	363	1,162	805	2,576
Wet Mixed Conifer	855	1,047	633	1,268	575	1,150	1,273	2,551
Spruce-Fir	90	10	115	231	164	329	185	370
Subtotals :	**4,501**	**1,453**	**3,349**	**6,862**	**3,067**	**6,290**	**6,701**	**13,739**
Totals:	5,954		10,211		9,357		20,440	

Traditionally on the ASNFs, low severity fire has been used successfully as: a slash cleanup and ground fuels reduction tool; site preparation of a mineral seedbed for natural or artificial reforestation; a means to lift the forest canopy; a tool to remove dead herbaceous matter and renew fresh growth; a catalyst in accelerating dead organic matter decomposition into soil-building elements. It will continue to be a useful tool for these purposes. Well-planned, well-timed, and well-controlled moderate to severe fire could be used to "sanitize" (kill or remove) disease/insect-infested tree groups or stands; create forest openings intended for tree regeneration in the group selection method; simulate an aspen coppice cut or conifer clearcut; and control unwanted woody and herbaceous species. See the table in Appendix B "Vegetation Management Practices" section of the proposed plan for silvicultural uses of fire.

Attempting to use fire (and/or other natural tree thinning agents) instead of tree cutting on suitable timberlands would be risky because there is no assurance that such methods would create the regulated forest needed for non-declining even-flow of harvest yields, neither in the short-term nor in the long-term. Much debate exists in forestry science on this matter. A study in southwestern ponderosa pine forest indicates that restoration of that ecosystem might be achievable solely with high and/or moderate severity prescribed fire (Fule et al., 2004).

As of yet, no conclusive textbooks have been written precisely on how to achieve a regulated forest with non-declining even-flow harvest levels by using fire as the primary or sole silvicultural thinning tool. Much literature makes a good case for using prescribed fire <u>after</u> prescribed cutting practices on the <u>same acres</u> (Arno and Fiedler, 2005; Stephens et al., 2009; Schwilk et al., 2009; Cram et al., 2006; Korb et.al., 2012; Friederici, 2006a). For more information on use of prescribed burning and fire-use as the only tree-thinning method, see report Appendix E2, and also the Fire Specialist Report.

Suitable Timberlands

Timberland suitability was determined for each alternative, based on the detailed description of the suitable timberland analysis process and criteria found in report Appendix A2. Acres of suitable timberlands would vary by alternative because the boundaries and acres of management areas differ between alternatives. The next table shows criteria used to identify lands suitable or not suitable for timber production, based on area objectives which limit industrial timber management activities.

Table 7. Lands suitable and not suitable for timber production, by area

Management Area	Timber Production	
	Suitable	Not Suitable
General Forest	X	
Community-Forest Intermix	X	
High Use Developed Recreation Area		X
Energy Corridor		X
Wild Horse Territory	X	
Wildlife Quiet Area	X	
Natural Landscape		X
Recommended Research Natural Area		X
Research Natural Area		X
Primitive Area		X
Recommended Wilderness		X
Wilderness		X
Other Areas		
Areas with soil condition rating of unsuited/inherently unstable		X
Lands not cost efficient in meeting timber production objectives		X
Grasslands, woodlands, interior chaparral, and riparian forests		X
Communication sites		X
Developed recreation and administrative sites		X
Eligible or suitable wild and scenic river corridors		X
MSO protected lands (PACs)		X

Timberland suitability was determined for each alternative. The original 1987 plan suitability classification did not clearly follow the same criteria and classification as outlined below. For a basis of comparison across all alternatives, **alternative A** was recalculated using the same process and PNVT concept as the **action alternatives**. In addition to these criteria, other considerations (e.g., timber production cost efficiency using the analysis process designed by Connelly 2009a and Connelly 2009b) were used to further eliminate acres from suitability classification (see report Appendices A3 and A3Roads, and supporting maps and worksheets on file in the Plan Set of Documents.)

Results of the suitability determinations are provided in the following table. **Alternative A** would have the most acres suitable for timber production, followed by **alternatives C and B**. **Alternative D** would have no suitable acres.

Table 8. Lands suitable and not suitable for timber production by alternative

Classification	Acres			
	Alternative A	Alternative B	Alternative C	Alternative D
Lands Tentatively Suitable for Timber Production	**807, 289**	**808,368**		
Lands where Management Area Direction Precludes Timber Production	12,258	65,497	27,321	145,118
Lands where Management Objectives Limit Timber Harvest	30,159	76,537	91,067	663,250
Lands that are Not Economically Cost Efficient	0	69,590	85,234	N/A
Lands Not Appropriate for Timber Production	**42,417**	**211,624**	**203,622**	**808,368**
Lands Suitable for Timber Production	**764,872**	**596,744**	**604,746**	**0**
Lands Not Suitable for Timber Production	**1,250,480**	**1,418,608**	**1,410,606**	**2,015,352**

Suitable timberland maps for **alternatives A, B, and C** are shown in report Appendix A4. **Alternative D** would have no suitable timberlands.

Steep slopes (over 40%) were included in the original plan as suitable timberlands for cable harvest, with no suitability update conducted after Plan Amendment #6 adopted the 1995 Mexican Spotted Owl (MSO) Recovery Plan Protected Habitat restrictions for steep slopes and MSO Protected Activity Centers "PAC"s (USDI-FWS,1995). **Alternatives B and C** do not include any steep slopes, or MSO Protected habitat acres in the dry and wet mixed conifer, spruce-fir, and pine-oak (approx. 30 percent of the ponderosa pine) types. Today these acres are not economically feasible, and are difficult to manage for regulated timber production under the current MSO Recovery Plan habitat management recommendations and minimum desired conditions. Thus for all even-aged treatments appropriately used in the spruce-fir type, the NFMA requirement to select the rotation age at culmination of mean annual increment for sustained yield would not apply.

Alternative A would provide the most acres of suitable timberlands; while **alternative C** would provide slightly more acres of suitable timberlands than **alternative B**. Steep slopes (over 40 percent) were included in the 1987 plan (**alternative A**) as suitable timberlands for cable harvest.

Alternatives B and C would not include any steep slopes because these areas are not economically feasible. Spruce-fir forest was included in the 1987 plan, but was classified as non-suitable for this analysis in **all alternatives** because the majority of it is located on withdrawn lands, is not cost-efficient, and/or is located in MSO PACs.

Alternative A would have the most acres of suitable timberland and the most regulated acres managed for long-term sustained yield of wood products. **Alternatives C and B** would have fewer acres managed for long-term sustained yield of wood products.

In **alternatives A, B, and C**, use of moderate and/or high severity fire for tree thinning and density reduction, especially across large areas of suitable timberland, would increase the risk that those acres could not become regulated with the balanced and sustainable progression of age classes needed to ensure non-declining even-flow[6] of future harvest volumes.

In keeping with its “natural processes” management emphasis, **Alternative D** provides no suitable timber acres because fire would be relied upon as a primary tool to thin the majority of acres, even in the first treatment entry. Moreover in theory, after the first cutting entry on the few mechanized thinning treatment acres, more natural agents like using fire and endemic insect/disease levels would primarily be relied upon to continue thinning all acres thereafter. The consequence of having no suitable timberlands, is that no long-term sustained yield of wood products could be assured. This does not mean that no volume would be available to supply markets. It only means that industrial volumes of traditional sawtimber and pulpwood would not be ensured for truly long-term sustained yield. See the Total Wood Products section below. Additionally, **Alternative D** allocates the most land to the Recommended Wilderness Management Area which precludes timber management. **If** desired tree cover is destroyed or degraded on these lands, limited reforestation activities would be emphasized to move those acres toward plan desired conditions.

Of the **action alternatives**, suitable timberlands may occur within the Community Forest Intermix Management Area in **Alternatives B and C**, but not in **Alternative D**. **Alternative C** provides slightly more acres of suitable timberlands than **Alternative B**.

Under **Alternative C,** mostly ponderosa pine, dry mixed conifer, and wet mixed conifer PNVTs would be treated because they dominate the suitable timberland areas. These acres would also receive more mechanical treatments and less treatment by prescribed fire, in order to provide the most wood and tree products for the local economy. Cutting treatments on grassland acres would not be emphasized, because sustained industrial tree production is not appropriate there.

Alternative B emphasizes treatments on both suitable and non-suitable timberlands by including objectives to treat Great Basin grasslands mechanically and use more fire treatments in the piñon-juniper woodlands. Fewer acres of suitable timberland mean this alternative would have fewer regulated acres mandated for long-term sustained yield.

Under **all alternatives**, if proposed plan desired conditions are met and maintained by the cutting practices used, the non-suitable timberland acres should provide long-term sustainable tree cover, although they would not be subject to the ASQ volume or LTSYC controls.

Under **all alternatives**, monitoring of soil productivity loss, and vegetation type conversions following severe burns will be needed during the next 1+ decades, to facilitate adjustments (reductions) in the acres classified as “suitable timberlands”.

Allowable Sale Quantity (ASQ)

Industrial wood volumes from annual cuts on suitable timberlands that were modeled in VDDT are summarized for decades 1 through 5 in the next table (table 9).

[6] Non-declining even flow is a policy governing the volume of timber removed from a national forest, which states that the volume planned for removal in each succeeding decade will equal or exceed that volume planned for removal in the previous decade.

Table 9. VDDT Model estimated industrial harvest volumes (in CCF) cut annually from all suitable timberlands for first five decades.

ALTERNATIVE A Suitable Lands												
AVERAGE Option Volumes in CCF	**Decade 1**	**Decade 2**	**Decade 3**	**Decade 4**	**Decade 5**		**Alternative A** has no high or low treatment objective options.					
Ponderosa Pine	48,116	46,636	45,953	45,300	44,503							
Dry Mixed Conifer	8,617	8,240	8,074	7,947	7,850							
Wet Mixed Conifer	9,192	9,901	10,685	11,546	12,199							
Spruce-Fir Mix	0	0	0	0	0							
Annual Cut Totals:	**65,925**	**64,777**	**64,712**	**64,793**	**64,552**							
ALTERNATIVE B Suitable Lands												
HIGH Option Volumes in CCF	**Decade 1**	**Decade 2**	**Decade 3**	**Decade 4**	**Decade 5**		**LOW Option Volumes in CCF**	**Decade 1**	**Decade 2**	**Decade 3**	**Decade 4**	**Decade 5**
Ponderosa Pine	83,865	84,081	84,141	84,315	84,665		Ponderosa Pine	12,920	13,044	13,096	13,313	13,355
Dry Mixed Conifer	14,299	14,607	14,748	14,768	14,860		Dry Mixed Conifer	2,203	2,226	2,257	2,290	2,315
Wet Mixed Conifer	14,960	15,188	15,736	17,111	17,720		Wet Mixed Conifer	1,995	1,892	1,825	1,808	1,879
Spruce-Fir Mix	0	0	0	0	0		Spruce-Fir Mix	0	0	0	0	0
Annual Cut Totals:	**113,124**	**113,876**	**114,625**	**116,194**	**117,245**		***Annual Cut Totals:***	**17,118**	**17,162**	**17,178**	**17,411**	**17,549**
ALTERNATIVE C Suitable Lands												
HIGH Option Volumes in CCF	**Decade 1**	**Decade 2**	**Decade 3**	**Decade 4**	**Decade 5**		**LOW Option Volumes in CCF**	**Decade 1**	**Decade 2**	**Decade 3**	**Decade 4**	**Decade 5**
Ponderosa Pine	178,278	125,155	107,457	102,491	100,786		Ponderosa Pine	21,219	20,238	19,519	19,204	19,105
Dry Mixed Conifer	33,576	25,347	24,462	25,077	26,049		Dry Mixed Conifer	4,013	4,007	4,081	4,210	4,339
Wet Mixed Conifer	48,032	43,253	42,536	42,455	42,861		Wet Mixed Conifer	4,823	4,324	4,107	4,052	4,161
Spruce-Fir Mix	0	0	0	0	0		Spruce-Fir Mix	0	0	0	0	0
Annual Cut Totals:	**259,886**	**193,755**	**174,455**	**170,023**	**169,696**		***Annual Cut Totals:***	**30,055**	**28,569**	**27,707**	**27,466**	**27,605**
ALTERNATIVE D has ZERO Suitable Lands = zero volumes cut would contribute to the ASQ.												

ASQ is expressed as an annual average of industrial wood cutting volumes from suitable timberlands to meet multiple-resource objectives and public demand. Next, table 10 displays the total ASQ volume estimates for the first decade needed to implement restoration treatments (as modeled in VDDT) and to also meet average public demand for sawtimber, pulp, and pole sales (not modeled in VDDT). Because the modeling done only represents one possible green-tree cutting scenario to implement each alternative, the resulting volume outputs shown previously are too precise for a forestwide programmatic assessment. Therefore, all ASQ values are rounded to the nearest thousand CCF for alternative comparison.

Table 10. ASQ volume from suitable timberlands for the first decade (rounded to the nearest thousand)

	Alternative A[2]	Alternative B		Alternative C		Alternative D	
Cutting Treatment Objective Level	Average[3]	High	Low	High	Low	High	Low
Annual Range of ASQ, in CCF[1]	N/A	122,000	26,000	268,000	39,000	0	0
Annual Average ASQ, in CCF[1]	73,000	74,000		153,000		0	

[1] All volumes shown above for all alternatives include green tree harvests plus extra annual average chargeable volume sold on incidental public permits and small salvage sales, to reflect the total commercial timber management program. Because incidental permits and small sales are based on public demand, their additional volumes are assumed to be constant across all alternatives. This extra sales amount is estimated at 8,467 CCF per year, based on district and forest records.

[2] Alternative A's ASQ was recalculated using the same methodology as the other alternatives.

[3] Alternative A has no high to low range, only the annual average.

Alternatives A, B, and C would have different ASQs because they were based on the expected level of cutting treatments on suitable timberlands (see table11). **Alternative D** would have no ASQ volume because there are no suitable timberlands.

ASQ volume for **alternative B** would be 122,000 CCF per year, as the maximum allowable sale quantity from suitable timberlands. Under **alternative C,** it would be 268,000 CCF maximum for any given year. For comparison, the 1987 Plan Amendment #1 ASQ volume was 198,000 CCF. The highest total harvest in recent years, occurred in 2011, and was approximately 103,000 CCF (Drury, May 2012).

Consequences of implementing the alternatives are that **alternative C** would offer the most ASQ volume of traditional sawtimber and pulpwood offerings for sale to the markets that may desire these products.

Alternative A would offer less ASQ volume than **alternatives B and C** because it does not have a high treatment objective. This amount or some higher amount could become the replacement ASQ for the 1987 plan if there had been no other needs for change to revise the plan (see chapter 1).

Suitable timberland acres are capable of producing greater annual harvest volumes than those shown in the above table. However, use of planned and unplanned fire under **alternatives B, C and A** would reduce available green harvest volumes, because varied amounts of moderate and/or high severity fire would be used to intentionally thin the forests.

Alternative B would reduce the most green volume because it proposes using more moderate and/or high severity fire to thin trees on forested lands, including some suitable timberlands. **Alternative C** would use less moderate and/or high severity fire on suitable lands to thin trees, resulting in more green volume available for cutting and industrial wood. **Alternative A** would reduce the least green volume killed by fire, because it uses the least moderate and/or high severity fire.

Trees intentionally killed by use of fire treatments may or may not be salvaged. Salvage of such trees would require removal within approximately 3 to 4 years post-burn before wood borers and other decay agents reduce their amount of solid wood fiber and market utility. Under **all alternatives**, unanticipated large-scale salvage volume (e.g., wildfire-kill, blow-down, insect/disease mortality) does not count towards the ASQ per the National Forest Management Act.

The ASQ volume control concept enacted by law is intended to prevent excessive tree losses due to "over-cutting" management beyond sustainable forest levels on suitable timberlands. Annual monitoring of cutting levels compared to the ASQ and regular reviews of the suitable timberland acreage classification are required, in order to reveal adjustments that may be needed before too many acres are over-cut in the long-run. However, ASQ does not adequately prevent excessive cutting on non-suitable lands, nor for losses due to the use of fire as an intentional tree-reduction tool. This analysis does not investigate "over-burning" management beyond sustainable forest levels, because no similar review process is required by law. Therefore, careful annual monitoring of prescribed fire-kill volumes on suitable timberlands can only be strongly recommended here, for comparison to the LTSYC in the first decade. Use of unplanned ignitions as "resource benefit" managed fires especially merit this monitoring.

Base Sale Schedule

This planning effort emphasizes proposed management *outcomes* rather than *outputs*. The desired outcome is to restore the forest type PNVTs toward desired ecological conditions, while also providing wood products to the economy as a *byproduct* of the restoration activities. Therefore, listing definite site-specific volume outputs tied to individual sales listed for each of ten years is not appropriate to provide here as a forest program target. Each revision action alternative offers a flexible range of annual cutting volumes, based on the realistic objective levels that help to frame the alternative. Annual volume levels offered for sale will vary as budgets, market demand, and opportunities occur.

For example, the annual cutting level for **Alternative B** may vary from one year to the next between the high and low range of ASQ volumes shown in table 10 above, provided the decade total does not exceed the annual average times ten. Therefore, forest-wide ASQ cutting volumes could fluctuate between 121,591 CCF and 25,585 CCF each year, provided that the total maximum volume of all cuts in the decade would not exceed 735,880 CCF for the 10-year total ASQ. The same interpretation would apply for **alternative C** should it be selected.

In contrast, **alternative D** would have neither of these limitations placed on its acres proposed for cutting; and **alternative A** has no high to low range, only the annual average.

If funding and workforce capacity should somehow become available to offer the high level volume of the selected alternative every year for the first decade, then that level would not be permissible within the ASQ decade total. However, given the high degree of "ecological departure" situation that these lands are currently in, a plan amendment could be justified to re-evaluate the ASQ for an increase to meet multiple-use objectives.

ASQ volumes from suitable timberlands only constitute a fraction of the total wood products that would result from cutting treatments implemented to restore forested acres toward the ecological desired conditions. In reality, a majority of industrial tree species in the traditional sawtimber and pulp size classes are no longer sold as these products. They are currently sold as fuelwood, and/or extracted from the forest and scaled as tons of biomass, which are not included in the definition of ASQ volume. This trend is expected to increase, as the nation continues to emphasize alternative energy (heat and electricity) generation from green biomass.

Therefore, any administrative ten-year action plan developed for forest vegetation management projects across all ASNFs lands (both suitable and non-suitable) is expected to reflect much higher total wood volumes than the ASQ volume levels stated in the Forest Plan base sale schedule stated above.

Long-Term Sustained-Yield Capacity

The LTSY level of 24 CF per acre per year becomes a baseline for comparison of estimated wood product outputs (volumes) by alternative. Total acres of suitable timberland in each alternative x 24 CF per acre, then converted to CCF derives the LTSYC. When rounded to the nearest thousand, the LTSYC for **alternative A** is approximately 184,000 CCF, **alternative B** is 143,000 CCF, and **alternative C** is 145,000 CCF. See table 11 below.

Under **all alternatives except D**, planned, scheduled entries of tree cutting on suitable timberlands would be necessary to move the forests toward an uneven-aged (regulated) balance of age classes and then to maintain the desired condition.

To comply with legal requirements of the National Forest Management Act (NFMA) and Multiple Use Sustained Yield Act (MUSYA), long-term sustained yield also means that ASQ volumes harvested from suitable timberlands cannot decline from one decade to the next. Ideally, harvest volumes below the LTSYC should continue increasing to eventually reach the LTSYC and then level off at or near that regulated value. The only exception to this rule is if the cutting volumes are departed above the LTSYC, in which case they would be expected to decline toward the LTSYC over time.

Long-term Sustained Yield Capacity in Relation to Estimated Industrial Harvest Volumes

As each alternative has different amounts of suitable timberlands, the LTSYC varies accordingly. Table 11 displays the annual ASQ volumes based on the high cutting treatment level for decades one to five, compared to the LTSYC for each alternative.

Table 11. Estimated annual ASQ volume by decade by alternative (rounded to the nearest thousand)

Annual High[1] Cutting Treatment Volumes in CCF	**Alternative A** Annually Cuts 10,041 average acres[2] of 764,872 acres of suitable timberland **LTSYC = 184,000**	**Alternative B** Annually Cuts 14,037 high acres of 596,743 acres of suitable timberland **LTSYC = 143,000**	**Alternative C** Annually Cuts 31,893 high acres of 604,746 acres of suitable timberland **LTSYC = 145,000**	**Alternative D** Annually Cuts only on non-suitable lands **LTSYC = 0**
ASQ Decade 1	73,000	122,000	268,000	0
ASQ Decade 2	73,000	122,000	202,000	0
ASQ Decade 3	73,000	123,000	183,000	0
ASQ Decade 4	73,000	125,000	178,000	0
ASQ Decade 5	73,000	126,000	178,000	0

[1] Alternative A only has an average
[2] Acres are based on the estimated cutting treatments modeled for ponderosa pine and dry and wet mixed conifer forests on suitable lands only

As seen above, when cut at the highest treatment objective levels modeled, **alternatives A and B's** volumes would not decline and would remain below the LTSYC. **Alternative A's** ASQ unrounded volumes for decades one through five are all within 1 to under 2 percent of each other, which indicates a flat line of sustained yield harvests. By cutting at a relatively level trend across all five decades as modeled, **alternative A** would fail to reduce any backlog of overgrowth by just barely keeping up with new growth each decade. VDDT methodology used in this analysis did not permit the ability to model the most logical changes in cutting methods for subsequent re-entries on acres previously treated with the model inputs. By decade three, less intermediate thinning treatments to cut smaller-sized trees would be used; instead more uneven-aged group selection cuts which require cutting bigger trees would be used, thus producing greater harvest volumes than those shown here for decades three through five.

Alternatives A and B comply with legal requirements by cutting at levels which do not decline and are below the LTSYC. The first five decades of VDDT modeling do not produce substantially increasing harvest volumes that ramp up closer to the LTSYC, due to predicted cutting levels on suitable timberlands according to budget and workforce estimates for these alternatives in this planning period. In a regulated (sustainable) forest, annual cut equals annual net growth, such that the forest never becomes overgrown or stagnant. **Alternatives A and B**, because they produce harvest volumes below the LTSYC, would continue to result in overgrown forests that would be more susceptible to uncharacteristic disturbances (e.g., severe wildfire, insect/disease outbreaks). These undesired events could result in additional deforested acreages. **Alternative B** would make more progress than **alternative A**, but still would not reach the LTSYC by decade five.

In contrast, the high objective ASQ volumes for **alternative C** would decline while exceeding the LTSYC in a departure situation. **Alternative C** would reduce the most amount of overgrowth backlog in the first three decades, and it would continue to remove more backlog in decade four until it levels off at decade five. Any departure (exceedance) level of cutting above the LTSYC such as seen in **alternative C**, especially in the early planning decades, is justifiable when any of the following situations occurs: 1) a need to drastically reduce or prevent high tree mortality losses from any cause; 2) it is possible to improve timber age class distribution, thereby facilitating the attainment of LTSYC; 3) implementation of the corresponding base sale schedule would have a substantial adverse impact upon a community in the local economic area; and 4) it is reasonable to expect that it would be better to attain overall multiple-use objectives in other ways; (source: see report Appendix F for directives). All four situations apply to the Apache-Sitgreaves NFs:

- Situation 1: High tree mortality losses would continue to occur in connection with: uncharacteristic wildfires; insect outbreaks abnormal in either intensity or acreages affected; elevated disease levels; new disease arrivals; and accelerated tree stress and deaths resulting from over competition with each other.
- Situation 2: Current age class distributions are skewed. Many acres are even-aged with certain age classes missing. A majority of acres still have far too many small-medium diameter trees that act as ladder fuels and aggressive competition for larger trees.
- Situation 3: Several "small tree" based industries have recently emerged to utilize the surplus numbers of saplings and pulp-sized trees that used to go to the paper pulp mill in Snowflake, AZ. Government grant dollars have helped these industries become established as collaborative partners to begin restoring our imbalanced forest conditions. Numerous new jobs have resulted or returned to this area (Hunt, 2012; ERI, 2007; Sitko and Hurteau, 2010; US Forest Service, 2008-CER). Apache and Navajo Counties have been among the most depressed economies in the nation (see SocioEconomics Report). Due to recently rising market demands since 2009, local White Mountain Stewardship operators have been keeping pace with treating all acres offered, almost as fast as we can prepare them and make them available (Drury, 2011). Limiting the ability to continue cutting surplus tree volume growth that is far above the LTSYC level could have some degree of adverse impact upon communities in the local economic area.
- Situation 4: Multiple-resource objectives would be best met by correcting the serious imbalance of excessive forest wood volume growth rates, which would help to reduce the risk of uncharacteristic wildfires and other extreme or long-lasting disturbances. These uncharacteristic events are not consistent with the proposed plan desired conditions, which are focused on restoring our forested ecosystem to benefit watershed/soils stability, riparian and aquatics, wildlife and fish habitats, ground vegetation and herbaceous cover, range production, water and oxygen cycles, and recreation experiences, as well as economics and the human environment.

Alternative C, because it produces volumes above the LTSYC, would contribute to the reduction in overgrowth and offer a greater opportunity to maintain forest lands at a sustainable level for at least the first four decades. ASQ cutting departures above the LTSYC can be temporarily justified to correct the imbalance of excess net growth, provided the volumes cut decline over time to eventually level out at or below the LTSYC. This is the case for **Alternative C**. This declining volume trend came from the VDDT model runs for decades one through five and is based on treatment inputs for each alternative that are documented in Appendices C, B5, E1, and E2. A declining trend is logical when heavy restoration cuts are needed early to prevent excessive tree mortality from severe wildfires, competition, and insect/disease outbreaks. Once overgrowth levels have been reduced, then subsequent decades should produce volumes which taper down toward reaching desired conditions that are intended to promote a more sustainable forest. Because VDDT modeling was not done beyond 50 years, it is assumed that continued aggressive cutting levels beyond decade five would be needed to bring forested conditions closer to desired conditions and the LTSYC.

Non-declining even flow of harvest volume from one decade to the next is not expected for **alternative C** until desired conditions are met. By the fifth decade, **none of the alternatives** would actually treat enough acres fast enough to fully reach desired conditions within the first five decades because the alternatives were realistically designed to reflect anticipated budgets and workforce capabilities. Because volumes were not modeled beyond the fifth decade, it is not possible to predict when their ASQ volumes might most closely meet the LTSYC. But in forestry theory, because **alternative C** produces a better-regulated forest the fastest it means that cutting departure above the LTSYC could diminish faster in the future than without such regulation.

Because **alternatives A and B** under-cut noticeably below the LTSYC, they would remain threatened by high mortality losses to uncharacteristic disturbance events. At some point **alternative C** would need to align with the LTSYC (i.e., regulated forest) to prevent over-cutting. VDDT modeling indicates that after 50 years of treatments the forested PNVTs would not fully reach desired vegetation conditions. Review of all VDDT model run vegetation outcomes and trends indicate that changes in management strategy would likely be needed following the planning period for **any alternative** (see the Vegetation Specialist Report).

For example, **unlike alternatives A and C**, modeling indicates that **alternative B's** restoration strategy would need to change <u>after</u> this planning period to steadily increase cutting treatments in decades two through five on closed canopy acres and shift to emphasizing low-severity prescribed fire, in order to sustain a non-declining even-flow of ASQ volumes. It is assumed that continued restoration treatments on suitable timberlands toward desired conditions beyond decade five would eventually increase ASQ levels closer to the LTSYC.

Initial modeling methodology used for **alternatives A and C** produced results compliant with the non-declining even-flow legal requirement by continuing the <u>same treatment strategy each decade</u> in the initial level of VDDT modeling. In the case of **alternative B**, however, the initial VDDT model runs which repeated the same treatment strategy in subsequent decades after this planning period originally produced ASQ volumes that consistently declined each decade, while staying below the LTSYC. Therefore, additional analysis at a more refined level of modeling revealed that the treatment strategy would need to change <u>after</u> the 15-year planning period for **alternative B** to produce the compliant results shown here in tables 11 and 12 (also see the "Methodology and Analysis Process" and "Relationship of Short-term Management to Long-term Productivity" sections).

Cuts under **alternative D** are not comparable because no suitable timberlands are present.

It is likely in some years that acres cut would not reach the *high* treatment objective level. So the next table compares the alternatives' *average* treatment objective cutting levels.

Table 12. Estimated ASQ volume and LTSYC in CCF of *average* objective harvest for decades one through five (rounded to nearest thousand).

Annual *Average* Objective Harvest Volumes in CCF	Alternative A Annually Cuts 10,041 average acres of 764,872 Suitable acres ***LTSYC = 184,000***	Alternative B Annually Cuts 8,010 average acres of 596,743 Suitable acres ***LTSYC = 143,000***	Alternative C Annually Cuts 17,541 average acres of 604,746 Suitable acres ***LTSYC = 145,000***	Alternative D Annually Cuts only on **Non-Suitable** Lands ***LTSYC = 0***
ASQ Decade 1	73,000	74,000	153,000	0
ASQ Decade 2	73,000	74,000	120,000	0
ASQ Decade 3	73,000	74,000	110,000	0
ASQ Decade 4	73,000	75,000	107,000	0
ASQ Decade 5	73,000	76,000	107,000	0

At the *average* cutting objective levels, only **alternative C**, during the first decade, would exceed (depart from) the LTSYC. Then it would drop below the LTSYC by decade 2 and stay below it thereafter. **Alternative B** maintains the same patterns as seen previously at the high level. When viewed at the *low* cutting objective levels, **none of the alternatives** exceeds the LTSYC as modeled.

Harvest volumes and departures were not modeled beyond decade 5, nor are they clearly predictable beyond that point. VDDT model trends become less reliable the farther they are projected into the future.

Cutting at the modeled levels is not expected to cause any programmatic irreversible or irretrievable commitment of timber-production resources. In fact, it is more likely that if cuts don’t occur at these higher levels, then the risk of adverse environmental impacts from uncharacteristic wildfires and other severe disturbances will not be avoidable. Even with elevated cutting levels, there would remain a risk that uncharacteristic wildfire, insect/disease outbreaks, and/or other major disturbances could alter the excessive growth imbalance before management actions can.

Under **all alternatives**, the cutting and total treatment levels projected for the first five decades would not reduce the forest overgrowth backlog to sustainable levels. Therefore, there would still be a risk of massive tree mortality due to overgrown stand conditions, large uncharacteristic wildfires, and insect-disease outbreaks during the planning period. Should a majority of remaining forest cover acres become deforested in this case, the local wood products industry would likely collapse, move elsewhere, or shift into temporary salvage and reforestation employment. The lost revenues from severely decreased wood products industry, recreation, and other forest uses could have major impacts to the local society (see SocioEconomics Report in the planning record).

Total Wood Products

Trees cut from non-suitable lands can also provide wood and tree products for local markets. Table 13 displays criteria from the proposed Plan where any amount of tree cutting can be an appropriate activity for meeting desired conditions, including lands not designated as suitable timberlands. This may involve removing just a single tree of any size, to implementing a clearcut, depending on the area management and/or project objectives.

Cuts from non-suitable lands may be a one-time entry, such as removing encroaching trees from grassland or a new energy corridor. Subsequent cuts may not be needed if desired conditions can be maintained with fire, or other methods. PNVTs with stump re-sprouting species (e.g., alligator juniper, oak species) may need additional cuts (or other tree control methods) that would produce less wood volume than the first entry. Nevertheless there is a rising demand from local markets for "non-industrial" tree species and sizes, such as juniper and piñon pine, whether they are thinned from woodland acres, or from grassland acres, or even from forested PNVT acres.

Table 13. Lands where tree cutting is generally appropriate to meet desired conditions (regardless of timber suitability), by area

Management Area	Tree Cutting[1]	
	Generally Appropriate	Generally Not appropriate
General Forest (includes all PNVTs present, see Other Areas)	X	
Community-Forest Intermix	X	
High Use Developed Recreation Area	X	
Energy Corridor	X	
Wild Horse Territory	X	
Wildlife Quiet Area	X	
Natural Landscape	X	
Recommended Research Natural Area		X
Research Natural Area		X[5]
Primitive Area		X[2]
Recommended Wilderness		X
Wilderness		X[2]
Other Areas		
Areas with soil condition rating of unsuited/inherently unstable		X
Lands not cost efficient in meeting timber production objectives	X	
Grasslands, woodlands, interior chaparral, and riparian forests	X	
Communication sites	X	
Developed recreation and administrative sites	X	
Eligible wild and scenic river corridors	X[3]	
MSO (Mexican spotted owl) protected and recovery habitat	X[4]	

[1] Appropriate refers to areas that are accessible and operable for cutting with motorized or non-motorized equipment. Most areas are appropriate for non-motorized (e.g., handsaw, axe) tree cutting, regardless of access.
[2] Trees may be cut in the Primitive Area or Wilderness Management Areas with non-motorized equipment (e.g., axe, bucksaw) and primarily for trail maintenance (FSM 2323.13f, 2323.53, 2326).
[3] Tree cutting is not appropriate in sections classified as wild except where needed in association with a primitive recreation experience such as to clear trails (FSH 1909.12 Chapter 82.51).
[4] Tree cutting must be consistent with the recommended habitat management actions, and with meeting or exceeding the minimum desired habitat conditions in the current (2012 revised) MSO Recovery Plan.
[5] However, cutting certain trees for research purposes is allowed inside RNAs.

The number of total annual mechanical treatment (cutting) acres by alternative for all PNVTs regardless of timber suitability classification) was displayed back in table 5. Table 14 below (next page) compares estimated wood product volumes for the first decade of plan implementation by alternative. To simplify table labeling, “ASQ” is used here to represent industrial wood volumes cut only from suitable timberlands, while “Non-ASQ” is used to represent non-industrial wood volumes cut from both suitable and non-suitable timberlands. (Volumes are not rounded here, to display the raw estimates resulting from modeling and recent local wood volume sales.)

Table 14. Estimated ranges of annual wood product volumes potentially available to offer in decade 1, by alternative from all NFS lands (suitable timberlands and non-suitable)

PRODUCT CLASS	Alt A Average	Alternative B		Alternative C		Alternative D	
		High	Low	High	Low	High	Low
Cuts on SUITABLE Lands:							
ASQ Industrial Species[1] (Timber 9+" and Pulp 5-9") **in CCF**	74,392	121,591	25,585	268,353	38,522	0	0
Fuelwood (5+" non-industrial conifer and hardwood species) **in CCF , Non-ASQ**	14,606	17,530	8,533	33,615	10,019	0	0
Biomass (0+" non-industrial sizes and species) **in TONS , Non-ASQ**	323,302	400,667	59,336	1,202,219	128,463	0	0
Cuts on NON-SUITABLE Lands:							
Non-ASQ Industrial Species (Timber 9+" and Pulp 5-9") **in CCF**	5,780	17,804	2,959	31,192	3,402	48,403	6,065
Fuelwood[2] (5+"non-industrial conifer and hardwood species) i**n CCF** , **Non-ASQ**	10,976	76,528	46,633	18,413	8,699	59,438	32,203
Biomass (0+"non-industrial sizes and species) **in TONS** , **Non-ASQ**	24,822	185,132	82,848	122,548	13,418	246,798	66,026
SUMMARY of TOTAL CUTS on ALL TREATED LANDS (ASQ and NON-ASQ COMBINED):							
Industrial Species[1] (Timber 9+" and Pulp 5-9") **in CCF**	**80,172**	**139,395**	**28,544**	**299,545**	**41,924**	**48,403**	**6,065**
Fuelwood[2] (non-timber conifer and hardwood species) **in CCF**	**25,582**	**94,058**	**55,166**	**52,028**	**18,718**	**59,438**	**32,203**
Biomass (non-industrial sizes and species) **in Tons:** or [3] **CONVERTED TO CCF:**	348,124 or **99,464**	585,799 or **167,371**	142,184 or **40,624**	1,324,767 or **378,505**	141,881 or **40,537**	246,798 or **70,514**	66,026 or **18,865**
GRAND TOTAL of ALL WOOD PRODUCTS, ALL in CCF :	**205,218**	**400,824**	**124,334**	**730,078**	**101,179**	**178,355**	**57,133**
AVERAGED GRAND TOTAL of ALL WOOD PRODUCTS, ALL in CCF :	**Alt. A 205,218**	**Alt. B Average 262,579**		**Alt. C Average 415,629**		**Alt. D Average 117,744**	

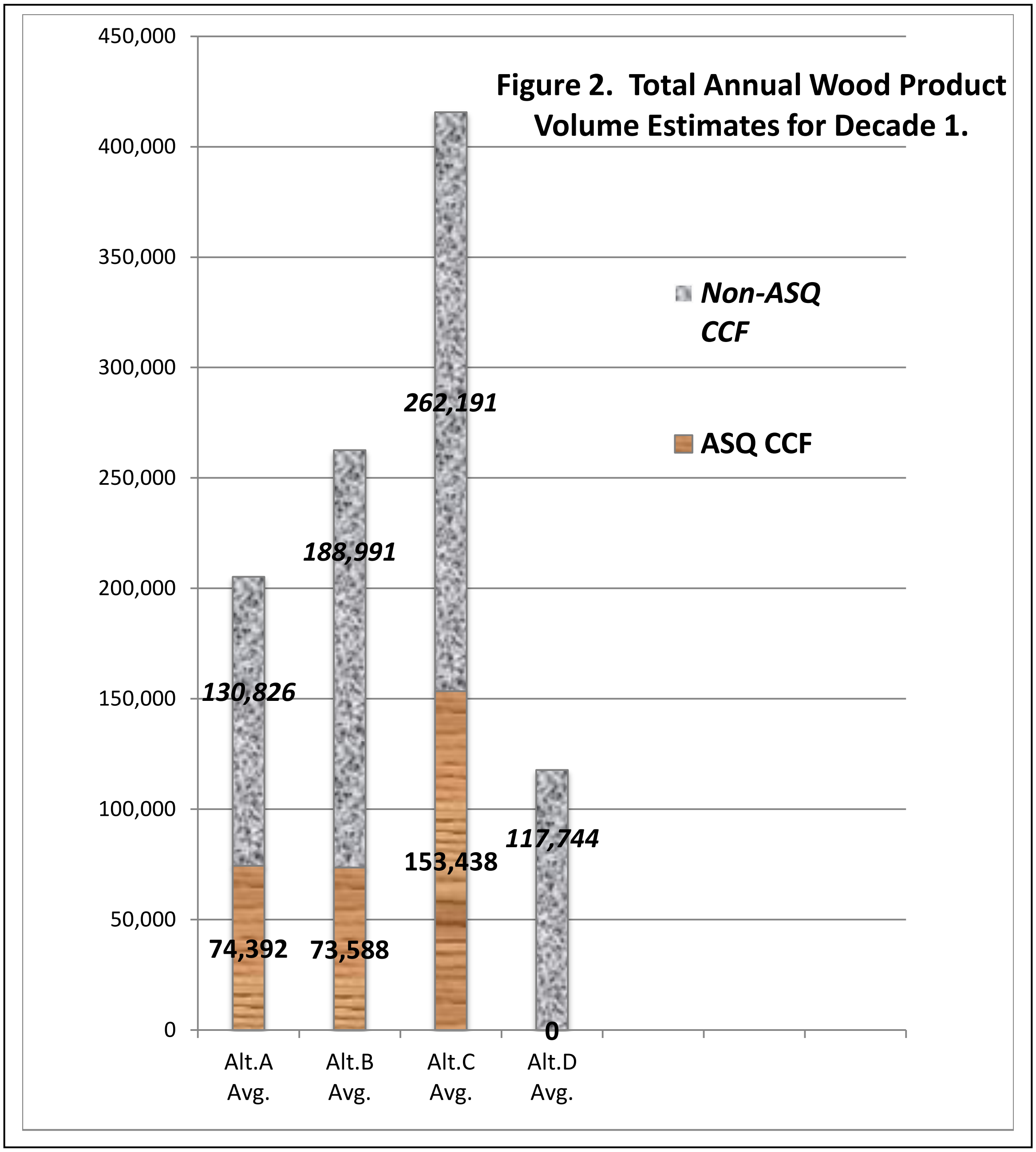
[1] Industrial species for all alternatives include different live trees modeled in VDDT for restoration cutting, plus additional constant volume sold in small sales and on TIM permits (miscellaneous live and dead small salvage sales, road and recreation site hazard trees, pulp and poles).

[2] Fuelwood for all alternatives is different live trees modeled for restoration cutting plus additional constant TIM permit sales for dead/down fuelwood sales, plus posts sold in TIM.

[3] Conversion factor used: 3.5 tons = 1 CCF. Source: R3 Measurements Specialist, based on R3 weight scale study conducted locally.

Converting biomass tons to CCF in the above table provides a comprehensible measure for fair comparison between alternatives when all three wood product categories are added together as one total CCF.

The total estimated annual average treatment objectives cutting volumes are graphed in the following figure (figure 2), with ASQ and non-ASQ volumes combined.



Alternative C would provide the highest average wood products volume for the first decade, followed by **alternatives B, A, and D**. However, the **action alternatives** would provide more average volume from non-suitable timberlands in the first decade than **alternative A**.

Under **all alternatives**, if plan desired conditions are met and maintained by the cutting practices used, the non-suitable timberland acres should provide long-term sustainable tree cover. However, these lands would not be subject to the ASQ volume or LTSYC controls.

Not included in the volume estimates are additional dead tree volumes from intentional thinning with moderate and/or high severity fire (both planned and unplanned ignitions). If salvage volumes of fire-killed trees were included, **alternatives A, B, and D** could possibly approach **alternative C** for total wood products available for at least the first few decades. However, this fire salvage would have to be harvested within approximately 3 to 4 years post-burn before decay agents destroy its wood fiber integrity.

In general, **Alternatives A, B, and C** would use a wide variety of mechanical treatment methods to meet multiple ecological needs. Because **Alternatives A and B** would emphasize the retention of more large and old trees than **Alternative C** would, use of certain cutting methods may be more limited under these two alternatives (see Appendices B1, B2, B5, and E2).

Alternative A would be reliant on tree cutting as the primary tool to thin the forest, with fire used mostly as a secondary, slash cleanup tool. This approach is slow and costly. Currently, it is uneconomical to move raw cut materials more than 70 miles. Raw wood values are so low that little cut volume is sold. The Forest Service has been paying local operators to cut and remove the volumes from the White Mountain Stewardship projects. Where it is uneconomical to move raw wood, a portion of the cut volume may be left and would be disposed of at additional cost to the government. As displayed in the previous table, **alternative A** would provide far less volume to support large, landscape-scale restoration efforts like the Four Forests Restoration Initiative (4FRI, see the cumulative effects section), than would the high and average treatment objective levels of **alternatives C or B**. Yet, **alternative A** would provide more volume if these two alternatives were to consistently be implemented at their low objective levels.

The **action alternatives** would rely on using fire as a primary tool to thin more of the forest (kill trees) than **alternative A**. Thus, less green wood and more dead and fire-charred wood available as a harvestable byproduct from these alternatives, provided enough woody material is left on-site for ecological needs such as soils stability, site productivity, and wildlife habitat.

Alternative B would fall in between the cutting levels of **alternatives C and D**, due to the blend of treatment methods and acreages proposed (see Appendices B1, B2, B5, C, and E2). It employs a tree cutting and burning strategy that restores more acres faster toward desired conditions than **alternative A**. It would not reach a regulated supply of sustainable timber as fast as **alternative C**, but it would do so faster than **alternative A** and would be more sustainable than **alternative D**. Less suitable timberland acreage enables more non-suitable lands to be treated with the fire-only method, in order to reduce the high costs associated with mechanized thinning, so that more acres can be treated annually overall by **alternative D**.

Alternative C would emphasize a mix of more cutting treatments designed for optimum commercial timber species volume production (maximized growth and harvest) on suitable timber acres, such that it should produce more total wood volumes than the levels that would be harvested in the other alternatives. **Alternative C's** high objective cutting level would produce the most total wood volume to support large, landscape-scale restoration efforts like 4FRI. However, in the first decade this alternative's low objective cutting level would produce less total volume than either the high or low objective level of **alternative B**. This is because **alternative C**

is focused on treating mostly suitable timberlands, while **alternative B** spends the first decade focusing on restoring grasslands and other non-suitable lands that can provide high volumes of non-ASQ wood products in addition to the ASQ volume.

Alternative D would provide the least wood volume for meeting social and economic desired conditions for local and regional markets and related jobs. It would produce the least wood product volumes, due to its emphasis on using fire as the primary treatment method, as well as a 16-inch diameter cap imposed on the few acres that are mechanically thinned or cut. After one cutting entry, those mechanical acres would be maintained by regular intervals of planned and unplanned ignitions thereafter. Long-term consequences of continuing understory burning beneath an unthinned overstory may result in failure to meet desired conditions. An over-abundance of large trees could eventually result with a generational gap lacking younger trees to replace older trees over time, as has been seen occur on acres of recent fuels reduction projects on the Apache-Sitgreaves NFs (Triepke et al., 2011; Abella et al., 2006; Youtz, 2010a; Drury, 2011. Dwarf mistletoe infection left in the unthinned overstory would also be difficult to control as it tends to intensify and spread to adjacent trees and the understories, causing mortality which interferes with the uneven-aged forest structure desired (see the Forest Health Report).

Not included in the above volume estimates are the additional dead tree volumes indirectly created by intentionally using moderate intensity prescribed fire as a tree-thinning tool (both planned and unplanned ignitions). Only volumes of live trees cut were modeled for this analysis, with incidental salvage volumes of wildfire-killed trees included. If salvage volumes of prescribed fire-killed trees were included, then Alternatives B and D might possibly approach Alternative C, for total wood products available to offer, at least in the first few decades. Estimates of this extra prescribed fire-created volume would require further analysis of the R3 FVS-FFE fire simulations.

As a major consequence of using fire to more quickly and cheaply kill trees of all sizes in **alternatives D, B, and A**, less green volume of higher market value wood would be available for harvest. Instead, lower market value wood would be offered from those acres, and it would have to be salvaged within about three years to still possess its solid fiber density and integrity that most markets need as a raw resource. Moreover, some markets cannot, or will not, use black-charred wood (e.g. pulpwood for paper manufacturing and wood heating stove pellets).

It is conceivable that intentional fire use to reduce treatment costs of moving toward vegetation desired conditions ultimately can create an extra cost when the resulting tree mortality volumes would need sale layout/preparation/administration (and possibly extra NEPA process) costs to offer the volume afterward for salvage. By thinning it mechanically first, with a low severity burn follow-up treatment, the green volume that could be provided for higher market price to meet social/economic desired conditions might turn out to be just as cost-effective as burning it at high and/or moderate severity and then salvaging the fire-kill.

Likewise, no long-term supply of wood volume could continue to come from grassland acres once they are restored by cutting and maintained by fire thereafter (basically a one-time harvest entry). **Alternatives B and D** would rely more heavily on fuelwood and biomass cut from grasslands than **alternative A**. **Alternative C** would rely the least on fuelwood and biomass cut from grasslands and other non-suitable timberlands.

Use of moderate and/or high severity fire combined with diameter caps as thinning tools used most heavily in **alternatives D and A**[7] would not assure removal of encroached off-site tree species of seed-cone bearing size/age for restoration to the correct fire regimes, thus perpetuating a species mix that is not well adapted to the site (report Appendix G and Triepke et al., 2011). These two management methods are less certain to selectively leave the tree sizes, species, and arrangements desired for a truly sustainable uneven-aged structure and predictable wood volume production in more challenging climate conditions. Failure to restore all forests and woodlands to their correct species composition, size distribution, and spatial arrangement can make them more vulnerable to climate shifts or other uncharacteristic disturbances. **Alternatives C and B** would utilize no 16-inch diameter caps. **Alternative A** would use fewer diameter caps than **alternative D**. Therefore **alternatives C and B** would provide more control over tree species composition on their mechanically treated acres.

Under **all alternatives**, there would be risks of using prescribed fire as follow: (1) some prescribed fires could continue to burn after field conditions change from the desired burn prescription; (2) some prescribed fires could escape and become wildfires; and (3) some planned ignition fires may not get accomplished due to narrow burning windows and/or smoke management constraints; (4) use of high and/or moderate severity burns may result in more acres needing reforestation efforts (e.g. Wilkins, Weimer-Durfee, and Wagon Draw resource benefit fires, per Richardson, 2012). All of these risks would be higher for **alternatives D** and **B**, over **alternatives C** and **A**, in this order.

Under **all alternatives**, restoration and maintenance of green tree thinning could be reduced if large salvage sales of fire-killed trees dominate the Apache-Sitgreaves NF's workload for the next 10-15 years. This could elevate the risk of losing even more acres to uncharacteristic disturbances. Under all alternatives, too much emphasis and time (NEPA, layout, administration) spent on efforts to salvage dead trees would detract from treating the overgrowth backlog that still threatens remaining green forest acres.

Forested/Overgrown Lands

The following table (table 15) displays the estimated percent of forested/overgrown lands that would be treated within the planning period. If continued at the same rate, the minimum number of years needed to treat all the forested/overgrown lands (approximately 673,437 acres) just once, is also shown. Cutting and burning treatments on suitable and non-suitable timberland acres are included. (For tree planting rates, see table 16.)

[7] Alternative A (1987 forest plan) does not specify a 16-inch diameter cap. However, this diameter cap has been used as a treatment in recent and current vegetation management. See "Other Planing Efforts" section of this report.

Table 15. Percent of forested/overgrown acres treated by year 15, and average years required to treat[1] all acres in need of thinning with one entry, by alternative average objective levels (both suitable and non-suitable acres are included).

Alternative	Total Annual Thinning[1] Treatments (acres)[2]	Percent of Forested/Overgrown Lands Thinned Annually[2]	Percent of Forested/Overgrown Lands Thinned by Year 15	Years Required to Thin All Acres of Forested/Overgrown Lands[2]
A	16,182	2.4 %	36 %	41.6 years
B	20,037	3.0 %	45 %	33.6 years
C	30,220	4.5 %	67 %	22.3 years
D	28,914	4.3 %	64%	23.3 years

[1] Treatments include cutting and the use of fire, but not planting.
[2] These values are for years 1-15 in all alternatives. The treatment rates are held constant here for a consistent basis of comparison across all alternatives, even though additonal modeling shows that alternative B would need to modify annual cutting rates on just the suitable acres in years 16-50 to provide non-declining ASQ.

Annual thinning treatment percentages in **all alternatives** would affect a minor amount (less than 3 to 5 percent) of the forested PNVTs each year, with nature managing the rest. Without fire as a thinning tool, treatment rates for all alternatives would be far slower. Restoration rates could be too slow and costly without incorporating fire treatments, in addition to cutting, as a thinning tool to increase treated acres. Those untreated areas would still have trees that continue to grow and die, are affected by insects and diseases, and possibly burned or affected by other disturbance processes.

According to analysis data displayed in tables 5 and 15, and Appendix E1 of this report, the small percentages of forested acres treated annually would take a number of decades just to implement the first treatment entry toward desired conditions. On most PNVTs desired conditions would need more than one entry to be achieved, especially when a cutting cycle of 30 years is recommended between cutting entries, and 3 or more distinct age classes need to be developed for uneven-aged structure.

According to table 15 above, **alternative A** would only treat about 36% of the forested/overgrown acres by year 15. The **action alternatives** would move more acres toward desired conditions faster, at treatment rates of about 45 to 67% of ground covered in the first 15 years. Only at these higher rates could subsequent entries manage to return back to the same acres again in about 20 to 30 years for follow-up treatments to maintain the benefits of the prior entry. (See the "Relationship of Short-term Management to Long-term Productivity" section for the modified cutting rate modeled on suitable timberlands for **alternative B** <u>after</u> year 15.)

<u>The true challenge under **any alternative**</u> will be to keep treating new acres each year, while at the same time returning to maintain those acres already previously treated. For an initial time, (varies by alternative), total annual treatment acres would have to increase exponentially to achieve both. This analysis reveals that **alternative C** would come closer to achieving this on suitable timberlands, and in the Community Forest Intermix Management Area than the other alternatives would.

Because the best we can do is only thin forestlands at a rate of 3.0-4.5% per year, it becomes <u>critically important to strategically place</u> those treatments in the <u>right priority locations across the landscape.</u>

This consideration makes **Alternative B** more advantageous over the other alternatives because of its emphasis to prioritize treatment locations inside the community wildfire protection plan (CWPP) areas and in priority watersheds which include large acreages of untreated pine and dry mixed conifer forests. These areas are located in Navajo and western Apache counties nearer to rail lines and centralized markets, with a greater success of being implemented as wood product transportation costs increase. **This alternative** also emphasizes more acres of fire treatments as a faster and more cost-effective restoration treatment that is less dictated by fluctuating wood markets. It also features treatment of grassland acres, which can function as natural fire-breaks when included as part of larger restoration projects on the landscape. This alternative could probably come close to meeting the needs of 4FRI markets and others, while also restoring the PNVTs most in jeopardy. By year 15, it would treat about 45% of the forested/overgrown acres.

Alternative C would emphasize treatments on suitable timberlands, the Community-Forest Intermix Management Area, and other lands that can contribute wood products. The suitable timberlands may or may not be near rail lines or centralized markets. **Alternatives A and D** would emphasize mechanical treatments around communities and in the Community-Forest Intermix Management Area (a subset of CWPPs), many of which have already been treated and now only require follow-up maintenance thinning that may produce less total wood volume in subsequent entries.

Alternative C would accomplish treatments the fastest at a rate 23 years to cover all acres in need of thinning, followed by **alternatives D, B, and A**, respectively**. Alternatives A, B, and C** would all use a mix of cutting on some acres with burning on other acres. **Alternatives C and D** treatment rates would permit more timely return entry intervals for required maintenance of restored desired conditions on the most acres.

In contrast, **alternative D** would accomplish treatments in just 24 years by using fire as the only tree thinning tool on many treated acres in need of thinning. Moreover, all cuts done under **alternative D** exclusively use diameter caps for large tree retention emphasis, which would stall progress toward or move those acres away from many desired conditions (Triepke, 2011; Abella et al., 2006). This is not evident in the VDDT model results for **alternative D** because the benefits of fire use on so many acres overshadow the negative cutting results.

This analysis shows that total treatment levels projected for the first 5 decades **under any alternative** never do get the forest overgrowth backlog down to sustainable levels; and so more massive tree mortality due to overstocked stand conditions, large uncharacteristic wildfires, and insect-disease outbreaks are inevitable to occur during this planning period, **regardless of the alternative chosen**.

Deforested/Early Development Lands

Once adequate quantities of green seed have been collected for each native tree species, then each alternative could begin planting activities on deforested lands. Cone collection may take about 3 to 10 years from present, depending on each species, but it would be the same constant for all alternatives.

For the estimated 37,695 acres (4% of all forested PNVT lands) proposed for artificial reforestation the following planting table (table 16) shows a similar timeline for establishing plantations. Both suitable and non-suitable acres are included. It displays the estimated percent of deforested lands that would be treated within the planning period. If continued at the same rate, the minimum number of years needed to plant all deforested acres targeted for artificial reforestation is also shown. Plantation success is assumed with the initial planting. If there is poor tree survival with replanting or additional fill-in planting required on some sites, then the timeframes shown would be longer.

Table 16. Percent of deforested acres planted by year 15, and average years required for each alternative to accomplish planting treatment one time, on deforested acres targeted for artificial reforestation (both suitable and non-suitable acres are included).

Alternative	Average Annual Planting Treatment Acres	Percent of Forest Planting Acres Treated Annually	Percent of Forested/Overgrown Lands Thinned by Year 15	Years Required to Plant Needed Forest Acres
A	880	2.3 %	35 %	42.8 years
B	1,623	4.3 %	65 %	23.2 years
C	2,066	5.5 %	83 %	18.2 years
D	413	1.1 %	17 %	91.3 years

Alternative C would plant the most acres, especially on suitable timberlands in order to return them into timber production as soon as possible. This rate is at the extreme high end of current workforce capabilities. **Alternative B** would plant at a rate consistent with current workforce capability, and it would focus on reforesting more of a mix of both suitable and unsuitable lands for ecological recovery emphasis, including some Mexican spotted owl habitat.

Alternative A would plant at the lower end of current workforce capacity, focusing primarily on sites near private lands and along highly visible roadways. **Alternative D** would emphasize letting natural processes dominate so that the vast majority of acres needing reforestation would be left for natural regeneration to occur on nature’s timeline. The few acres planted would be near private lands and in some Mexican spotted owl habitat identified for accelerated recovery.

At the planting rates modeled (see Forest Products Specialist Report in the plan set of documents), **alternative A** would plant an average of 880 acres a year, thereby treating all of the deforested acres proposed for artificial reforestation within 43 years. **Alternative B** would plant an average of 1,623 acres a year, thereby treating all of the deforested acres proposed for artificial reforestation within 23 years. **Alternative C** would plant an average of 2,066 acres a year, thereby treating all of the deforested acres proposed for artificial reforestation within 18 years. **Alternative D** would plant an average of 413 acres a year, thereby treating all of the deforested acres proposed for artificial reforestation within 91 years.

Under **all alternatives**, rates of natural conifer regeneration would be the same. Regeneration occurance and survival would depend upon local site conditions and climate over time.

However, a portion of deforested acres may not return to a productive forested condition. A body of research in the southwestern ponderosa pine forest type has shown that, on average, approximately 50% of severely burned acres tend to convert to grass/forb/shrub/rock lands that can take a very long time to return to forest, possibly centuries (Roccaforte et al., 2012; ERI, 2011; Savage and Mast, 2005; Strom and Fule, 2007). Artificial reforestation is needed to reduce that percentage (Higgins, 2008; ERI, 2012b). Climax spruce-fir and upper elevation (wet) mixed conifer forests have been documented as also undergoing very long-term type conversions to grass/forb/shrubland following severe fire (Alexander, 1974).

These environmental reactions can be highly variable, depending on factors such as: unfavorable soil, site and weather conditions for seed germination and/or successful seedling establishment;

quick domination by prolific root-sprouting species such as oak, aspen, and other woody shrubs; stiff competition for bare soil, water and nutrients by thick grass cover; a lack of cone-bearing seed trees; size of created openings too large for wind-dispersed seed to reach the opening interior from seed trees on the perimeter; erratic seed production, topsoil loss due to water/wind erosion; substantial rodent, bird, insect consumption of tree seed (Jones, 1974; Alexander, 1974; White, 1985; Savage and Mast, 2005; Puhlick et al., 2012). Thick seedling/sapling cover ("hyper-dense forest") that can become established may also be vulnerable to fire reburn destruction (Savage and Mast, 2005), and to insect damage (see Forest Health Specialist Report), as well as some wildlife damage. If more workforce capacity and funding become available, more acres of possible grass/shrub site conversion lands could be planted for return to forest cover.

The existing condition has 21.5% of all forestland acres in an undesired deforested condition. VDDT modeling shows that by year 15, **Alternative A** would have improved to 6.6% of ground left in deforested condition, while **Alternative B** would have 5.7%, **Alternative C** leaves 6.5%, and **Alternative D** leaves 6.7%. These figures include natural and artificial reforestation combined within the model transitions, as the results of cutting, burning, planting and natural stage progressions. Even though **Alternative C** plants more acres annually, curiously **Alternative B** is indicated by VDDT as the better management strategy for reforestation overall. Under **all alternatives**, no tree planting could be done on forest lands expected to convert into grass/forb/shrub/rock cover, unless extra workforce capacity and/or funding is made available.

Under **all alternatives**, early development forest lands would need time to grow, with periodic pre-commercial thinning taking place (either mechanically or by prescribed fire) to maintain vigor and facilitate growth into larger size classes. Protection from excessive animal, insect/disease, and fire treatment damage would be necessary. Fire use could be the most cost-effective means of thinning small trees under 5 inches diameter, but has its limits as a silvicultural tool beyond that, especially on suitable timberlands.

Arno and Fiedler (2005, chapters 4 and 16) and Feidler et al., (2010) present various case studies as examples of combining prescribed fire with tree cutting as a complete and effective restoration treatment in western USA forests. They present strong rationale against using fire by itself as the only restoration tool.

Savage and Mast (2005) show a proposed model diagram from their research suggesting that frequent surface fires in the ponderosa pine type could be used to break up "hyper-dense" pine regeneration from suffering another future crown fire, by maintaining clumped pine patches with open spaces between the patches. This concept is presumed to also apply to other PNVTs in Fire Regime I, like dry mixed conifer.

The US Forest Service Southwestern Region used Forest Vegetation Simulator-Fire and Fuels Extension (FVS-FFE) modeling applied to regional FIA plots for each plan revision PNVT to calibrate the VDDT model structural state transitions (Weisz et al., 2012; and report Appendix B4). Those results show that when low severity prescribed fire is applied as the only treatment to thin the seedling/sapling states (state *B* = open canopy, and state *F* = closed canopy) in the ponderosa pine and dry mixed conifer PNVTs, a variety of transitions can occur.

Ponderosa pine closed canopy seedling/sapling state *F* responds as follow: 25% of the treated plots transition into the desired open canopy seedling/sapling state *B*; while 42% stayed in the closed state *F*; while another 33% of plots lost enough seedling/sapling sized trees that they converted into larger size classes of trees also present (states *C*, *G*, and *D*).

Should prescribed fire be applied or allowed to creep into ponderosa pine open canopy seedling/sapling state *B* to keep it open, the following responses may result as predicted by the model runs: only 20% of plots stayed in the desired open state *B*; 40% moved into the grass/forb/shrub state *A*; while another 40% of plots lost enough seedling/sapling sized trees that they converted into larger size classes of trees also present (states *E* and *J*).

VDDT model acres of ponderosa pine converted from the seedling/sapling structural state to the grass/forb/shrub state may represent the desired canopy gaps between pine regeneration patches that are desired forest structure to prevent future crown fires. However, these results also suggest that if low severity fire is used to thin acres already regulated for uneven-aged management, fire results may be too unpredictable to maintain the proper balance of regulated age/size classes for long-term sustained yield. Similar plot transition results occurred in the Regional FVS-FFE model runs done to calibrate the VDDT models for the dry mixed conifer and piñon-juniper woodland PNVTs. Thus, using fire-only to thin the early development forest acres would need very careful application and control to successfully meet and maintain desired conditions on suitable timberlands in the frequent fire types. Careful long-term monitoring and adaptive management would be key to this effort.

FVS-FFE model results are more difficult to determine low severity fire effects upon just the seedling/sapling component of the wet mixed conifer and spruce-fir PNVTs, because their structural states combine the seedling/sapling size (<5” diameter) with the small size class (5-9” diameter). Given that these two PNVTs are composed of species that are less fire-adapted, it is likely that even more of the seedling/sapling sized trees would be killed by prescribed fire, with less success to maintain this youngest age class on the landscape. Thinning by cutting would be more preferable to ensure that the correct prescription for desired tree stocking per acre is met and maintained in each size class. Therefore, those alternatives which use the least amount of exclusive fire as a thinning tool on suitable timberlands would be preferred in the infrequent fire forested PNVTs. Waiting until the regeneration has reached merchantable size to thin mechanically could be a more cost-effective solution.

Where maintaining a strong aspen component on the ASNFs landscape is desired long-term, keeping all fire (all severity levels) off of aspen regeneration/early development acres would be imperative (Fairweather, 2008; Roccaforte, Nov. 2012; and see the Forest Health Specialist Report).

Relationship of Short-Term Management to Long-Term Productivity

Several short-to-long-term relationships have been covered throughout this report where pertinent to the topic. In keeping with the natural ranges of tree lifespans and forested ecosystem development, this analysis considers short-term to be within the 15-year planning period, and long-term is considered to be after that time out to 50 years and beyond. Indeed, what actions are implemented today can influence forest conditions for hundreds of years from now. Development of mature forest with a late-successional (old growth) component that was lost in stand replacement disturbances does not occur in the short-term, but the process can be initiated almost immediately. Likewise, conversion from even-aged forest to uneven-aged forest is not likely to fully occur on many acres within 15 years, yet the actions undertaken now will directly affect that outcome in decades hence.

The previous section above addressed the short-term need to return existing deforested PNVT acres to adequately-stocked tree cover in order to improve long-term timber production and ecosystem recovery. There is an additional risk of the possible need to increase reforestation activities resulting from large acreages treated with moderate and/or high severity fire that may burn out of prescription, which could be higher for **alternatives D and B**, over **alternatives C and A**. Additional deforested acres caused by this management emphasis during this planning period would delay their long-term productivity of harvestable wood fiber, at a possibly higher total long-term restoration cost.

On those acres which are overgrown (departed from desired conditions), short-term cutting departures above the LTSYC level are necessary to bring excessive tree stocking under control as soon as possible. This would enable the treated forest types to reach desired conditions faster than without treatments. It would also improve vigor of individual trees to help withstand or adapt to environmental stressors. In the meantime, such treatments will possibly help to avoid rapid tree losses, and severe losses of other key ecosystem components, to uncharacteristic disturbances expected to continue before the desired conditions are met across the greater landscape. Treatment projects should be located strategically across the landscape to help minimize spatial impacts of such undesired disturbances. As a result key components at risk like large/old trees, critical wildlife habitats, native species, and soil productivity, would benefit long-term (FRCC, 2003).

In this LTSYC departure context, only **alternative C** would provide such benefits the fastest during the short-term (15-year planning period). **Alternatives B** and **A** respectively do not provide these benefits to as many forested PNVT acres within the same time frame (refer back to tables 11 and 15 discussion in those sections). **Alternative D** would initially treat (thin) almost as many acres as **alternative C** would within the first 15 years. But because it has no suitable timberlands designated, cutting levels compared to LTSYC and ASQ would remain unknown and untracked over time; so long-term productivity would not necessarily be measured based on net growth compared to controlled cutting levels. Long-term sustainability of uneven-aged desired forested conditions under **alternative D** would certainly not be achieved after year 15, due to the primary uses of fire and large tree retention on a large-scale basis.

In order to sustain a non-declining even flow of ASQ volumes on suitable timberlands in **alternative B**, additional VDDT modeling revealed that the restoration strategy for decades two through five would need to do the following: increase treatment acreages in closed canopy transition vegetation states in the ponderosa pine and dry mixed conifer PNVTs; and shift to using low-severity prescribed fire as a maintenance tool for thinning just the seedling/sapling sizes.

These modeling shifts represent adaptive management that is predictable because as more acres are restored to desired open-canopy in these two PNVTs, cuts in each transition state would produce less volume per acre; thus the need to cut more acres overall to sustain the same total volume yields. Likewise, using moderate-high-severity fire as a thinning tool would predictably reduce measurable volume available for ASQ harvest. Thinning only seedlings/saplings that have very little measurable wood volume by using only low-severity fire would not impact available ASQ volume.

These shifts in management methodology could begin after the planning period. It is assumed that continued restoration treatments toward desired conditions beyond decade five would eventually bring **alternative B's** ASQ levels up closer to the LTSYC, provided uncharacteristic disturbances don't occur first to drastically alter the trends shown in this analysis.

The long-term need to keep **alternative B** from producing a declining ASQ yield in decades 2-5 required modeling constraints applied to the ponderosa pine and dry mixed conifer PNVTs (also discussed previously in the LTSYC section of this report), which revealed the following possible effects or consequences of continuing to implement this alternative after this planning period:

- The need to cut increasingly more suitable timberland acres in subsequent decades after the planning period, by especially targeting the remaining acres of closed-canopy structural states. This would exclude the MSO PAC acres because they are not classified as suitable timberlands. The need to cut increasingly more suitable timberland acres makes sense because as more acres are restored to desired open–canopy, cuts in each state will produce less volume per-acre, thus the need to cut more acres overall to maintain same total volume. This also makes sense when considering that in **alternative B** sometime after decade 2 many non-suitable acres (such as grasslands) should theoretically be finished with restoration cutting, and those annual treatment acres could be shifted into additional cuts on suitable timberland acres.

- Budget and workforce levels would need to increase accordingly to mechanically cut more acres each subsequent decade.
- Treatments in the wet mixed conifer type would not need to make such shifts, because desired conditions for this PNVT do not emphasize as much open-canopy forest.
- Increased acres of cutting in decades 2-5 decreases the re-entry intervals on all suitable timberland acres (all three suitable PNVTs combined) from approximately 43 years in decade 1, to 31 years by end of decade 5. This new re-entry interval result is comparable to the Southwestern Region's ideal 30-yr. re-entry cycle that they modeled for LTSYC.
- The additional cutting acres treated in decades 2-5 for **alternative B** would still not be as many as those cut in **alternative C**.
- Using a mix of low plus moderate and high severity fire in decade 1 is needed for cost-effective restoration and is realistic to expect with intended use of unplanned ignition fires. Conversion to using all low-severity fire in decades 2-5 on suitable timberlands for ecosystem maintenance is another effect of needing to keep the ASQ volumes up at a non-declining level. This makes sense because low-severity fire only thins (kills) seedling/sapling sized trees which do not contain harvest volume, while moderate-high-severity fires kill larger trees that would reduce available harvest volume.
- If needed, use of moderate and high-severity prescribed fire could still continue to be used on non-suitable timberlands in decades 2-5 to economically thin trees larger than the sapling size for restoration purposes. If leadership wished to continue using moderate and/or high-severity fire as a management tool on all forested lands after this planning period for **alternative B**, the consequence to avoid violating the non-declining ASQ legal requirement would be a need to remove all forested acres from the suitable timberland classification at that time.

An increasing body of research is becoming available locally and regionally which generally demonstrates the economic practicality of implementing restoration projects at relatively low financial costs compared to the higher financial costs of wildfire suppression and post-fire recovery efforts. Severe wildfire costs to society are especially high when a full accounting of both short- and long-terms effects includes the ecological and social values of natural resources lost in stand-replacement wildfires such as old growth, critical wildlife habitats, watershed stability, carbon storage, air quality, wood volume, and recreation/scenic values, along with burned area emergency response actions and reforestation costs among others (Combrink et al., 2013; Snider et al., 2006; ERI, Sept. 2011; Donovan et al. 2008; Huang et al., 2013; Lynch, 2001; Waltz et al., 2014; Fiedler et al., 2010.) To the extent that **each alternative** would implement ecosystem and fire regime restoration activities to reduce undesired stand-replacement wildfires and/or improve forest resiliency, **all alternatives** are expected to reduce social and economic costs associated with wildfire suppression and post-wildfire recovery. See other specialist reports for more detailed economic analyses.

Climate Change Considerations

Regardless of its underlying causes, climate change is another factor which must now be addressed with respect to forest restoration and management, and related effects upon forest products. Fulé (2008) suggests that forest restoration guided by historical reference conditions of fire regime, forest structure, and composition is still useful in a changing climate. Kerhoulas et al. (2013) document multiple research studies in which both small and large pine trees in northern Arizona benefitted from restoration thinning with respect to growth responses 5 to 10 years after treatment, including during drought years. Additionally, in a mixed conifer forest study, Fulé et al. (2009) further perceive the usefulness of such restoration as a useful starting point for that specific site to persist under the anticipated future climate regime. Other notable authors stress a "restoration imperative" (Arno and Fiedler, 2005), and "an imperative for action" (Vose et al., 2012).

An imperative for action presents the twofold challenge of adapting to changing climate and also managing carbon. Examples of *adaptation* actions include: reducing non-climatic stressors in forests (e.g. non-native pathogens and insects), implementing fuel reduction, and reducing stand densities. *Carbon management* examples include: reducing deforestation, increasing afforestation (ie. reforestation in our case here), reducing wildfire severity, increasing tree growth, and increasing use of wood-based bioenergy (Vose et al., 2012).

Although uncertainty exists about the magnitude and timing of climate change effects on forest ecosystems, sufficient scientific information is available to begin taking action now. Specific strategies and actions will differ by location, inherent forest productivity, and local/project-level management objectives (Vose et al., 2012).

Currently a major strategy to insure that at least a subset of managed forests will not be affected extensively by climatic change is to provide as wide a range of diversity as possible. Under traditional silvicultural practices, diversity can be provided by a mix of timber stand structural conditions ranging from even-aged monocultures at various developmental stages, to multiage species mixtures; and by applying treatments at a variety of spatial and temporal scales. But silvicultural concepts and practices need to shift toward accepting a tradeoff between traditional industrial plantation and thinning schemes for efficient timber production versus managing forestlands as complex, adaptive ecosystems. As future variability and uncertainty increase, as has been predicted under global change, the increased emphasis on adaptation will become more important where providing various ecosystem goods and services is most important (Puettmann, 2011). Conversely where efficient production of industrial timber is most emphasized, there may be less certainty of the flexibility needed for forests to adapt to changing environmental stressors.

Forest Plan classification of lands according to potential natural vegetation types (PNVTs) and successional status under the **action alternatives** would more easily enable managers to view forest and woodlands as the complex, dynamic, and potentially adaptive ecosystems that they are (US Forest Service, Dec. 2008-ESR). The current 1987 Plan (**alternative A**) only classifies vegetation according to the existing cover types visibly present at this point in time, with the implication that the cover type present is the one that management should continue to maintain there. It directs forest managers to maintain the existing type, even if that type is a conversion (or high departure) from the PNVT that would be more sustainable in that location had normal disturbance processes been allowed to continue there over the past 100+ years. In other words, the current Plan does lacks direction for forest restoration from an ecological, science-based framework, such as presented in Reynolds et al., 2013.

Species-specific tree regeneration needs are increasingly less likely to be met due to loss of mature (seed producing) trees across increasingly large areas where high-severity wildfires and bark beetle-induced mortality have occurred, coupled with ongoing and projected increases in drought stress due to climate change (Williams et al., 2012; Vose et al., 2012). Long-term forest structural and compositional changes and type conversions from forests to shrublands or grasslands are expected to be an increasing risk, especially where tree planting efforts are not well designed to account for changed site conditions and climate.

Tree species currently preferred as “industrial” for timber and other traditional uses may not be as readily available in the next 50+ years or so, as it may become less prudent or less possible to plant them and expect them to mature and reproduce successfully. The early recovery role of native vegetative sprouters (like aspen, oaks, and alligator juniper) on deforested sites is already becoming more important in future forest species composition mixtures. Accordingly, the target tree densities in thinning prescriptions would need adjustment to facilitate success of the more hardy species. The recovery role of native nitrogen-fixing species (like New Mexico locust and other leguminous shrub/herbaceous species for example) may need consideration on nutrient-depleted sites; yet if soil nitrogen levels increase on other sites because of higher atmospheric nitrogen deposition, then the role of nitrogen fixation may be re-evaluated when species mixtures are considered (Puettmann, 2011). Under **all alternatives,** selection of hardier native conifers (like Chihuahua pine and junipers) and non-coniferous tree species for reforestation efforts would be wise to capitalize on genetic diversity most adaptable to a wide range of possible future conditions.

With the diversity of native tree species that exist here today, it is expected that more than one tree species are capable of surviving climate shifts in any direction, provided management efforts enable enough healthy sub-populations to remain with a broad gene pool within the local range of each species. Thus, various wood and tree products should remain available for society’s use during this planning period. Beyond this planning period greater utilization of non-traditional woody species might be expected. Under **all alternatives,** continued monitoring and adjustments to the acres classified as suitable timberlands will be needed.

Under a projected persisting warmer/dryer climate fewer tall, straight-boled trees would be able to grow, for milling large or high-grade solid wood boards. Such boards would become higher priced, as their raw source might be somewhat rare. However, society has already shifted into commonly using oriented strand board, pressed particle board, and finger-joined trim/mouldings in the construction industry now, so that solid wood boards are in less demand.

Climate change and its impacts on forests would likely affect market incentives for investment in biomass technology and wood-conservation techniques. The market for wood products in the U.S. is highly dependent on the acreage, location, and species composition of forests; supplies of wood; technological change in production and use of wood; availability of wood substitutes; demand for wood products; and international competition. Rising atmospheric CO_2 would increase forest productivity and carbon storage in forests if sufficient water and nutrients were available. Any increased carbon storage would be in live trees. However, in the Southwest and Apache-Sitgreaves NFs, as discussed above, overall production may be limited by a decrease in available water. While increases in wildfire may decrease some available wood supply, treatment of wildland-urban interface and restoration of the fire-adapted ecosystems on the Apache-Sitgreaves NFs and elsewhere may increase the overall availability of small-diameter timber and related wood products (Joyce et al., 2001).

All alternatives could promote a future sustainable availability of various wood products, by moving forested and woodland PNVTs toward desired conditions, which should make these lands more resilient in responding to climate change. By implementing treatments that can reduce losses to drought, insect/disease outbreaks, and severe wildfires, the alternatives would rank in this order from fastest to slowest restoration rates: **alternative C,** followed by **alternatives D**, **B, and A**.

Multiple socioeconomic impacts often follow drought and severe insect outbreaks. Timber production, manufacturing, and markets may not be able to take advantage of vast numbers of killed trees, and beetle-killed timber has several disadvantages from a manufacturing perspective. In, addition, when insect outbreaks occur, the public often perceives this as an increased fire risk and as detrimental to the aesthetics of montane areas (Ryan et al., 2008). These factors could drive future public policy. Furthermore, wood supplies would vary by forest and woodland type (Sprigg et al., 2000; Joyce et al,. 2001).

As increasing tree mortality rates are already underway in relation with these very same climate-related factors, wood markets may be asked to take more dead and black-charred wood than their enterprises can utilize. **Alternative D**, followed by **alternatives B, C, and A** would create more intentionally fire-killed volume in addition to dead trees already being offered for salvage.

Salvaging and converting biomass into boards, fuelwood, and other wood products (as a byproduct of forest restoration) could help reduce carbon loss from fire. Another consideration may be to use biomass for bioenergy production. Bioenergy production can be carbon neutral and could replace the fossil fuels in generators. Mobile generation facilities could provide power to schools, hospitals, and command centers in the event of an emergency.

If new markets for forest biomass to generate heat and electricity in place of fossil fuels should develop locally or regionally, then traditional "non-industrial" wood species and sizes could become more of an "industrial" demand. Indeed, this trend is already somewhat underway. Alternatives offering the most dependable supply of wood volume from both suitable and non-suitable timberlands would provide the most flexibility to meet changing market demands, in this order from greatest to least: **alternative C, B, A, and then D**.

Forest and woodland restoration treatments under **all alternatives** could have positive and negative effects on the land's ability, within those treated acres, to sequester carbon from the atmosphere. Many complex variables and tradeoffs are involved. In terrestrial ecosystems, huge amounts of existing carbon are typically stored in living forests, woodlands, and herbaceous vegetation. Nationally, forests are estimated to absorb about 10-12% of the anthropogenic CO_2 emissions in the USA (North et al., 2009; Ryan et al., 2010). Large/old trees, plus large snags, large logs, coarse woody debris, vast root systems, and organic soil reserves, found in tree groups and stands that have reached old growth status store existing carbon in their tissues for hundreds of years. Management actions which retain these features on the landscape will keep a large degree of carbon stored on-site, until it is gradually released through wood decay.

Vose et al. (2012) predict that here in the Southwest, "Increased disturbances from fire and insects, combined with lower forest productivity at most lower elevation locations, will result in lower carbon storage in most forest ecosystems. The fire-insect stress complex may keep many low-elevation forests in younger age classes in perpetuity." This suggests that helping large trees retained on the landscape to survive drought, reducing their stress from competition (including reducing excess numbers of young trees), and preventing their losses to severe wildfire and/or insects/diseases, should be forest management emphasis.

Very old trees in decline, diseased trees, and those in densely overstocked stand densities have stagnant growth rates due to high competition for limited resources, and therefore do not typically sequester much additional carbon. Opening up such stands followed by maintenance thinnings would promote more vigorously growing trees (Kerhoulas et al., 2013), which have higher rates of photosynthesis and respiration. Thus their tissues can capture more carbon dioxide in exchange for oxygen released (Hurteau and North, 2009; Hurteau et al., 2010; North et al., 2009; Ryan et al., 2010). Improved vigor and sap flow can also help them resist drought and bark beetle attacks. Trees harvested and converted into durable wood products like furniture and construction materials could capture carbon for many decades, thus keeping it out of the atmosphere (Finkral and Evans, 2008; Ryan et al., 2010). Existing young forests or those regenerated after severe wildfires are equally important for sequestering more carbon, if kept at proper density levels and in good health to maintain vigorous tree growth rates (Hurteau et al., 2010; North et al., 2009; Ryan et al., 2010).

Stand-replacement wildfires consume trees, snags, logs, root systems, and accumulated soil organic matter (carbon sinks) thereby releasing massive pulses of carbon emissions into the atmosphere (Hurteau and North, 2009; North and Hurteau, 2011; Dore et al., 2010.) Severe fires also convert most remaining stored carbon into decomposing stocks, suggesting a long-term emissions increase and significant reduction in live-tree sequestered carbon (North and Hurteau, 2011). Post-wildfire erosion of soil organic matter can transport carbon off-site (Ryan et al., 2010). Forests which burn very severely, followed by post-fire topsoil erosion, can set back reforestation efforts for decades, and possibly convert significant acreages of forest cover to grass, shrub, or rock cover for hundreds of years if not permanently (Hurteau and North, 2009; North et al., 2009; Ryan et al., 2010; plus see the "Deforested/Early Development" sections of this report). Initial treatments that restore forest health, and subsequent treatments that maintain forest resiliency over the long run, would help prevent severe wildfire carbon emissions, as well as prevent a long-term loss of forests from performing their carbon sequestration role in the environment (Finkral and Evans, 2008; Hurteau and North, 2009; Dore et al., 2010).

Projects that harvest trees for fuelwood can quickly or eventually release carbon emissions if smoke is not well-filtered at time of combustion. Alternately, use of fuelwood, mill waste, and forest biomass for heating or energy production can reduce fossil fuels emissions, which is generally considered to be a net improvement for the atmosphere (Finkral and Evans, 2008; North and Hurteau, 2011; North et al., 2009; Ryan et al., 2010). Projects that create excessive amounts of slash not utilized by industry would release carbon emissions when the slash is burned to reduce fire hazard. Mechanized harvesting, transport, and industrial processing equipment also emit carbon exhausts. Projects that use more wildland fire as a thinning and ground fuels reduction tool would release carbon emissions, but not likely as much as large stand-replacement wildfires do. Therefore, the many positive benefits of continued tree harvest can be offset to some degree by the negative effects (Huang et al., 2013; North and Hurteau, 2011; North et al., 2009).

Overall however, with respect to atmospheric carbon levels, it is believed that a net benefit can generally be gained from proper and regular management to maintain healthy forest conditions, especially if the forest management actions used are designed to reduce equipment and slash emissions (Finkral and Evans, 2008; Hurteau and North, 2009; Hurteau et al., 2010; North and Hurteau, 2011; North et al., 2009). Recent research in a northern Arizona ponderosa pine forest has found that live tree carbon stocks in today's fire-suppressed forests are 2.3 times greater than historic forest carbon stocks. Post-thinning carbon stocks can fall within the range of historic carbon stocks, but higher levels of thinning are more similar to the historical forest and more sustainable in the face of climate change. Thus, choosing to maximize the existing forest carbon stock comes at cost of reduced stability because of wildfire risk (Hurteau et al., 2010).

Carbon tradeoffs of fuels-treating forests may have very different short- and long-term costs. In wildfire-burned forest, fuels treatments have a higher immediate carbon cost, but in the long-term may benefit from lower decomposition emissions and higher carbon storage (North and Hurteau, 2011).

The fate of carbon stocks due to restoration thinning treatments will vary based on site characteristics, tree densities, machinery used, wood utilization rates, the fate of wood products, and the reduction in wildfire threat (Finkral and Evans, 2008). Additional variables can include: haul distances from the treatment site to industrial mills; degree of prescribed fire consumption of coarse woody debris and organic soil matter; insects like bark beetles and wood borers attracted to burned areas; amount and species of herbaceous vegetation response; changing climate effects on future tree survival and growth rates.

Most authors list the following management strategies, while one paper (Ryan et al., 2010) lists them in this particular order of decreasing certainty and increasing risk: avoiding deforestation; conducting reforestation; increasing the growth rate of existing forests; use of biomass energy and durable wood construction products to reduce fossil fuels emissions from manufacturing; performing forest fuel-reduction treatments which trade current carbon storage for the potential to avoid larger carbon losses in wildfire.

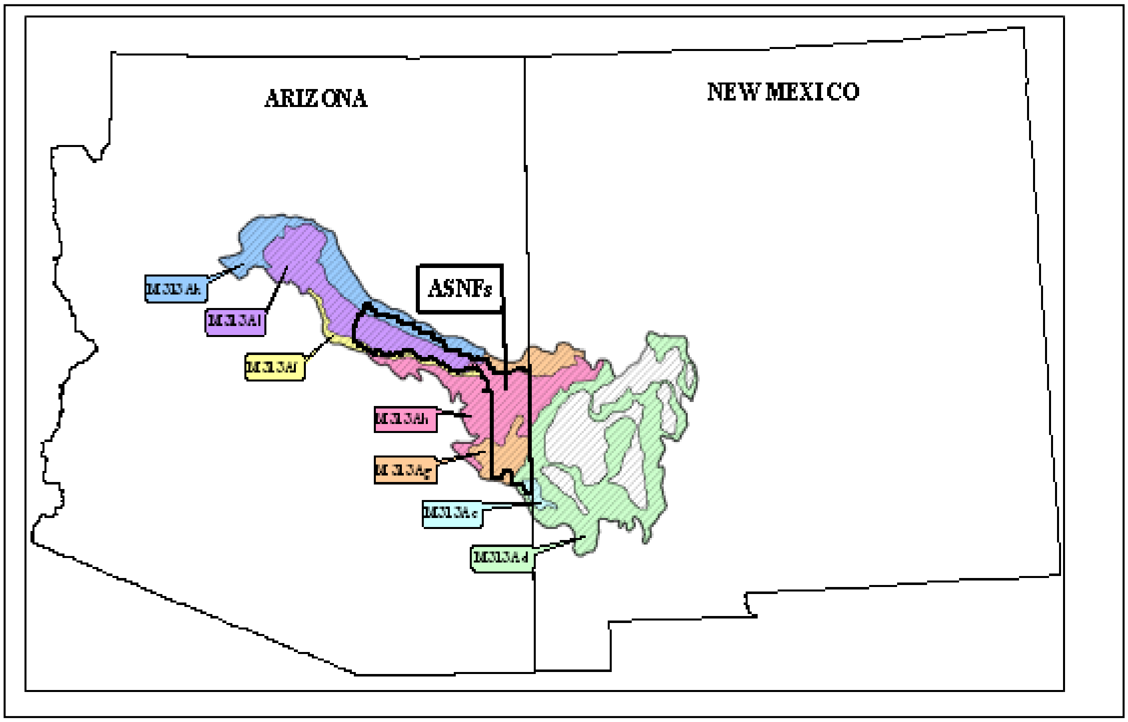
Ryan et al. (2010) further point out that lengthening harvest intervals or decreasing harvest amounts to conserve carbon stores may increase species and structural diversity in some cases, but also include the risks of more wood products being harvested elsewhere to meet demands and carbon loss in disturbance. They summarize the situation well by stressing that "each strategy has risks, uncertainties, and importantly, tradeoffs….Climate change may increase disturbance and forest carbon loss, potentially reducing the effectiveness of management intended to increase forest carbon stocks…most of these strategies currently do not pay enough to make them viable. Forests offer many benefits besides carbon, and these benefits should be considered along with carbon storage potential."

Attempting to compare the Apache-Sitgreaves NF revised forest plan alternatives in this respect would be pure speculation without the ability to reliably estimate the many unknown variables involved for various sites and projects. **All alternatives** would provide direction for projects to: retain balanced amounts of snags, logs, old growth and larger trees (see Appendix **I** to this report for the action alternatives' direction), maintain species biodiversity within the species composition appropriate to each PNVT, including improved herbaceous vegetation condition; improve or maintain structural diversity; reduce overstocked stands to improve tree vigor, growth, and health by reducing competition; restore forest resiliency to uncharacteristic disturbances; reduce stresses from non-native plants, insects, and diseases; improve resiliency to climatic stressors; and thus improve the adaptive capability of forests to climate change.

Cumulative Environmental Consequences

The cumulative effects area for this analysis of forest products is the White Mountains-San Francisco Peaks-Mogollon Rim M313A Ecoregion Section and the seven subsections within the ecoregion (see map 1). In addition to the Apache-Sitgreaves NFs, this ecoregion includes: most of the Coconino NF, portions of the Prescott and Tonto NFs, the southern end of the Kaibab NF, and all of the Gila NF and portions of the Cibola NF in New Mexico. Non-Forest Service land ownerships in this ecoregion include: BLM lands; Arizona and New Mexico state lands; Fort Apache and San Carlos Apache Indian Reservations in Arizona; other tribal lands in New Mexico; and private lands.

Map 1. ASNFs in context to the land areas of the White Mountains-San Francisco Peaks-Mogollon Rim M313A ecoregion



Past, present, and foreseeable forest and woodland management actions on Federal and tribal lands which could contribute to cumulative effects are fire suppression and the lack of thinning trees less than 9 inch diameter that have resulted in an overabundance of small trees with no market value. A similar situation exists on state and private lands.

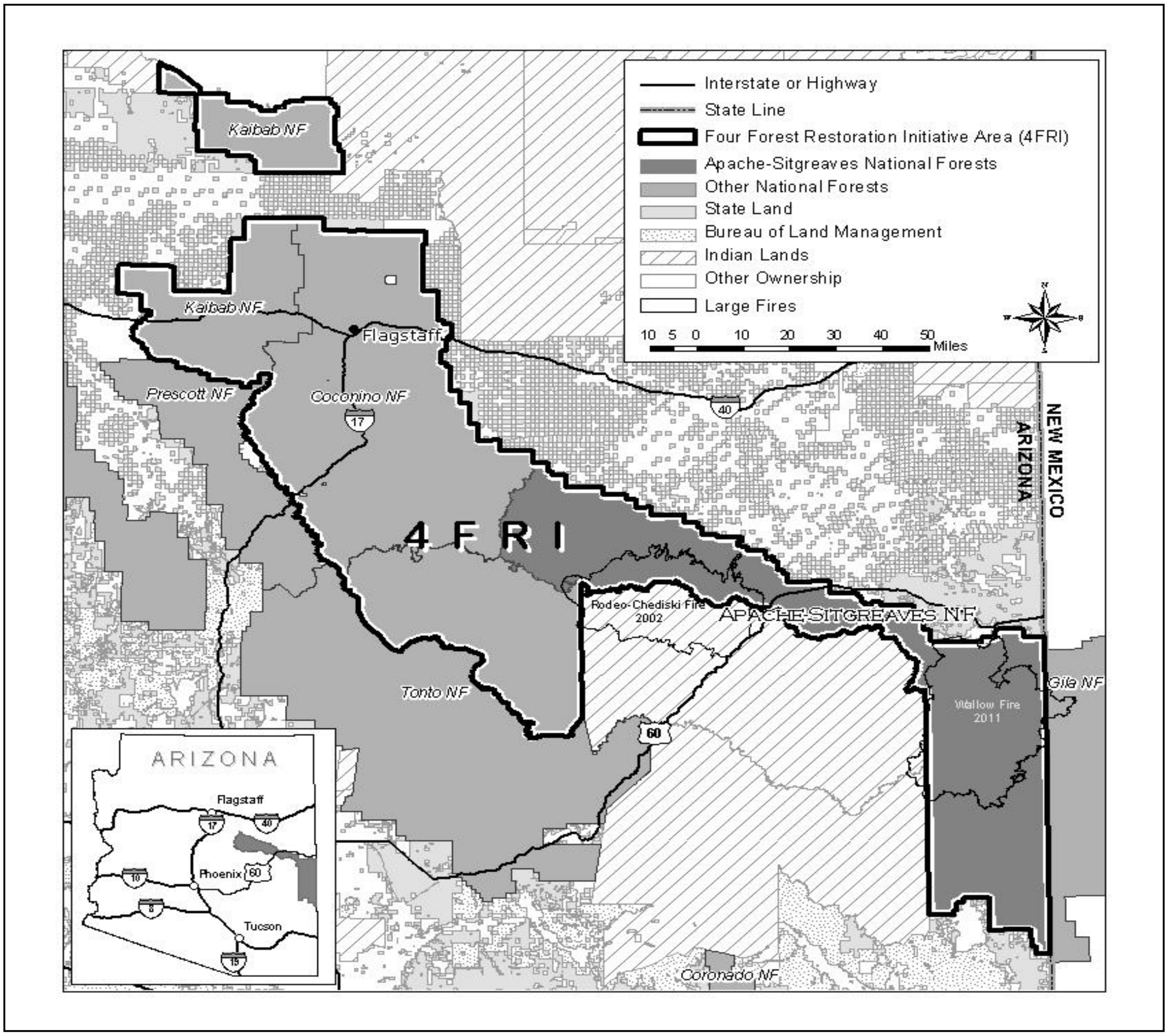
National forests and State, tribal, and private lands have not been able to institute long-term uneven-aged management practices designed to provide sustainable levels of wood products because adequate markets to purchase small diameter trees have not existed on a consistent basis. Management emphasis has focused on short-term fuels reduction at a cost to the land owner.

Wood volumes cut from State and private lands are less likely to impact the total market situation, as their treatments are smaller, widely scattered across the ecoregion, and less likely to provide long-term wood volumes. Tribes typically utilize their cut volumes in their own industries, although they may supply some to local markets. Therefore, the bulk of products available to markets come from Federal lands.

Future forest/woodland management strategies across all other national forests within the ecoregion are expected to be similar to those proposed for the Apache-Sitgreaves NFs. They are revising their land management plans or intend to revise their plans in the near future. The other national forests and the Apache-Sitgreaves NFs would use the same (or very similar) desired conditions for the forested and woodland PNVTs, with uneven-aged silviculture and the return of fire and other natural disturbances to their natural roles.

The largest foreseeable action is the Four Forests Restoration Initiative (4FRI), for which the contract was recently awarded, and some work has begun. This project includes 2.4 million acres on four national forests (Apache-Sitgreaves, Coconino, Kaibab, and Tonto) in northern Arizona, and it will focus on restoring the ponderosa pine and dry mixed conifer forested PNVTs (see map 2 on next page). Several of its landscape scale projects are planned within the White Mountains-San Francisco Peaks-Mogollon Rim Ecoregion. The management actions associated with many future 4FRI projects may be implemented in this planning period. This initiative seeks to develop sustainable markets for wood products as the result of restoring and maintaining desired conditions, which are similar across all four national forests involved.

Map 2. Four Forests Restoration Initiative project scale in Northern Arizona



Logging/thinning industrial operations may need to expand considerably to utilize all the material potentially to be offered annually across the ecoregion (ERI, 2012a; Hunt, 2012). If that does happen, and demand rises more than expected, then it may be possible to treat more acres annually with cuts. In that case, the ASQ might need to be re-evaluated to accommodate a greater early departure above the LTSYC, for the opportunity to reach desired conditions faster. However, if national and local economies/budgets are unable to overcome rising transportation costs and logging/thinning costs, then a glut of wood products may result. This could jeopardize the Apache-Sitgreaves NFs ability to meet maximum treatment acreage objective each year. Should that happen, then return cutting cycles on suitable timberlands would be missed and uneven-aged management strategies would suffer delayed attainment of desired conditions as a negative consequence. More use of controlled fire than originally planned for the chosen alternative could be needed as a primary tree thinning method on suitable timberlands. That would provide its' own consequences of increased smoke outputs, as well as less management control over tree thinning to create/maintain an even progression of age/size classes for long-term sustained yield.

The 4FRI project is likely to become the major instrument to implement **alternatives A, B, or C** treatments on the ponderosa pine and dry mixed conifer forest lands. It has the potential to become the principal market for the majority of logging operations in north and central Arizona during the planning period. Treatments and harvest volumes on the Gila NF would not be included in 4FRI.

Only alternatives C and B are expected to provide enough total cutting volumes to support the Apache-Sitgreaves NFs share of 4FRI demand and that of other local markets. At its high objective level, **alternative C** may be more suited to supply the high volume that 4FRI is expected to demand because the **other alternatives'** cutting volumes (especially **alternatives A and D**) may not be high enough. **Alternative B's** high and low treatment objectives would provide more wood volume to 4FRI than **alternative C's** low objective would. (**Alternative B's** total maximum average volume would be about 263,000 CCF, with a permitted high of about 401,000 total CCF in some years.)

Under **all alternatives**, new industrial uses for small diameter (non-commercial sized) trees (Livingston 2008, 2006, 2004), uses for previously non-industrial tree species, and improvements with in-forest wood removal as well as new milling efficiencies (waste reductions) are further expected to help support developing markets to better utilize more of the same volume offered per acre (Drury, 2013).

Given the large forested acreages removed from immediate timber production by the Rodeo-Chediski, Wallow, and other large wildfires since the year 2000, wood volumes higher than those produced annually by Alternative C are not readily available within the 15 year life of the revised plan. To increase post-Wallow volumes offered annually above those already analyzed would require either cutting more acres per year, or cutting more commercial-sized trees per each acre treated annually, or both. In the professional opinions of the ASNFs Planning Team Biologists, increases in cutting levels beyond those analyzed in detail would have the potential to threaten the viability of some wildlife and/or fish species (WhiteTrifaro, 2014). Moreover, alternatives to cut higher annual volumes than those analyzed in alternatives B and C were considered but dropped from detailed analysis as unrealistic for the ASNFs expectations for annual budget and workforce capacities, as well as market capacity (Drury, 2013). If the 4FRI-treated acreage ends up being limited to mostly ponderosa pine and mixed conifer acres, with less emphasis on treating the other PNVT acres, this could also be a limiting factor preventing volume offerings above those analyzed in detail.

Alternative A is not expected to provide enough volume for 4FRI because this alternative emphasizes mechanical treatments around communities. Currently, most areas around communities have already been thinned and now only require follow-up maintenance thinning during this planning period. As a result, harvesting may shift to other national forests for more volume, which could pull operators and contractors away from completing restoration work elsewhere on the Apache-Sitgreaves NFs. A Forest Service strategy for 4FRI is to discourage Federal payment for tree cutting and removal services, in favor of returning to selling the cut trees at minimal to fair sale values. This shift in strategy could eliminate some logging/thinning companies from fully participating, and/or reduce the number of sales sold as transportation fuel prices rise. Fewer cutting treatment acres could result, and they would likely be located closer to established markets, and/or to lands nearest to railroad lines.

Alternative D can provide wood volumes during the planning period, but would fall short of contributing to sustainable markets. It treats so many more acres exclusively with fire, and cuts on several PNVTs for which 4FRI has no focus, thereby limiting the amount of harvestable green wood volumes to support the markets dependent upon the 4FRI collaboration.

All ASNFs project-level decisions must be compliant with the forest plan in place at that time. Therefore, any NEPA projects on the ASNFs developed under guidance of the 1987 forest plan, but with analysis finalized after decision signature of the revised forest plan, will be required to comply with the new plan.

See the Socioeconomic Resources section for additional cumulative environmental consequences.

Unavoidable Adverse Environmental Consequences

The proposed plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Therefore, decisions made in the proposed plan do not cause unavoidable adverse environmental consequences. The application of standards and guidelines during future project and activity decision-making would provide resource protection measures and would limit the extent and duration of any adverse environmental impacts.

Irreversible and Irretrievable Commitment of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those lost for a period, but could be regained, such as the temporary loss of timber productivity in forested areas kept clear for use as a power line rights-of-way or road.

Because the proposed plan does not directly authorize or mandate any site-specific project or activity (including ground-disturbing actions), none of the alternatives cause an irreversible or irretrievable commitment of resources. Future project-level decisions under any of the alternatives may result in potential irreversible or irretrievable commitments of resources, which would be disclosed accordingly with the project site-specific analysis.

Adaptive Management

The desired conditions, management approaches, standards and guidelines, and **action alternatives** for the proposed plan provide the adaptive framework to help deal with impacts from climate change. They focus on creating and/or maintaining resilient and redundant resource conditions to provide reasonable assurance of the ability to adapt to a changing climate. Each alternative emphasizes some level of return to desired forest/woodland structure, function, species composition, health, fire regime, and other natural disturbance patterns that evolved here during millennia in which variable climate patterns were present.

When fire is used intentionally to manage woody vegetation it becomes a silvicultural tool requiring the applied knowledge of tree/shrub species silvics. Therefore it requires planning and involvement of a regionally-certified Silviculturist working in close cooperation with an experienced and credentialed fuels specialist to develop the prescribed burn plan (Bartuska and Croft, 2001; Rasure and Harbor, 2011; also see report Appendix B1-Table 1) and monitoring elements. A consequence of shifting into using more fire as the tree-thinning tool of choice across all action alternatives, would be the critical silvicultural timing needed for repeat fires to occur at least once every 15 years (or sooner), as a tree stocking control method. Cool ground fire often acts as a good seed-bed preparation that increases the abundance and survival of natural conifer regeneration. New pine, juniper, and Douglas-fir regeneration that become established on average-to-highly-productive sites can grow rapidly enough into the large sapling/pulp/small pole-size to reach height and/or bark thickness that are less susceptible to cool ground fire (Boehning,1982-2014; Youtz, 2010b; Jones, 1974; Laughlin et.al, 2011; Roccaforte, Nov. 2012).

If project-level decisions should choose to implement moderate severity fire as the only tree stocking control method on suitable timber lands, then the timberland suitability classification and the ASQ would need to be re-evaluated. The traditional long-term sustained yield concept of “cut = net growth” would no longer be applicable, unless adjusted to account for “cut + burn = net growth”. If the burning program fails to keep up with the needed schedule, then excess trees will need to be thinned by cutting instead, which could require plan amendments to modify the management objectives for any action alternative selected.

If we expect fire to keep the forest thinned out in place of cutting excess trees, then it <u>must</u> occur before those trees are too large for fire to do its intended job. Missing regular fire cycles for any reason (limited burning condition windows, low budgets, workforce shortages, restrictions on smoke production, etc.) jeopardizes reaching and maintaining the desired conditions (Sackett et. al., 1994), so adaptive management would be needed in that case. Should planned maintenance of desired conditions with the use of fire not occur frequently enough to reduce numbers of natural tree regeneration on a regular basis, then cutting re-entries would be required to accomplish that goal (and higher wood products volumes may result). This consequence would be the least under **alternative C**; and the greatest under **alternative D**, which relies more heavily on using fire across the most treatment acres as the only tool for tree thinning. While wood volumes removed from grassland restoration treatments could likely be limited to one cutting entry, wood volumes cut from woodlands and non-suitable forested lands would likely require repeating entries, as would repeating cuts of non-suitable species and sizes on suitable timberlands.

The NFMA requires re-evaluation of the forest plan’s suitable timberlands every 10 years, during which time market demands may become more clear. If resource conditions and/or available volume should change before then, updated analysis could be performed to revise the plan’s ASQ accordingly. Recalculation of suitable timberland acres and ASQ may need to consider shifts of tree species ranges across the landscape onto different areas, and tree growth rate changes in response to shifts in climate. The LTSY may need to be recalculated as well. Timber growth and yield models and landscape level vegetation models would have to be recalibrated for these new calculations. New markets to utilize more abundant species would likely develop. If certain tree species or sizes become rare and in higher demand, they may bring high enough market prices to offset currently cost-prohibitive cable or helicopter harvesting operations.

Another component of the proposed plan is the chapter on monitoring strategy. Information from monitoring items listed there will enable changes needed in the plan for adaptive management. The Forest Service would continue to monitor market demand and if resource conditions allow, the plan could be amended to increase the ASQ if needed.

Other Planning Efforts

Several other planning efforts were previously described in the Cumulative Effects section.

Although the proposed plan (**alternative B**) emphasizes addressing the needs of communities at risk of catastrophic fire, it is not entirely consistent with the Community Wildfire Protection Plans (CWPPs) for Apache, Navajo, Coconino and Greenlee counties, which were published in 2004 and 2005. These CWPPs include a generic prescription to "thin from 40 to 60 BA, with a 16-inch diameter cap" on Federal lands, which may not move project areas toward the land management plan's desired conditions. As designed, **alternative C** would be inconsistent with such a prescription, while **alternative D** would adopt the 16-inch diameter cap for nearly all cuts. **Alternative A** may continue to use this prescription on many treatment acres. Under **all alternatives**, this generic prescription would not automatically be proposed or adopted at the project level. However, the CWPP prescription will need to be considered as an alternative analyzed in detail under any project (**regardless of plan alternative**) proposed under the Healthy Forests Restoration Act of 2003. Even though **Alternatives B and C** were designed to have no 16" diameter cap cuts, they would still retain numbers and densities of large trees for compliance with the current Mexican Spotted Owl Recovery Plan on PAC acres and on Recovery nesting/roosting habitat acres (USDI-FWS, 2012).

The 4FRI public stakeholders group has adopted an "old growth protection and large tree retention strategy" (OGP&LTRS) proposed for their desired inclusion with all 4FRI NEPA planning on the four 4FRI national forests (4FRI, 2011a - revised 2012; 4FRI, 2011b). Although the OGP&LTRS does not dictate a universal upper cutting size limit (diameter cap), it does universally dictate keeping all pre-European-settlement (ie. old) trees in all cases, as a pseudo "one-metric-fits-all" management approach based on social and political values, much like a diameter cap (Sanchez Meador et.al., 2015). The OGP&LTRS proposes very specific tree retention requirements that are much too prescriptive for a programmatic land management plan, and too detailed for fine-scale modeling in this analysis. The strategy's details would need to be analyzed at the project level, as they apply to very site specific conditions that may differ from the purpose and need to move certain project acres toward desired conditions. Covington (2000) supports engaging community-based partnerships but also advises against a "one-size-fits-all" restoration approach.

The OGP&LTRS is not appropriate to adopt within a programmatic land management plan because it:

- Reduces the flexibility that project-level deciding officials may need to design treatments that promote site-specific desired conditions suited to the actual acres involved.
- Only permits cutting large post-settlement trees under all the certain exceptions listed therein; prohibits cutting any pre-settlement tree for any reason regardless of tree size or condition.
- Fails to permit cutting old/large hazard trees for public safety, new utility corridors, and for ecologically beneficial road realignments.
- Fails to permit cutting old/large trees heavily infested with insects or disease as a control method, which is inconsistent with one of their goals stated on page 3 "…to restore healthy...stands, …"
- Provides an incomplete definition of the ponderosa pine/Gambel oak forest type per the 1995 and 2012 Mexican spotted owl recovery plans (USDI-FWS, 1995 and 2012). Moreover it only cites the 1995 Mexican spotted owl recovery plan, which is now obsolete.
- Has an exception category entitled "Aspen Forest & Woodland" (pages 17-18) which only addresses aspen, and curiously offers no discussion or big tree retention criteria whatsoever for pines encroached into woodlands.
- Has a "large young tree" marking exception category which states an objective that conflicts with multiple use and sustainable harvest on suitable timberlands. The stakeholder document admits on page 25 that this exception category still requires "additional collaborative analysis and clarification". This statement is footnoted as having been finalized on July 15, 2011 inside the document cover date of Sept. 13, 2011, which is further labeled on their website filename for this same document as "revised August 2012". So we must assume this category is in their final and approved text as written on page 23. Therefore it still conflicts with uneven-aged management and sustainable harvest on suitable timberlands, because it permits no removal of those pre-settlement (old) trees that are beyond viable seed tree age, and/or are likely to infect younger age classes with disease. Removal of over-mature and/or unhealthy trees is needed to make room for regeneration and progression of younger age classes, including room for large, healthy mature trees to develop into good seed-cone bearers.
- Suggests on page 5 that uneven-aged silviculture goals are "production-oriented", when in fact both uneven-aged systems (individual tree selection and group selection) are emphasized in USFS Region 3 plan revision because they are the only way to ensure that the forest is sustainable over the long-term by keeping a progression of all age classes present concurrently. Likewise, page 21 of the OGP&LTRS document states "The stakeholder group does not support the cutting of large trees to create regeneration openings", which is an integral part of the uneven-aged group selection method, as well as an important forest management step mimicked for northern goshawk habitat needs incorporated into the plan's forested PNVT desired conditions (Reynolds et al., 1992; Reynolds et al., 2013). Group selection cuts need to be used to convert exiting even-aged stands to uneven-aged stands, because the individual tree selection method does not do this.
- Is difficult and time-consuming to implement, as field crews must look for pre-settlement tree evidence (e.g., stumps, stump holes, logs, snags) at every seep, spring, wet meadow, riparian strip, within-stand openings, etc. in order to leave large replacement trees for that pre-

settlement evidence. Also, such evidence may no longer exist, or be much more difficult to find, after severe wildfires like the Wallow and Rodeo-Chediski.

- Does not address the fact that in the majority of WUI acres already treated across the ASNFs practically all trees ≥16” DBH were left un-thinned in the most recent entry, with nearly all the smaller trees removed on many acres to achieve WUI objectives. This is especially the case on the Apache NF, where that large tree overstory is growing back into an interlocking canopy, such that the next thinning entry will require thinning primarily of large trees to break up the main canopy so it cannot easily carry crown fire. Post-settlement-aged large trees can be the focus of this fire hazard reduction maintenance in many stands, but removal of some pre-settlement-aged trees may also be required to meet WUI thinning objectives in some stands.

- Only covers ponderosa pine large/old trees for the 4FRI forest treatments (footnoted on page 3 of the OGP&LTRS document), but not other tree species in the other forested and woodland potential natural vegetation types (PNVTs) expected to be treated by 4FRI and/or by other implementation projects during the life of the ASNFs land management plan.

- Appears to be written primarily by citizens who are mostly familiar with northern Arizona pure pine forest conditions. Fails to address the more diverse ASNFs forest conditions containing off-site species encroached into our forest and woodland types as large-but-young seed trees that need to be removed for restoring correct tree/veg. species composition to the corresponding fire regimes in our PNVTs here.

- Concludes that monitoring the outcomes of implementing the OGP&LTRS will be done. If the stakeholders’ ecological restoration goals are not achieved by this strategy, they are committed to adapting their policy to achieve better outcomes. If adopted into the ASNFs revised plan and then changes are made by the stakeholders during the life of the plan, some sort of plan amendment may be required, possibly allowing one or more external parties to make a Forest Service decision.

- Incorrectly uses the term “old growth trees” several times, which is not consistent with the ASNF plan’s definitions of “old growth,” “old growth components,” and “old tree” (see the plan’s glossary).

- Moreover, the ASNFs’ plan does not need to incorporate the OGP&LTRS because the plan directs project managers to retain appropriate amounts of large/old trees and/or old growth in numerous plan decisions (see report Appendix **I**).

No other potential conflicts are evident from this analysis between the proposed action and the objectives of Federal, regional, State, local, or Tribal land use plans, policies, and controls for the area concerned.

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Credits

Major supporting contributors to this report are:

Nancy Loving, Forest GIS Specialist
Chris Nelson, Forest Soils Scientist (timber suitability)
Mitchel White, Forest Ecologist (VDDT model cutting volumes, some climate change info)
Deborah MacIvor, Forest Engineer (road cost calculations in economic efficiency study)
Ray Rugg, Apache Zone Timber Staff (logging operability mapping)
James Youtz, Southwestern Region Silviculturist (advice, review, and edits)
Jerry Drury, Apache-Sitgreaves Timber Program Mngr./Natural Resources Staff Officer (review and edits)
Michelle Davalos, Forest Planner (editing and formatting)

Appendices - Forest Products Report

Due to the size and nature of these appendices, they are available in the Planning Record Set of Documents as separate electronic files. They are listed below as an index.

Appendix A1: 1992 WO amendment to FSH 2409.13, zero code. 08/03/1992. (5 page **.pdf** doc.)

Appendix A2: Timber Suitability Analysis Procedures and Alternative Tables (12 page .**pdf** doc.) By C. Nelson, N. Loving, M.Boehning, M.Davalos. Finalized August (15), 2012.

Appendix A3: Suitable Timberland Logging Cost Efficiency Analysis (Excel Spreadsheet with "Read Me" tab and 12 worksheet tabs). By M. Boehning and D.MacIvor, March 5, 2012.

Appendix A3Roads: Road Maintenance, Reconstruction and New Construction Costs Developed for the Suitable Timber Lands Economic Assessment Worksheet. By Forest Engineer D. MacIvor, March 5, 2012. (9 page **.pdf** text doc.)

Appendix A4: Suitable Timberland Maps, for Alternatives A, B, & C: Six small **.jpg** image maps by N.Loving, March 15, 2012; and six large **.pdf** PNVT maps for logging cost efficiency analysis, by N.Loving, March 2, 2012.

Appendix B1: Surrogate Methods of Prescribed Cut and/or Burn Adopted by USFS Region-3 in the R3 FVS Process for Evaluating the Effects of Vegetation Management Activities in the Forest Plan Revision Process. By M. Boehning/Region-3, finalized Aug. 1, 2014. (11 page **.pdf** doc.)

Appendix B2: Silvicultural Rationale for Different Timber Management Approaches and Cutting Mixes by Each ASNFs Alternative for Modeling in VDDT. By M. Boehning, March 15, 2012. (5 page **.pdf** doc.)

Appendix B3: Sample PNVT Percentages of Surplus and Deficit Structural States on the ASNFs, Differences between Current and Desired Conditions. By M. White and USFS Region-3 (2 page **.pdf** doc/diagram, using PPF PNVT as an example.) Feb. 6, 2012.

Appendix B4: USFS Region-3 FVS Model Prescribed Treatment Resulting State Transitions for Calibrating VDDT. By Region-3 Plan Revision Timber Working Group. Assembled for display by M. Boehning, 5/6/12. (Excel spreadsheet with a "Read-Me" tab and 5 large worksheet tables.)

Appendix B5: Apache-Sitgreaves NFs Silviculture Tree Cutting and Planting Prescriptions to Model in VDDT – prepared by Alternative, PNVT, Suitable and Non-suitable timberlands, Hi and Low treatment objectives, by M.Boehning, completed Feb. 21, 2012. (Four **.pdf** docs of 60 total colored tables assembled and labeled by each Alternative.)

Appendix C: ASNFs Master Acreage Tables for Treatments to Model in VDDT on Suitable, Non-Suitable, and Fire-Only Lands, by PNVT and Alternative. By C.Nelson, 2/10/12. (2 Excel spreadsheets)

Appendix D1: Sample live green tree raw cutting volumes table from VDDT run. Tables generated by M.White. (2 large Excel spreadsheet tables, using Alternative B, PPF PNVT, Suitable lands, Decade 1, High and Low options as examples.) Sept. (15) 2012.

Appendix D2: Cutting Volume Spreadsheets of all wood products from VDDT, by PNVT, product type, and Alternative. By M.Boehing, 3/21/12 through 9/26/12. (large Excel spreadsheet with 5 worksheet tables)

Appendix E1: Acreages of treatment methods modeled in VDDT, by alternative. By ASNFs Plan Revision Team, M.Boehning, and M. Davalos. Updated 5/1/12. (1 large Excel spreadsheet)

Appendix E2: Acres by treatment type used to model the low and high annual treatment objectives in VDDT. By ASNFs Plan Revision Team and M. Davalos, May 26, 2012. (4 page **.pdf** table)

Appendix F: Youtz, James A, and Don Vandendriesche. September 5, 2012. R3 White paper K entitled: National Forest Planning and Sustained Yield of the Timber Resource Long-Term Sustained-Yield Calculations for Forest Land and Resource Management Planning. USDA Forest Service, Southwestern Region, Albuquerque, NM, and Washington Office Forest Management Service Center. (39 pp. **.pdf** doc.)

Appendix G: Sample USFS Region-3 FVS model results of pre-cut, harvest, and post-cut tree species composition changes for the Free Thinning, Diameter Cap, and Group Selection cutting methods used in VDDT (using the Dry Mixed Conifer PNVT, veg. structural state I as one example.) FVS Model runs done by Region-3 in 2010-2011. Results of 3 simulations assembled for display by M.Boehning in May (15), 2012. (16 page **.pdf** doc. of FVS stand output tables with color emphasis added.)

Appendix H: USFS Forest Inventory Data Online (FIDO) website queries of ASNFs years 1985/1999-2008/2009 FIA plot data showing mortality trends of large trees due to causes other than fire, insects, disease or animals (Website homepage screen capture + 4 large tables, double-sided). Queries run by M. Boehning on 5/17/2011. (10 page **.pdf** doc)

Appendix I: Forest Plan Revision Direction Applicable to Old Growth/Large Trees, in preferred alternative B and common to all alternatives. List compiled by M.Boehning on 4/9/2014. (5 page **.pdf** doc)