Sinlahekin Wildlife Area

Fuel Reduction and Fire Regime
Restoration Plan
Volume 1: Management Strategies

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Introduction

Sinlahekin Wildlife Area (SWA) is managed by Washington Department of Wildlife to provide quality wildlife related recreation opportunities on approximately 14,000 acres of land in North Central Washington. The SWA is a 12-mile long narrow valley that has streams, lakes, swamps, steppe and deciduous forest as well as conifer forest. The primary management objective is to maintain and enhance wildlife habitat. The SWA is visited by thousands of people each year.

The ecological sustainability, wildlife and beauty of the SWA is at risk due to fire suppression and use of the land for timber, forage, farming and recreation over the last 100 years. These activities have altered historical biological processes, causing adverse impacts on aesthetics, plant and animal communities and they have increased potential for high intensity fire events.

Some of the most notable changes that have occurred on the SWA landscape following Euro-American settlement are:

- Increase of non-native plants with a corresponding decline of native plants
- Increase of the woody shrub component in rangeland and grassland
- Increase in tree densities and historically uncharacteristic high fuel loads
- Decline of late seral species
- Change of tree species ratio (increase of Douglas-fir and decrease of ponderosa pine)
- Increase in tree pathogens
- Altered hydrologic function
- Altered nutrient cycling

Many of these changes can be attributed to the alteration of the historic low-elevation fire regime that was characterized by frequent, low-severity fires. Fire was a regular disturbance agent that profoundly influenced the condition of the pre-European settlement landscape.

In addition to naturally caused fires, fire was a tool used by native Americans to enhance the productivity of the land. The native people living on the SWA relied upon native plants and wildlife that thrived under the historic frequent fire regime. Lush grass/forb steppe and open forests of the low and mid-elevations provided habitat for wildlife and produced a large portion of the sustenance required for their survival.

Some of the early European settlers also used fire as a tool. An example is Tratnik Ranch at Aeneas Valley near the west fork of the San Poil River. This ranch was managed through the 20^{th} century with fire as a primary management tool.

Today, there is broad acceptance that much of the inland dry site ecosystem has an elevated risk of severe wildfire and severe wildfire effects. While there is consensus that there is a problem, the complexity of ecosystems combined with conflicting social priorities has resulted in gridlock. Each local area has its own particular combination of environmental, political and social needs that are further compounded by regulatory limitations. These needs can best be addressed through the collaborative efforts of those who are most familiar with the land.

The SWA Fuels Reduction and Fire Restoration Plan involves working with the local community on projects that will restore the sustainability, functionality, productivity and resiliency to the SWA landscape. This strategic plan is the starting point in this process.

The SWA Fuels Reduction and Fire Regime Restoration Plan provides detailed strategies for management direction that will begin to restore conditions that permit fire to be used as a tool to maintain the fire dependent ecosystem. In addition, Analysis and Appendices are presented in Volume 2 of this report documenting the supporting data and rationale for these management intervention strategies. A set of burn plans is provided that covers the entire SWA.

Background

The SWA was originally established in 1939 using Pitman-Robertson funds to purchase the land for public hunting and outdoor recreation opportunities. Securing mule deer habitat was the primary purpose for acquiring the original land parcels. Today the SWA encompasses nearly 14,000 acres of land. Wildlife food plots and shrub plantings, feeding programs and weed control are some of the management tools used to enhance habitat for deer as well as other game animals. Wildlife management has changed as knowledge has been gained. Today it is widely accepted that restoring ecosystem function similar to historic conditions will provide the best chance for maintaining a dynamic wildlife habitat in space and over time. The SWA managers have been working toward this goal using various intervention activities.

One of the most significant insights that has come to light with regard to ecosystem health is the importance of fire. The historic fire regime in the

SWA was characterized by frequent, low intensity fires that suppressed the growth of woody understory species while allowing larger trees to survive.

Restoring fire to the SWA landscape is one of the major challenges of managing the SWA lands. The indigenous plants and animals evolved with fire as a regular and frequent occurrence. Native Americans recognized the benefits of fire and used fire to enhance their hunting and gathering lifestyle.

Numerous studies in the latter part of the 20th century have quantified the changes of structure, species mix, density and fuel loads on dry site forests and forest/steppe ecotones that have resulted in the absence of fire[1]. These altered forest conditions have increased the risk for uncharacteristically severe wildfires.

Restoring and maintaining ecosystem function will require ongoing activities that will change over time as knowledge is gained. This plan has been developed to provide a framework for doing so in a holistic and inclusive manner that uses adaptive management.

Objectives

Restoring fire and resultant processes is a primary management objective on the SWA. Other accompanying issues such as invasive species and soil degradation will need to be addressed in the process of reintroduction of fire. Restoration of prescribed fire will achieve the objective of habitat dynamics and enhancement through:

- Reduction of the risk of undesired impacts from high intensity fire on soil, water quality, forest structure, successional stages, spatial relationships of plant communities in various successional stages and plant communities in general
- Creation of a post fire soil nutrient flush promoting rapid, nutrient rich plant growth
- Renewal of fire dependent plant species such as ponderosa pine, aspen and buckbrush (*Ceanothus velutinus*[*])
- Reducing overstocked coniferous forest canopies while promoting the development diverse understory and aspen communities
- Creation of snag habitat

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[1] Kaufmann, Merrill R.; Fulé, Peter Z.; Romme, William H.; Ryan, Kevin C. “Restoration of ponderosa pine forests in the interior western U.S. after logging, grazing and fire suppression”, CRC Press, 2005

∗ Aspen and buckbrush are both in decline on the SWA and are beneficial to wildlife

- Increasing fire resistant late successional forest structure with an increased ratio of ponderosa pine to Douglas-fir
- Maximization of the capture and slow release of water through less interception loss*, lower transpiration, and improved soil structure*
- Restoration of historic lower treelines
- Reduction of tree pathogen levels
- Increased abundance of early successional plant communities on the landscape
- Increased mosaic patterns of successional plant communities

The above list includes some of the major direct functions of fire in low and mid elevation dry landscapes. Fire was a major determinant of dry site ecosystem conditions for thousands of years before fire exclusion over the last century brought about today's non-sustainable conditions. Reintroduction of fire will influence the interactions between other ecosystem elements and restore the dynamics that sustain wildlife populations within a range of historic variability.

Strategy

The management plan for the SWA is based on the location, timing and type of intervention treatments that will result in long-term restoration of landscape-level ecological processes and natural structure to the extent that is both effective and practical. Achievement of the objective of restoring fire and resultant processes to the SWA will require:

1. implementation and maintenance of a long-term program
2. community support
3. education
4. planning
5. monitoring
6. adaptive management

Each of these components is interdependent. Addressing biological needs of the SWA ecosystem must be integrated with community education to gain support for changes that will occur during the restoration process. Planning for restoration activities must include adequate opportunities for public participation. Monitoring the effect of activities will provide quantitative data to determine whether treatments are effectively meeting objectives.

∗ Interception loss refers to precipitation intercepted prior to reaching the watershed surface.
∗ Soil structure refers to mineral and organic soil elements bound together by mineral or organic material to form aggregates from 10 to 55 mm.

Monitoring increases our understanding of ecosystem functions and helps provide examples for education. Succesful implementation of long-term restoration objectives will require a collaborative effort to analyze results at each outcome phase and revise strategies accordingly.

The key to community support is communication. This includes maintaining hard copy archives of ecosystem assessments. Making use of the Internet can facilitate the sharing of information among stakeholders and the public. Traditional methods to communicate such as meetings, signs, brochures, radio and newspaper notices remain important to insure that a broad public audience has an opportunity to keep informed. This is important since fuels treatments and the reintroduction of fire involve changes in the way people have traditionally understood the role of fire in wildlife habitat restoration.

The understanding of fire by the general public has been influenced by over 60 years of the Smokey the Bear campaign. The media sometimes perpetuates the idea that fire is “bad” with descriptions of fire events like “destruction” and “catastrophe”. Blackened landscapes are not considered to be aesthetically pleasing. Camping areas and lakes surrounded by fire-blackened hills are not popular for recreation, even though the condition is short lived. Every effort must be made to keep the public informed and updated on scheduled activities. Alternative camping and recreation sites must be available when prescribed burns affect popular parts of SWA. Notification of likely smoke impacts need to be communicated well and their rationale should be given clearly in order to garner public support that is critical to an effective program of prescribed fire.

The effort to re-educate the public, lawmakers and stakeholders about the importance of fire in maintaining healthy ecosystems will dovetail with a multifaceted education and outreach program designed to raise the level of understanding of fire-dependent ecosystem dynamics on the role of fire. The campaign will include materials with differing levels of detail and complexity suitable for K-12 students to resource professionals. These materials will be available online and in hard copy form.

Educational materials will be coupled with scheduled field days that will permit those with a higher level of interest to observe the progress of restoration efforts first hand. In addition there will be self-guided tours with informational signage at treatment areas with detailed information for each site available online.

Another educational component is to encourage participation by the academic community. Involvement of local students will promote community ownership in the project. Relationships with College and University students and professors will facilitate two-way exchange of information enhancing the students' educational experience while providing research and teaching opportunities for professors.

Successful restoration of fire to the SWA is dependent on an inclusive planning process. Researchers have gathered detailed information of the effects of fire on soils, plants and wildlife. Computer models have also been developed to predict fire behavior. Inclusion of adjacent landowners, resource managers, forestry contractors and cattlemen in the dialogue will assure that those affected by restoration practices will be informed and their concerns will be addressed. Providing a process for public involvement will not only keep the public informed, but will also provide broad based experiential knowledge with insights that are sometimes overlooked by specialists with a more focused area of expertise. Time spent on this process will facilitate the effort and improve restoration outcomes.

Monitoring is an essential part of the restoration process that allows management to adapt to changes in the ecological and administrative system. Unique combinations of ecosystem conditions on each particular location may require modification of implementation practices and of management plans in order to address particular biological needs. Base line and post treatment monitoring will provide knowledge that can be applied to future treatments. Monitoring protocols must be clear and consistent to assure that future managers will be able to replicate them. Permanent monitoring sites will be of great benefit over time.

Quantified outcomes will provide information that will guide future intervention practices on each site. Adaptive management based on site-specific information will result in continual improvement of management practices. The predictability of outcomes will also be improved as knowledge is gained.

A fire restoration strategy that includes these elements will achieve the objective of restoring fire and fire-dependent processes to the SWA, while meeting societal needs.

Initial Planning

The Sinlahekin Phase II initial planning process integrated assessment data from Phase One of the fire regime restoration project with additional fuels and field assessment information gathered through the summer and fall of 2004 and analyzed through 2005 and 2006 (see Volume Two Analysis and Appendices Analysis-A through F). A geographic information system (GIS) was used to map the location of cover types, treatment areas, and many other ecosystem elements, and to analyze the temporal and geospatial interaction of these elements for long range planning. The information was used in conjunction with fire behavior modeling programs to identify areas where it would be most effective and practical to reintroduce fire over time.

Out of a total area of 14,370 acres in the SWA, 5,659 acres have planned burns on them with 2,588 acres in conifer forests that may also require mechanical treatment (see Volume 2 Analysis and Appendices Analysis-A through F). Another 2,716 acres of coniferous forest that are outside of planned burn units are also in need of fuel reduction that may be possible through mechanical means. The parts of the SWA that do no have planned burn units are those with challenging topography or difficult fuel conditions (high and low levels) or with adjacent land ownerships that will require extensive site specific mitigation or cooperative management prior to fire reintroduction.

Soils are a primary determinant of the productivity of terrestrial ecosystems. Soil is a combination of air, minerals, water and organisms that support plant life. Soil condition directly affects the types of plants and the growth of plants that occur on those soils. Numerous disturbances from raindrops to landslides impact soil. Fire can impact soils to varying degrees depending on its intensity and duration, soil type, moisture, topography and chemistry. High intensity fires of long duration can create sterile patches in the soil. Fires can create a hydrophobic surface layer that may delay plant reestablishment and increase the potential for runoff damage. Fires generally provide a nutrient flush that enhances plant growth. Heavy machinery used for fuels treatment can compact soils and strip protective duff layers or break up and redistribute coarse woody debris on the soil surface. Effects of fire and mechanical disturbances on soils are highly variable and to a large extent determined by timing, techniques and soil type. For example, ground based harvest equipment can result in no soil compaction when used on frozen ground or deep snow while spring logging on the same site could create severe compaction. On the other hand sandy gravelly soils are less susceptible to compaction under all conditions.

Unwanted spread of invasive plant species can be a problem with the re-introduction of fire in this area. Many invasive species benefit from the conditions created by fire, i.e., soil disturbance, increased solar exposure, nutrient release, reduction of competition, and improved seed spreading and germination. The strategy used to control invasive species is to use a comprehensive toolbox (integrated weed management, or IWM), be site-specific, monitor both before and after treatments, and use prevention as a tool of first resort. Prevention includes a number of measures. Livestock exclusion should be used after a fire until vegetation recovery is well established. Equipment should be steam-cleaned prior to moving between infested sites. Soil disturbances from treatments, including line construction, should be minimized. Contractors need to be able to identify invasive species that they will encounter. Rapid recovery of vegetative cover should be enhanced whenever possible through the use of plant propagation with native or sterile species.

Habitat maintenance and enhancement must be within the ecological parameters of a sustainable fire regime similar to the historic fire regime. Modifications on the timing of prescribed fires will provide a level of control to enhance particular plant species such as bitterbrush and *Ceanothus* that are important deer browse. Renewal of fire adapted native plants will also improve upland bird habitat.

The risk of negative fire impacts, such as fire escape and smoke production, will be minimized by adhering to burn plan prescriptions and by combining mechanical fuel reduction in conjunction with burning (see the Burn Plans). Mechanical treatments will consist of pruning, non-commercial and commercial thinning, fuel reconfiguration and slash treatments. These activities will modify forest structure and fuel levels to modify fire behavior. Thinning dense suppressed conifer thickets will add ground fuel to assure that fire will carry, while reducing the risk of mortality of legacy and potential legacy trees from torching. Slash treatments include pile burning prior to controlled burns to further reduce fuels. Commercial thinning has the potential to offset some of the costs of restoration. Prescribed burns and mechanical fuels reduction activities are designed to create forested and nonforested habitat conditions in the SWA that are sustainable under a frequent fire regime.

Implementation

The re-introduction of fire to the SWA presents numerous challenges. The main challenge is the inability to precisely predict the results of management activities due to the complexity and unpredictable nature of ecosystem processes and fire itself. This challenge is addressed through integration of planning, implementation and monitoring. Planning involves weighing options and probable outcomes following treatments. Implementation produces measurable results that can be compared to predictions. It is expected that monitoring each management activity will provide lessons that will influence future activities. Monitoring is an essential component of this management strategy, which will assure that this knowledge is documented. Future managers will be able to base their treatments on the quantified outcomes of previous activities.

The core of the initial restoration treatments will be accomplished through prescribed burning. Some of the burn units will require mechanical treatments to modify fuel loads and structure. Mechanical treatments can be used to manipulate fuels, forest pathogens and generate revenue. They can also cause impacts to soils and contribute to the spread of noxious weeds. Weighing pros and cons of mechanical treatments will determine which combination of treatments will most effectively achieve fuel reduction and pathogen control objectives. Timber prices are the most obvious driver for commercial thinning, but emerging technologies that utilize formerly non-merchantable material for biomass utilization may increase management choices.

Nine burn units were delineated (figure Analysis-12) Detailed burn plans have been created with a high level of confidence that they will successfully meet management objectives with a minimal chance of negative impacts. The burn plans were created using computer modeling techniques combined with experience and knowledge gained through years of experience on prescribed burns and wildfires.

Monitoring the outcomes of all treatments will be anchored to photo points, as they are cost effective and easily replicated. Photo points will be located at several locations within the burn units based on the various cover types. In addition to the basic photo points, treatment specific monitoring protocols should be developed and used to gather data appropriate to the treatment. A monitoring database should be used to organize the information to permit tracking of information over time. In addition to a hard copy archive the information could be made available online and could be used for educational purposes. A database consisting of electronic forms and photo sets organized by location can be stored on a website maintained by local schools or WDFW.

Planning, implementation and monitoring of the restoration process could be followed closely by community and academic participants such as local K-12, Community College or other College University participants. Both Wenatchee Valley College North and Tonasket Alternative School have expressed an interest in participating in monitoring projects on the SWA. The former also uses the SWA to study entomology and botany in the Northwest Environments class.

Monitoring

Monitoring, simply put, is checking at regular intervals in order to find out how something is changing, progressing or developing. The monitoring strategy for the SWA is to adapt existing protocols that will combine the strengths of academic rigor with field experience to provide a flexible framework for gathering general and detailed information with research, management and educational values. The approach consists of monitoring protocols with varying levels of detail and precision. Monitoring protocols can be as simple as having minimally trained volunteers establish permanent photo points. More complex monitoring can be designed to meet specific needs.

Descriptive narratives and permanent photo points are a minimum level of monitoring that will be required for future managers to determine the outcomes of intervention activities. Existing monitoring protocols that are good models to use as a basis for the SWA include that of the Jornada Experimental Range[2], the Nature Conservancy's Fire Learning Network, and several long-term experimental forests managed by Universities or by agencies.

Appendix C gives an example of a custom monitoring form that can be gathered using a transect or plot monitoring system.

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[2] Herrick, Jeffrey E., et al, "Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems, Vol I and II", USDA – ARS Jornada Experimental Range, PO Box 30003, MSC 3JER, NMSU, Las Cruces, New Mexico 88003-8003 http://usda-ars.nmsu.edu/

Forest Management Prescriptions

Introduction

Forest management prescriptions are written directions for activities that are designed to achieve desired outcomes. On privately owned commercial timber land, silvicultural prescriptions are the norm. Silviculture is the study, cultivation and management of forest trees, and it is primarily concerned with the production of high quality timber. Watershed and wildlife elements are often secondary considerations on commercial timber lands regulated by minimal Forest Practices regulations. On the SWA the primary management focus is maintaining sustainable dry site forest and shrub-steppe wildlife habitat in conjunction with recreation.

The SWA intervention prescriptions for this project differ from traditional silvicultural prescriptions in that they are designed to create conditions that will allow the restoration of fire dependent ecosystems and to permit fire to be used as a primary management tool. Use of prescribed fire is intended to mimic historic processes and thus favor fire dependent sustainable wildlife habitat on the SWA. In addition, management with fire can sometimes accomplish silvicultural objectives at a lower cost than traditional mechanical manipulation. Implementation of these prescriptions is the first step toward creating fire tolerant, sustainable open forest conditions similar to those that existed prior to European settlement.

Aboriginal use of fire and lightning ignited fires burned frequently across the low and mid-elevation inland landscape on a regular basis prior to European settlement. These frequent fires kept forest fuels at a level that usually resulted in low intensity fire behavior. The fires maintained an open forest structure with a high percentage of mature fire resistant ponderosa pine and fewer Douglas-fir. Numerous grasses, forbs, shrubs and tree species are dependent on fire or fire products, e.g., ash, heat, smoke, minimal soil exposure. Further, palatability and nutritional values of forage for herbivorous wildlife species are enhanced by periodic fire. Fire also contributes to the production of dead wood and snags, creating other habitat components for wildlife.

The SWA prescriptions are designed to maintain an intermediate and mature tree component following fire events. Many of the high-density stands on the SWA will require reduced surface, ladder and canopy fuel levels to achieve this objective. The secondary objective is to create a wildlife habitat that includes the fire dynamic component, the results of which provide more robust and sustainable conditions for a greater diversity of wildlife. Downed woody debris, snags and dense canopies are habitat elements for numerous wildlife species that must be actively maintained during treatments. The key to designing intervention prescriptions will be finding the balance that will achieve both objectives. Trees left following fuels reduction activities, “leave trees”, are more important than the volume of timber that is removed to meet short term economic objectives.

Factors that decrease a tree’s risk of mortality during fire events are thick bark, absence of lower limbs or nearby ladder fuels, and low to moderate levels of duff or needle litter. Larger, older trees with intact bark and no dwarf mistletoe or elytroderma are the most fire resistant and are obvious candidates as leave trees. However, broken top trees, hollow trees and trees with extensive dwarf mistletoe (DM) or elytroderma-induced brooming provide habitat for multiple species. Maintaining both types of trees is necessary to achieve diverse forested ecosystems and wildlife habitat.

Natural Leave Tree Selection

The core prescriptive element of the forest intervention process in the SWA is Natural Leave Tree Selection (NLTS, see Appendix A). Natural Leave Tree Selection is a methodology that takes into account multiple criteria when making determinations on what trees will remain to achieve forest management objectives following a commercial or non-commercial thinning activity. NLTS is a process that requires forest practitioners to be knowledgeable of the particular ecosystem processes of their locale. The methodology was developed in order to respond to the need for “forest” management rather than “tree farming”. This need was recognized in Europe during the latter part of the 19th century in response to the decline of productivity in the forests that were intensely managed since the early 17th century. Scientific evaluation of these forests determined that a lack of biodiversity and disruption of multiple ecosystem elements were causative factors negatively impacting the vitality of the forested ecosystems. Maintenance of natural systems is the basis of NLTS.

NLTS integrates forest knowledge gained through academic study, years of forest work and interactions with agency and private foresters. The basis of NLTS is the result of observation of forest management by forest owner/managers Frank Tratnick, who lived on the San Poil River headwaters in North Central Washington, and Dan E. Miller, who lived in New Bedford Ohio. Both of these men spent a lifetime getting to know their forests. They managed each part of their forest, accounting for all aspects of management including soils, aspect, plant community, pathogens and wildlife. Their forests produced high quality timber along with diverse wildlife habitat and hydrologic benefits. NLTS is designed to provide a framework for forest practitioners to use that will assure that multiple ecosystem elements will be considered when selecting trees that will be left following mechanical thinning operations.

NLTS requires a basic understanding of forest dynamics. It involves "reading" the forest in order to select the trees that will be left standing following mechanical treatments. The selection criterion (see appendix B) assures that multiple short and long term objectives will be met. The intervention prescriptions have inherent flexibility to address micro site conditions within stands. In addition they strike a balance between simplicity and complexity that will allow forest workers to follow the prescriptions with reasonable economic efficiency.

NLTS involves evaluation of multiple factors to determine the particular trees that will be left following non-commercial and commercial thinning. Particular wildlife habitat objectives and micro site opportunities will determine the relative weight that each criterion will be given. Micro site opportunities occur where existing habitat values differ from the rest of the stand. For example, a large diameter Douglas-fir tree that is heavily infected with dwarf mistletoe is still valuable to wildlife. While the overall objective of the thinning activities may be to reduce Douglas-fir and increase ponderosa pine, taking advantage of the habitat provided by the DM infected tree might be deemed a higher priority micro site opportunity.

While most stands of trees on the SWA currently have stocking levels that place them at high risk for stand replacing fires during wildfire events, each stand will be left with differing stocking levels by following NLTS guidelines.

Initial objectives within most conifer stands on the SWA are to enhance the survival of legacy trees[*] and potential legacy trees[*] during fire events, while maximizing sustainable forested wildlife habitat. Fire resistant open forests consisting of fewer, but larger, trees will require reducing fuel loads and tree densities. Fuel loads can be reduced by fire, but following a hundred years of fire suppression, many of the stands have an elevated risk of high intensity wildfire behavior with likely high tree mortality during fire events. A series of mechanical fuels reduction treatments may be required on some stands, or parts of stands, before this risk is reduced.

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[*] Legacy trees are the dominant trees in a mature stand of trees that have survived from a previous cohort of trees. Legacy trees, most often in their second century of life, have a proven ability to survive and thrive on the particular soil type, slope, aspect, moisture regime and disturbances of the particular micro site.

[*] Potential legacy trees are trees within an intermediate or mature stand that have the most vigorous growth rates and have the best chance of surviving longer than the other trees of the stand

SWA forest densities will reflect the variability of the terrain, soil, understory plant community, pathogen levels, species mix, tree condition, water availability and fire hazard instead of timber production objectives. Leave trees will be unevenly distributed throughout the forest. There will be clumps, clusters and groups of trees that will be separated by clearings that vary in size. The range of forest density, tree age classes and other structural features will increase and continue to grow in complexity as fire supplants mechanical treatments as a primary management tool.

The NLTS process involves micro site management with leave tree selection based on site-specific conditions. Ideally a multi-disciplinary team will be involved with the NLTS process. At a minimum it will require a wildlife biologist and forest ecologist to assure that forest technicians will be able to mark trees and oversee forest practitioners on a silvicultural prescription that a contractor can implement. Variable densities and basal areas that reflect topography, soils and the stage of succession are relatively easy to recognize in the forest, but difficult to quantify in terms of trees per acre or basal area as there will be a wide range of both. Some training, e.g., on the ground proactive experience, will be necessary, as outcomes following NLTS aren’t easily quantified.

In addition to leave tree selection, activities and activity methodologies that will best meet ecological and economic objectives must be determined for each stand. Many variables must be considered to find the balance between the two overall objectives over the short and long term, e.g., large diameter Douglas-fir may provide forest structure elements that are more desirable than promoting the ponderosa pine component. Ecological benefits must also be weighed against the financial costs incurred.

Initial activity decisions will be based on limited knowledge, but over time, monitoring data will provide more surety in the prediction of outcomes. The interrelatedness of all forest components is only understood on a coarse level. Counting and measuring trees, noting tree pathogens, identifying plant communities and classifying soils are activities that provide a starting point for getting to know the SWA forested landscape and how it responds to various treatments.

The NLTS process identifies stand conditions that may require intervention. Each condition is described simply (see NLTS Prescription example below). This easily understandable information provides the manager with enough information to assign site-specific management priorities for each stand. Management priorities combined with individual leave tree evaluation and selection processes will result in micro-site management within each stand. The outcome of this approach is that forest technicians and practitioners will be provided the flexibility to respond to the unique attributes of each particular forest site when selecting leave trees.

Example NLTS Prescription

A. Stand Description:

Aspect – NE
Slope – 15 to 25%
Soil – Nevine gravelly deep
Water Retention – Moderate
Tree Species – Douglas-fir 75% ponderosa pine 25%
Density – 300 trees per acre in patches with small clearings
Structure – Douglas-fir poles < 20% live green crown, 3 inches to 8 inches DBH except on the edges of thickets with live green crown touching the ground. Approximately 5 legacy ponderosa pine and 5 dominant Douglas-fir trees per acre
Plant community – Snowberry and pine grass in clearings; diffuse knapweed on old road; duff beneath thickets
Pathogens – Dwarf mistletoe infecting 80% of Douglas-fir; Western pine bark beetle
Adjacent Stands – northeast and east open ponderosa pine; southwest talus; north aspen
Access- adjacent to abandoned road

B. Intervention Priorities

1. Thinning

a. Leave 100% of ponderosa pine legacy trees and dominant Douglas-fir
b. Leave 50% of non-legacy ponderosa pine (taking least viable trees)
c. Leave 50% of Douglas-fir poles > 6 inches DBH
d. Leave 0% of Douglas-fir poles < 6 inches DBH
e. Leave 10% of dwarf mistletoe infected thickets that do not threaten ponderosa pine legacy trees or dominant Douglas-fir

2. Commercial thinning

a. Pole salvage with forwarder over abandoned road if market conditions allow
b. monitor for noxious weed presence and in continuous patches that will be used for hauling, treat prior to use of haul road

3. Slash treatment

a. Hand pile heavy concentrations
b. Lop and scatter where possible

4. Controlled fire

a. Use low intensity fire

b. Protect isolated thickets with foam

Fuels Reduction Treatment Priority

Fuels reconfiguring and restructuring treatments (FRRT) are the first priority intervention objective on the SWA. Stands were prioritized for treatment based on the following factors:

1. Stands at risk of high-mortality fire that need careful FRRT to achieve acceptable survival of legacy trees
2. Stands likely to have flame lengths greater than 4 feet during controlled fire events
3. Pole stands that will require thinning to support the development of legacy trees
4. Deciduous stands that may require fire to function as sustainable wildlife habitat, i.e., aspen groves

Prescribed fire is the preferred method of FRRT where possible. However existing fuel loads will sometimes require that mechanical fuels treatment take place. Mechanical fuel treatment restructures, relocates or removes fuels from the forest.

Controlled Fire

Fire has been an integral part of terrestrial ecosystems of the inland northwest for thousands of years. Benefits of fire and fire by-products are listed below. Fire:

- Provides a nutrient flush (releases minerals and nutrients tied up in dead vegetation)
- Lowers the acidity of soil (raises pH)
- Increases soil humus
- Adds charcoal to the soil providing permanent cation exchange sites
- Improves moisture retention and provides habitat for soil biota
- Lengthens the growing season by warming the soil earlier in the spring due to the albedo on the dark surface
- Smoke increases the germination rate and vigor of seeds
- Creates a seed bed
- Renews understory shrubs
- Thins the forest
- Helps control dwarf mistletoe
- Costs less than some mechanical treatments
- Creates diversity through variable intensity, location and fuel stratum affected
- Creates a mosaic of plant associations and succession

- Produces smoke and charcoal that can inhibit pathogens
- Produces heat

There are also some negative aspects to consider in restoring fire. Some of the possible unfavorable effects of prescribed burning include:

- Loss of control of selective mortality to targeted species
- Escape or potential liability to other ownerships
- Smoke production that can impact populated areas
- Excessive mortality
- Higher fire spreading rates in treated stands
- Need for more frequent management intervention

There are also limitations to the exclusive use of fire on some SWA locations such as:

- Excessive fuel loading
- Broken rocky ground that won't carry a fire, but will smolder and creep for months
- Steep rocky slopes without feasible fire line locations contiguous to land under other ownership

Fuel reduction treatments were prioritized for the entire SWA (see Volume 2, Analysis), based on the need to modify fuel characteristics, accessibility and consideration of treatment effects on stand character and future fire behavior.

Forest fuels are classified into groups based on their size, arrangement and water content. They include 1-, 10-, 100- and 1000- hour dead fuels (based on time required to be burnable), litter, duff, live herbaceous fuels, live woody fuels, canopy fuels and ladder fuels (fuels with a vertical profile that connect the surface fuels to the canopy).

The natural accumulation of duff and litter from needle drop and small branches builds up a carpet of fine material several inches thick covering much of the forest floor. Under historic fire regimes, these fine fuels loads were kept low. The fine fuels determine how a fire will travel, and this coupled with the loading of fuels determines its rate-of-spread and severity. Severity refers to total heat dissipated per unit of time, and it correlates with increased mortality to trees or other vegetation. Fire severity increases when there is a buildup of dead surface fuels.

Factors that increase fire spreading rates include heavy loads of fine, flashy fuels, and open canopies that receive more wind.

Ladder fuels can be live or dead lower limbs, fallen trees hung up in other trees, heavily limbed recent snags, underbrush or any other flammable material that can create flame lengths which provide avenues to the canopy of the forest. High-density stands of trees with a continuous canopy can carry fire easily from tree to tree. When this occurs it is called a crown fire that results in large areas of tree mortality. Crown fires that carry through the crown without surface fire are called active crown fires, while crown fires that require surface fire to maintain them are called passive, or torching crown fires.

The use of prescribed fire requires detailed burn plans. Burn plans were developed for nine "burn units" covering about half of the SWA. Each burn plan is a comprehensive planning document that helps to minimize the risks and negative impacts such as smoke and legacy tree mortality.

Initial treatments will address the problems caused by 100 years of fire suppression, while preparing the ground for future maintenance with controlled fires. The desired condition is to have a landscape that is resilient to fire, and to achieve this within a reasonable timeframe. The costs and benefits of achieving this goal were evaluated over the entire SWA by dividing the landscape into ten randomly placed areas and burn units that would receive ten initial treatments.

Controlled fire costs range from $50 to $120 per acre while fighting wildfires can exceed $1000 per acre without achieving control over fire effects[*]. It is an absolute necessity to have fire as a disturbance agent in order to maintain a fire dependent ecosystem on SWA.

Mechanical Fuels Treatment

Fuels treatment entails a combination of reconfiguration and reduction of burnable material.

Many areas will need to be mechanically treated to reconfigure and/or reduce fuels prior to the use of controlled fire. Areas where risks of controlled burning may compromise efforts to burn, e.g., heavy fuels on extremely steep slopes. Mechanical treatments can manipulate fuels and forest structure, but cannot provide the fire effects that sustain fire

[*] Prior to the reintroduction of controlled fire, some mechanical fuel treatments may be necessary to assure that the controlled fire will achieve the desired results. The cost of this initial treatment may range from $150 to $500 per acre for thinning and fuel reconfiguration. In commercial thinning the sale of material will offset the costs.

dependent ecosystems. Therefore mechanical treatments may be used prior to controlled burns within burn units.

Reducing tree density, reducing surface fuel loads, and raising canopy base heights are primary benefits of mechanical treatments, i.e., fuels reconfiguration. A range of treatments is available from simple chain saw thinning and hand piling to the use of sophisticated tree-cutting machinery capable of processing merchantable material and smashing the tops and branches onto the ground. Other forms of mechanical treatment could include masticators that knock down trees and grind them into small pieces. Undesirable effects include soil disturbance, compaction, soil displacement and the spread of alien species.

Soil disturbance by ground based equipment may reduce the productivity of the site by compacting or displacing topsoil. These impacts can be reduced or mitigated by limiting the number of skid trails, operating on frozen ground, snow or slash mats, or rehabilitating impacted areas. Prevention is usually preferred over mitigation.

Non-commercial thinning, hand pile and burn

Non-commercial chain saw thinning of high-density small diameter trees followed by hand piling and burning of slash and accumulated downed woody debris, is an inexpensive, low impact method. Ground disturbance is minimal and the soil sterilized beneath small hand piles are recolonized by soil biota relatively quickly, leading to increased habitat diversity. However these sites of sterilized soil may also provide opportunities for noxious weeds.

Mechanical slash treatment

Mastication and chopping implements are mounted on wheeled or tracked machines. They consist of many iterations and styles of rapidly moving heavy-duty steel or carbide teeth or blades that reduce woody material into smaller pieces. Design features allow some of the machines to knock over or break trees down before they are reduced while others are strictly for downed material. Some of the machines integrate the material into the soil while others distribute it across the soil surface. Material integrated into the soil can reduce nitrogen available to plants. Large amounts of the material covering the soil can act as mulch inhibiting plant establishment. Ground disturbance with these machines can be extensive. Small chipping machines are used in some instances as an alternative to burning. The chips are generally dispersed at low levels that won’t inhibit plant growth.

These methods achieve fuels reduction and reconfigurations objectives, but are a radical alteration of other ecosystem processes that break down woody debris and build soil. Chips do not provide the continuity of intact material or provide large downed woody debris desirable for wildlife and as a medium for fungal colonization. Fungi are a food source for micro and macro organisms that are an integral part of a functioning forested ecosystem.

Commercial thinning

Commercial thinning and timber harvest involves cutting down trees and removing, or yarding, them to an area where they can be loaded onto trucks. The loading area is called a landing. The material is then hauled to facilities to be processed into wood products, e.g., chips, firewood, posts, rails, hog fuel or saw logs. Removal of merchantable material has the potential to have significant impacts on the soil, however winter logging with 24 inches of snow or 6 inches of frozen ground reduces impacts. Options for removing the material range from dragging with horses to lifting them out with helicopters. Recently, attachments for small tractors and ATV's along with other small yarding equipment has become commercially available. Continual development of yarding equipment to meet ecological and economic objectives is taking place.

There are three basic yarding techniques: ground based, cable and helicopter. Ground based systems utilize equipment to drag or carry the material to a landing. Cable systems use steel cable with multiple winches and a system of pulleys or a carriage that is attached to a cable to yard the material. Cable systems range in size from "jammers" that consist of two winches and a small arch on the back of a flat bed truck to high lead towers that are 120 feet tall. Different carriage systems are designed for maximum yarding distances from 900 feet to as much as 3000 feet. Helicopter yarding involves a winch line for flying the material out.

Yarding impacts affect soil, understory vegetation and leave trees.

Soil consists of mineral, humus and biotic components. Soil develops over time in response to the interrelationships between the biotic components and the influence of the physical factors of temperature, moisture and wind. Physical forces such as foot traffic and burrowing animals are ongoing impacts that affect soil conditions throughout the forest. Soil structure includes clumps of mineral particles held together by colloidal clay or organic matter. Structure is important for maintaining soil porosity, which allows for water infiltration and gaseous exchange necessary for plant growth and soil stability. A loss of porosity can increase the rate of surface runoff following high intensity rains, resulting in soil losses through erosion.

Yarding large volumes of logs with ground based equipment or with cable systems that drag logs over the ground can break down soil structure. This not only lowers porosity, but also creates a growing medium that favors invasive species that may spread to surrounding areas and crowd out native plants. Another challenge encountered when yarding logs is the damage to leave trees. Stripping bark from the boles of leave trees exposes the cambium and sap wood to pathogens.

Carriage cable systems and helicopter yarding systems lift logs off the ground. These systems have minimal impact on forest soils, however they are limited to the removal of larger material due to high costs. Generally they are used for harvest on ground that is too steep (over 35% slope) or on sites that are too far from landings for ground-based equipment to be feasible.

Commercial thinning has the potential to meet multiple management objectives while generating income to offset the costs of intervention treatments. It also carries the risk of producing negative outcomes with mitigation costs that exceed income.

Careful consideration of ecological impacts and costs are necessary when planning treatments.

Treatment Costs and Returns

The monetary cost of non-commercial and commercial thinning is highly variable. Terrain, tree density and distance from roads have a significant impact on treatment costs. Non-commercial thinning costs range from $100 to $300 per acre. Hand piling can cost $250 to $600 per acre. Burning slash piles is very weather dependent and can be as much as $200 per acre. Harvest costs for ground based logging are $182 - $267 per thousand board feet and $210 - $296 for cable logging[3]. Helicopter logging costs range from $250 to well over $300 per thousand board feet[4].

The sale of merchantable material will defray the cost of intervention practices. The majority of commercial material that will be available during the initial treatments will be less than 12 inches DBH with at least half of the volume being classified as small diameter material with top diameters 4-7

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[3] Mason, C. Larry, and others, "Investigation of Alternative Strategies for Design, Layout and Administration of Fuel Removal Projects", Rural Technology Initiative College of Forest Resources University of Washington, Box 352100, Seattle, Washington 98195-2100, www.ruraltech.org, 2003.
[4] Inland Forest Management Newsletter, 2004, Inland Forest Management
123 South 3rd St. P.O. Box 1966, Sandpoint, Idaho 83864, 208-263-9420.

inches. This type of low value material coupled with the lack of local infrastructure to deal with this type of material will likely result in overall costs of $169/ acre (2003 figures)[5]. Today's average cost for mechanical fuels treatment less the returns from timber sales will be approximately $200/acre.

Hopefully frequent controlled fires will result in a more productive forest with minimal mechanical thinning costs and larger diameter merchantable timber that will have lower harvest costs and higher returns.

Forest Stand Types and Treatments

Prior to fire exclusion, low and mid-elevation forest land across North Central Washington had more extensive stands of open, fire- and drought-resistant ponderosa pine and larch with less dominance by Douglas-fir.

Many pathogens were self-limiting in the 19th century open forests, as tree densities were generally low enough to maintain tree vigor, which enhanced tree defenses.

Dwarf mistletoe (DM) is a parasitic plant that spreads to nearby trees by seeds, but rarely affects trees further than 100' feet from the seed source. DM produces "brooms" in infected lower limbs with increased needle accumulation and small branch production below and within the broom. During fire events the risk of torching or bole damage increases. When the host tree dies the parasite also succumbs.

Western and mountain pine bark beetles are an emerging insect pest threat throughout the interior west. Fire suppression and overstory harvesting with an inadequate thinning program resulted in dense stands of suppressed trees. These stands provide habitat for the beetles. These native beetles have a relatively short flight range not over a quarter of a mile. The reproductive strategy of these bark beetles involves concerted attacks on susceptible trees coordinated by pheromone signals. Production of pitch is a tree's primary defense against this insect. Vigorous open grown trees have the ability to resist attacks more than suppressed, crowded trees. Insect populations in dense stands of low vigor trees have a much higher likelihood of successfully reproducing and reaching epidemic levels.

During treatments attention should be given to root rot pathogens that may be affected by treatments. Dense stands of trees competing for limited

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[5] Rogers, Heather K. "Investigation of Alternative Fuel Removal Strategies", A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science University of Washington, 2003.

moisture are less resistant to pathogenic fungi. Honey mushrooms (*Armillaria* spp.) are a common root rot fungi that usually damages only low vigor trees. Thinning may be of benefit if there are large numbers of low-vigor trees. But some fungi, for instance *Annosus* root rot, can spread through damaged bark. For this species, mechanical thinning could be counter-productive to long term stand health.

Dense pole stands of Douglas-fir are ideal habitat for Douglas-fir tussock moths and spruce budworm. Both of these insects have had widespread population spikes during the second half of the 20th century resulting in large-scale damage or mortality.

Pole stands

Pole stands consist of trees that are so closely spaced that there are no or very few dominant trees*. Diameters of poles vary up to about 16 inches DBH and stand density ranges are typically 200 to 600 trees per acre. Trees in a pole stand have a low live green crown to height ratio, often less than 15%. This results in low vigor trees that are susceptible to pathogens. The growth rate on these trees is very slow due to the intense competition for water. There is usually very little understory vegetation as very little light penetrates the dense canopy. Ground fuels consist of needles and branches with occasional "jackpots" of heavier fuels following pathogenic tree mortality. These stands may have an elevated risk of crown fires because of the continuous canopy and intermittent ladder fuels. Where pole stands are composed primarily of ponderosa pine, the heavy needle accumulations can produce flame lengths longer than 6 feet, with accompanying high fire severity.

The present condition of SWA forests has large numbers of suppressed pole-sized trees 6 to 16 inches DBH. This is largely a consequence of suppression of fires that would have killed recruitment trees before they reached tree size. Ponderosa pine is fire resistant and drought tolerant. Its bark is thicker and flakes off when exposed to fire. It has a taproot that quickly reaches deep into the soil to access water. Larch is fast growing and develops thick fire resistant bark. Douglas-fir is is more shade tolerant than either ponderosa pine or larch. This latter trait has contributed to a greater percentage of the SWA forest having dense stands of shade tolerant Douglas-fir poles along with a higher crown fire potential.

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* Dominant trees are those trees in a stand, that have a higher live green crown to height ratio than surrounding trees. Dominant trees are older or grew more vigorously than other nearby trees. The additional leaf area allows them to absorb more sunlight, water and nutrients.

Intervention activities that involve mechanical fuels reduction will favor retention of ponderosa pine and larch in upland stands where these two species are currently in decline.

Fuels treatments are challenging in pole stands because thinning transfers canopy fuels to the ground. Without treatment of downed material, which has very little commercial value, the risk of high intensity fire behavior is increased. In addition the full force of the wind is no longer deflected by the dense stand structure. Thinning often results in numerous bowed and broken trees. The lack of a robust root system can also lead to windthrow, the uprooting of trees during wind events.

Pole stands of both Douglas-fir and ponderosa pine are found on SWA. Many of the Douglas-fir stands have high incidence of dwarf mistletoe infection that further elevates the risk of high intensity fire behavior.

Intervention in pole stands

Thinning at least 50% of the stems per acre is an intervention activity that is necessary to bring pole stands into a condition that will allow fire to be reintroduced to the sites, while minimizing unwanted impacts. Resulting broken and windthrown trees will provide snag and a down woody debris (DWD) component to the site following treatment.

Non-commercial thinning followed by hand piling and burning may be necessary in some instances where the proximity of more desirable stand conditions requires immediate fire hazard reduction. Commercial thinning is preferable in stands where there is a sufficient quantity of commercial timber and ground suitable for mechanized harvest equipment (under 35% slope in close proximity to haul roads).

Controlled fire alone may be the best course of action where Douglas-fir pole stands are adjacent to firebreaks and thinning isn't economically feasible. A controlled fire with sufficient ground fuel, and timed to burn hot will result in immediate and delayed mortality in Douglas-fir stands. Follow up controlled fire, timed to consume fallen trees on an incremental basis, will further reduce fuel loads to sustainable levels.

Ponderosa pine poles are less susceptible to fire, but may be thinned in a similar manner by increasing ground fuels with thinning slash.

Mixed mature and pole stands

Mixed mature and pole stands consist of dominant trees surrounded by poles. Diameters of poles vary up to about 16 inches DBH. Dominant trees in these stands often have less than the optimal 35% live green crown, but may still have the structural integrity to remain standing following thinning operations. The age of dominant trees should be considered in designing treatments to resemble historic conditions. Historic conditions can be determined by observation of older stumps, in previously logged areas or by snags and downed old trees in virgin forest. In most cases these stands had open forest characteristics.

Intervention in mixed mature and pole stands

Intervention in these stands will be focused on enhancing the survival of the dominant trees. Breaking up the canopy by removing poles that are nearest to the dominant trees will reduce competition for sunlight and water, while lowering the risk of mortality during fire events.

Initial intervention activities should be designed to retain all of the largest diameter trees that are over 150 years old as well as retaining enough of the remaining dominant trees to provide wildlife habitat at a density that the stand is capable of supporting. At least 50% of the poles should be removed during the first entry. Over time these stands should be converted to open forest.

The same challenges remain in regard to generating revenue to defray the cost of treatments, as most of the material that must be removed is small diameter and has little commercial value.

Fire must be introduced carefully following treatments to protect the dominant trees. The dominant trees contain the genetic material that contributed to their ability to live and thrive on each particular site.

Mature coniferous rocky stands

Stands of mature trees in boulder fields and along the base of talus slopes have, for the most part, lower tree densities than pole stands. Within these stands there are micro sites with soil accumulation that has resulted in higher tree densities. Individual trees growing in the open are much more vigorous than trees in pole stands. Trees that took root in the soil between the rocks have less competition from understory plants and surrounding trees, and may have more water from channeling by the rocks. They have a high live green crown to height ratio that enhances their growth rate. The increased exposure to sunlight also enhances the vigor of dwarf mistletoe on infected Douglas-fir trees on some of these rocky sites. In low-density stands where it will spread slowly, DM-infected trees can be left to provide winter cover for mammals and rodents.

Other than wetland areas, these sites are affected much less by fire. The paucity of understory vegetation (light fuels) limits fire intensity and the ability of fire to travel across the stands.

These areas have the greatest potential for maintenance of late succession stand structural attributes as the natural topographical resistance to fire can be enhanced with minimal management activities.

Intervention in mature coniferous rocky stands

Intervention in these stands will only be necessary along the periphery and in the higher density portions of the stands where full crowns, particularly those infected with dwarf mistletoe, have created ladder fuels and the potential for crowning fire activity among legacy and potential legacy trees. This can be accomplished with a combination of non-commercial and commercial thinning and pruning.

Limitations for commercial harvest by ground-based equipment on some of the sites will require helicopter harvest, but the commercial value of the timber would be sufficient to offset this cost.

The use of controlled fire will present challenges, as intermittent ground fuels are not amenable to carrying fire.

Medium density conifer stands

Conifer stands that are moderately dense, 100 to 200 trees per acre, have numerous trees with greater than 25% live green crowns and multiple size classes. In addition to poles and understory trees, there are also numerous dominant and co-dominant trees. There is also a fairly continuous understory plant community in this forest type.

Individual trees are more vigorous and less water-stressed than in pole stands. However even moderately dense stands on dry sites are stocked at unsustainable densities. Fungal pathogens and elevated insect populations are resulting in higher mortality levels during drought years. A relatively slow growth rate in medium density Douglas-fir stands has contributed to the spread of dwarf mistletoe. These factors contribute to a buildup of ground and ladder fuels due to the absence of fire.

Intervention in medium density conifer stands

NLTS directed non-commercial and commercial thinning, with a target goal of a reduction of tree densities to 50 to 100 trees per acre, followed by reintroduction of fire, will encourage development of the stand into a multi-aged, fire tolerant, open forest.

Open conifer stands

Open conifer stands consist of widely-spaced individual trees and clumps of trees with openings. Stocking level is often due to a slightly improved microclimate, soil condition, intermittent watercourse or concentration feature that improved the chance for tree establishment and survival. Once a tree is established it creates a microclimate for additional tree establishment by providing shade, especially on its north side. These trees are called nurse trees. Fallen logs act in the same manner. Swales and north slopes of draws are also places where trees can become established. Low density of the stands limits most pathogens with only occasional tree mortality.

Open stands have higher loads of understory shrubs and more small trees than those areas would have had in the 19th century. Needle accumulation is heavy.

Lower limbs of open grown trees of the 19th century endured needle scorch and fire-induced pruning during fire events. Today's SWA open grown trees often have large lower limbs in direct contact with the ground. During wildfire events these limbs can carry fire up the canopy resulting in mortality. Therefore, limbs should be pruned above the height that flames will reach.

The accumulated needle duff beneath trees can be over a foot deep. Pine needles tend to generate the longest flame lengths, while needle duff under Douglas fir tends to smolder. If the smoldering duff layer reaches the bole of a tree, it can effectively girdle the tree. Feeder roots also grow close to the surface in this nutrient rich layer and may be killed during spring fire events.

Intervention in open conifer stands

Occasional mechanical thinning of the smaller trees from some of the groups may be necessary to improve the vigor of legacy or potential legacy trees.

Riparian conifer

Conifer stands adjacent to streams and wetlands of the SWA are found along the side canyons and alluvial fans in the valley bottom. Stands are linear and can extend for miles, but they are usually interrupted by canopy gaps. The trees have access to plentiful water and are generally quite vigorous. Stocking levels can be much higher, and control is exerted by soil condition as much or more than competition. Stands can be open or dense. Diversity and coarse woody debris (CWD) loads are high, along with wildlife use.

The value of riparian habitats was summarized by Wheeler and others [6]:

> "In their historic conditions, these riparian habitats were dominated by very large, open-growing pine and larch (Larix occidentalis) with numerous species of hardwood trees and fruit-bearing shrubs. If these conditions can be restored, these habitats can again support some of the most diverse bird communities in North America. For example, a recent examinations of riparian habitat for birds done on the Bitterroot National Forest in western Montana showed that species richness was 29 percent greater in deciduous riparian patches than in surrounding pine-fir forest, and 44 percent greater than in coniferous riparian areas lacking the seral, deciduous understory."

In a number of areas riparian conifers have shaded out aspen and water birch. Riparian conifer stands normally have higher fuel loads than adjacent uplands since they are more productive. Unlike upland stands, these areas historically burned in a patchy fashion, with mixtures of both high and low intensity. Restoring this type of mixed-severity fire to the landscape will be difficult. It is difficult to control mortality and coarse woody debris retention with fire, and the risk of undesirable effects to wildlife habitats is high. But without intervention, stand replacing events in these canyons have the potential to destabilize slopes and contribute to mass wasting and extreme erosion.

Shrubs and hardwood trees sprout from existing root systems after fires, while conifers do not. Following fire events, slope and bank stabilization will occur more rapidly with an intact shrub and hardwood tree component.

Intervention in riparian conifer

The objective of intervention in riparian conifer stands is to reduce the likelihood that a wildfire could consume a large portion of these areas in a short time. However, terrain limitations in side canyons make intervention extremely difficult. Most of the side canyons are inaccessible to ground based equipment and road building would cause more damage than an extreme fire event. The use of controlled fire is also difficult due to the presence of large logs and coarse woody debris (CWD) that could smolder

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[6] Wheeler, F. J.; Redman, T. S.; Tewksbury, J. J. 1997. Montane riparian habitat for birds: islands of diversity, retreats for survival. In: Natural Resource News. Blue Mountain Natural Resource Institute, LaGrande, OR. Spring 1997: 10-11.

and re-ignite after a burn. In addition, regrowth is rapid and downfall of snags is continuous, so intervention frequency would have to be frequent to be sustainable.

Creation of fuel breaks in adjacent stands or across drainages and cautious use of adaptive management are tools that can be used to reduce the spread of a wildfire. Controlled fires can be allowed to creep downhill from a black line above. Creative use of high line cable systems or helicopter logging can be used in some stands. Stands on the valley floor for the most part can be treated using ground based logging and fire control equipment (feller processor, forwarder, and hand crews).

On the alluvial fans, dense stands near access roads can be opened up to provide more growing room for the leave trees. In these stands, removal of all of trees under 12 inches DBH and the smaller 50% of the trees from 12 to 24 inches DBH or 20 trees per acre will leave only the largest and most fire resistant trees, while opening the canopy to promote shrub and hardwood tree growth.

Upland aspen stands

Upland aspen stands and their riparian counterparts, are a diverse and important wildlife habitat Aspens require more moisture to survive than conifer forest or steppe, but following establishment, annual leaf drop and inputs of woody debris builds soil rapidly, and improves water infiltration and retention. Following thousands of years of soil building the deep, rich soils beneath an aspen grove function much like a sponge that captures and slowly releases snow pack runoff and precipitation.

Transpiration within an aspen grove creates its own microclimate that raises humidity and lowers temperatures. This microclimate is ideal for numerous wildlife species, birds and invertebrates. In addition the soft and fungus susceptible wood is easily excavated by cavity nesting birds.

Aspen stands sprout from extensive root systems following disturbance. Fire renews the vigor of aspen groves by killing above ground portions of the clone and stimulating roots to sprout into young, vigorous trees. A thinning process that is a function of light and water availability continues until there is a disturbance event. The vigor of the clone depends on the leaf surface area of the above ground components. Without disturbance the tree portion of the clone will decline due to pathogens. Loss of leaf surface reduces the amount of sugars that maintain the root system. This leads to a decline in vigor for the entire organism and possible mortality.

The lack of fire disturbance has resulted in decline of many SWA aspen groves. The decline is being exacerbated by conifer encroachment in some of the groves. The deep rich soils provide moisture and nutrients that encourage plant growth. With the demise of aspen trees conifers can gain a foothold in the stand and eventually overtop the aspen canopy. Shade intolerant aspen cannot survive low light conditions beneath the shade of conifers and continue to decline.

Intervention in aspen stands

Activities that will renew the vigor of aspen groves are fire, tree cutting, and in some cases elimination of most of the encroaching conifers. Density, timber volume and size of the conifers, along with accessibility, will influence methodology for dealing with conifer encroachment. Issues such as small diameters or limited numbers of merchantable trees or inaccessibility can be addressed through the use of non-commercial thinning and/or girdling conifers. Additional fuel consisting of thinning slash may improve the effects of controlled fire and create snags that will provide additional habitat. Leaving a few large diameter conifer trees per acre will not significantly affect a fire renewed aspen grove.

Commercial thinning of conifers may be appropriate when evidence of an aspen grove consists of a few scattered understory aspen trees. Topographical and soil evidence will aid in identifying remnant aspen groves. Scattered slash from the commercial thinning operation will increase ground fuels that will raise soil temperatures increasing the efficacy of the burn for stimulating root nodules.

Every opportunity will be taken to rejuvenate aspen groves on the SWA.

Summary

Fire reintroduction is necessary to maintain the inland fire dependent ecosystems found on SWA. Mechanical fuel reduction activities will be required on some of the forested portions, which have very high fuel loads that have accumulated over the years without fire. Enhancing the chances for survival of legacy and potential legacy trees is paramount, as the larger and usually older trees have demonstrated the ability to survive and thrive in the area. Initial steps that must be taken to reintroduce fire will be expensive, but over time the benefits will accrue and future costs will go down.

Appendix A
SWA Intervention Process

1. Evaluate General Stand Conditions
    a. Topography – slope and aspect influence
        1) Soil stability
        2) Soil moisture
        3) Hydrologic function
        4) Evaporation rates
    b. Soil
        1) Base material (base rock, glacial till, coarse or fine)
        2) Sand, silt or clay
        3) Depth (determined by plant community or tree vigor)
        4) Duff layer (Low, moderate or high)
    c. Moisture
        1) Water courses such as draws
        2) Low, medium, high (in context of surrounding areas; sand hills vs. sub-irrigated meadows)
    d. Tree species
        1) Ponderosa pine
        2) Douglas-fir
        3) Spruce
        4) Aspen
        5) Cottonwood
        6) Other
    e. Tree density
        1) Low (0 to 50/ac), moderate (50 to 150/ac), dense (150 to 200/ac), extreme (> 200/ac)
    f. Understory species (list indicator species for plant associations)
    g. Condition by categories
        1) Saplings
        2) Mature
        3) Old (> 100 years)
        4) Multi-aged (range)
        5) Chronological age range
        6) Average live green crown
    h. Pathogens
        1). Insect
        2) Fungal
        3) Other, e.g., mistletoe, porcupine
    i. Fire hazards
        1) Dead surface fuels (1-hr, 10-hr, 100-hr; tons per acre)
        2) Live herbaceous fuels (tons per acre)

3) Live woody shrubs and small trees < 6 feet tall (in tons per acre)
4) Ladder fuels (low, medium, high)
5) Canopy fuels (crown height, crown base height, interspersion)
6) Coarse wood and jackpots (> 3 inches diameter; tons per acre)

j. Stand History
   1) Stumps
   2) Snags
   3) Fire scars
   4) Existing legacy trees
   5) Stand description in 1900

k. Potential future conditions
   1) Treatment options
   2) Expected outcomes

l. Existing wildlife habitat
   1) Classify cover type
   2) Habitat usage by species
   3) Notes

m. Past wildlife habitat
   1) Cover type
   2) Habitat potential based on presumed past conditions

n. Potential future habitat
   1) Cover types
   2) Habitat potential habitat based on expected outcomes following management activities

2. Develop stand-specific treatment objectives
   a. Tree stem density alteration by diameter size class
   b. Tree species ratio change
      1) Ratio of pine to fir target
      2) Others
   c. Pathogen level manipulation
      1) Insect
      2) Fungal
      3) Other
   d. Fuel load changes
      1) Dead surface fuels (1-hr, 10-hr, 100-hr; tons per acre)
      2) Live herbaceous fuels (tons per acre)
      3) Live woody shrubs and small trees < 6 feet tall (in tons per acre)
      4) Ladder fuels (low, medium, high)
      5) Canopy fuels (crown height, crown base height, interspersion)
      6) Coarse wood and jackpots (> 3 inches diameter; tons per acre)
   e. Understory plant management
      1) Expected species and cover

2) Noxious weed prevention (minimize ground disturbance; minimize seed introduction from machinery or animals)
3) Noxious weed control – Integrated Pest Management, chemical controls; cultural controls (silviculture; manual control)
3) Grazing practices if applicable

f. Wildlife habitat enhancement
1) Priority habitats and species
2) Habitat needs for other species

3. Management Activity Methodology
a. Prescribed burns
b. Mechanical thinning
1) Non-commercial (hand falling)
2) Commercial (hand falling, feller buncher, feller processor processing system)

c. Material handling
1) Slash treatment
(a) Broadcast burning
(b) Piling and burning (hand or mechanical)
(c) Chipping
2) Merchantable material
a. Ground based (horses, skidder, shovel)
b. Aerial (cable yarding, helicopter)

d. Understory vegetation
1) Weed control
2) Seeding (specify if using site specific native seed or not)
3) Planting

e. Soil Disturbance
1) Prevention
a. Frozen ground
b. Snow
c. Low impact equipment
d. Aerial operations (cable or helicopter)
2) Mitigation
a. Slash
b. Chips
c. Mulch
d. Water bars
e. Cloth

4. Natural Leave Tree Selection
a. Identify dominant, co-dominant and wildlife trees
b. Evaluate each identified tree for:
1) Vigor - percent live green crown, terminal bud growth, pathogens, etc.

    2) Competition - present and future (lower crown in decline or maintaining)
    3) Growth factors – soil depth and type, water supply and sunlight
    4) Threats – erosion, shallow soil, mass wasting, windthrow risk, fuel loading ladder fuels, pathogens
    5) Wildlife habitat – multiple tops, broken or dead tops, bole damage, root or heart rot, brooming (dwarf-mistletoe or elytroderma) or snag recruitment trees*
  c. Select leave trees
    1) Clearly mark take trees with tree paint at 5' above ground level
    2) Mark leave trees with tree paint at ground level

5. Monitoring
  a. Permanent monitoring (established or new)
    1) photo points
    2) transects or plots
  b. Temporary monitoring (as need and funding opportunities arise)
    1) photo points
    2) custom protocols (woody debris, soil movement tracking, etc.)
    3) timber cruise data
    4) plant surveys
    5) research projects

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* snag recruitment trees – trees that are left specifically to provide snag habitat. Different species and size snags provide habitat for different wildlife species. Maintaining higher densities of trees and leaving some thickets of trees and trees in decline will promote future snag habitat.

Appendix B
Harvest/Yarding Systems

Ground Based

Manual Log Length

Description

Manual log length cutting is tree falling and bucking (cut into log lengths) with a chainsaw followed by dragging the logs to a landing (loading area) with draft animals or machinery.

Equipment Options:

- Chain saw.
- Draft animals: horses, mules or oxen equipped with harness and log chain or cart and arch with a hand winch to raise one end of the log(s) off the ground.
- ATV (All-Terrain-Vehicle) equipped with a chain, skidding arch or forwarder trailer*.
- Farm tractor with a skidding winch, arch with a winch or forwarder trailer.
- Tracked skidding machine: a tracked vehicle such as a bull dozer equipped with a cable winch, hydraulic grapple or a forwarder trailer.
- Skidder: a rubber tired all wheel drive vehicle equipped with a winch or hydraulic grapple.
- Tracked skidding machine or bulldozer with winch or grapple.
- Shovel: a track hoe with grapples that lifts logs and moves them toward the landing incrementally (usually used only for short distances).

Ecological Impacts:

Tree falling is a skilled profession. Falling trees without damaging leave trees and laying the logs out in a fashion that enables them to be skidded without damage to leave trees requires conscientious, skilled fallers. Economic incentives are often at odds with that objective. Equipment type and operator skill to a large degree determine outcomes from the skidding or forwarding part of a commercial thinning operation.

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* forwarder trailer – a woods trailer usually equipped with a hydraulic arm with a grapple that can load logs

Mitigation of Ecological Impacts:

- Prevent negative impacts through contractual language that provides incentives for quality work.
- Carefully evaluate site conditions followed by selecting the most appropriate harvest system.
- Stabilize soils and use recovery techniques that may include water bars*, slash or log placement on skid trails, seeding and/or plantings.

Mechanical Harvest Systems

Description

Whole tree harvesting involves tree falling and stacking with a harvester head mounted on tracked or wheeled equipment followed by dragging the logs to a landing (loading area) with skidding machines followed by mechanical delimbing. Cut to length systems involve tree falling, limbing and bucking by a tracked or wheeled machine equipped with a processing head followed by hauling to the landing on a trailer (forwarder).

Equipment Options:

- Feller buncher: these come in numerous iterations from small skid steer mounted units to large track hoe units that can handle trees up to 30 inches DBH.
- Processing heads for cut to length systems are limited to trees under 20 inches DBH and can be mounted on farm tractors to large track hoes.
- Skidding equipment can be the same as for other ground-based methods.

Ecological Impacts

Equipment type and operator skill to a large degree determine outcomes from the skidding or forwarding part of a commercial thinning operation.

Mitigation of Ecological Impacts

- Prevent negative impacts through contractual language that provides incentives for quality work.
- Carefully evaluate site conditions and then select the appropriate harvest system.
- Use soil stabilization and recovery techniques water bars, slash or log placement on skid trails, seeding and/or plantings.

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* water bar – a small water diversion structure consisting of soil pushed up on a skid trail; intervals between water bars is determined by slope and soil type

Aerial Harvest Systems

Description:

Aerial harvest is tree falling and bucking (cut into log lengths) with a chainsaw or feller buncher, followed by yarding with a cable system or helicopter.

Equipment Options:

Chain saw or feller buncher.
High lead yarding tower with winches.
Yarding tower with stationary cable and carriage.
Helicopter equipped with a winch system.

Ecological Impacts:

High lead towers require corridors and may drag logs on the ground as well as damage leave trees. Aerial harvest systems are more expensive and may require the removal of a higher percentage of larger trees to be economically feasible.

Mitigation of Ecological Impacts:

Prevent negative impacts through contractual language that provides incentives for quality work.
Carefully evaluate site conditions and select the appropriate harvest system.

Appendix C
Assessment and Monitoring

Assessment and monitoring will provide information on ecosystem conditions. This sample monitoring system will provide information at a level of detail and accuracy that will permit informed forest management decisions to be made followed by short and long term quantifiable outcomes of treatments. Perpetual refinements, to improve efficiency, are expected as technology and field experiences dictate.

The Protocols are designed to quantify the condition of different ecosystem elements. They will be used to assess conditions prior to treatments and to monitor conditions following treatments. Ongoing monitoring (repetition of assessment protocols) will provide a way of quantifying the effectiveness of treatments.

Ecological Management Goals

- Increase native plant species and reduce non-native plant species
- Increase elements of wildlife habitat
- Increase areas of late successional species
- Minimize crown fire potential in managed areas
- Promote tree growth and vigor in managed stands
- Maximize capture and release of precipitation
- Allow natural disturbances to occur

Quantifiable Indicators

Vegetative cover

- Growth rate
- Structure
- Species and density
- Insect and disease
- Downed woody debris
- Plant community
- Non-native species

Soil and water

- Sil type and texture
- Soil bulk compaction at depth

- Soil aggregability
- Soil porosity
- Water retention
- Hydraulic conductivity
- Observable erosion patterns
- Soil movement
- Soil turnover (measured by lichen abundance when present)

Wildlife

- Direct observation
- Use of callling stations
- Nesting
- Cavity nest observation
- Food source presence and utilization
- Down woody debris presence, quality and utilization
- Droppings
- Tracks
- Priority Habitats and Species (PHS) database review

Ecosystem Assessment Protocol (Example)

I. Preliminary Mapping (Map Info generated; guidelines for mapping)
   A. Reference Maps (can be combined if not too cluttered)
      1. Soil
      2. Topography
      3. Water
      4. Roads
      5. Structures
   B. Working Maps (preliminary unit delineation with office generated polygons and a ruled sheet with a 132-dot grid)
      1. Existing use (farmland, pasture, range, etc.)
      2. Riparian or wetland buffers
      3. Stand maps (if discernable on aerial photos; open or closed canopy, aspect, etc.)

II. Data Gathering Preparation
   A. Preliminary Office Tasks
      1. Directions to the site
      2. Field copy of soil survey description
      3. Stream type and wetland data
      4. Previous Forest Practices permits
      5. Road Maintenance and Abandonment Plans
      6. Endangered, Threatened or Sensitive species list for the area
      7. Noxious weed list
   B. Tools (minimum)
      1. Field sheets (general and transect data sheets; slope correction table)
      2. Clipboard, small note pad, Pencils
      3. Zip lock baggies
      4. Small pill bottles
      5. Calculator
      6. Compass
      7. Clinometer
      8. Soil rod
      9. Digging implement (potting tool, small masonry trowel, etc.)
      10. 200-foot or 66-meter tape
      11. Flagging
      12. Wire flags
      13. Easy erase white board 10 X 12 inches and markers
      14. Red and white staff (English or metric)
      15. Camera
      16. Plant Association guidebook, list of indicator species
   C. Tools (optional)
      1. Penetrometer

    2. Laser range finder
    3. Laser target or partner with light clothing
    4. GPS unit
    5. Altimeter
    6. Digital camera
    7. Tape recorder
    8. Data Logger

III. Field Work

- A. Orientation
    1. Locate boundaries of site
    2. Determine if office generated stand polygons are adequate to delineate differences on site
    3. Mark existing stand boundaries and any new areas in the order that data will be gathered
- B. Data gathering
    1. Fill out field sheets while becoming familiar with the site
    2. Mark potential transects and photo points on a working map in pencil
        - a. Establish transect and photo point criteria for areas of:
            - 1) Transition
            - 2) Non-native plant species
            - 3) Disturbance
            - 4) Significant pathogen activity
            - 5) Stand or site condition
            - 6) Other conditions noted
    3. Select transects that will best track the changes that occur on site
    4. Follow Transect protocols
    5. Use transect site candidates as photo points

IV. Recording Data

- A. Maps
    1. Create a GIS map of stands using GPS locations and photo-interpretation
    2. Draw any additional mapped stand boundaries
    3. Label polygons
    4. Label transects and photo points
    5. Make any corrections to original maps
- B. Data
    1. Enter information into a spread sheet or data base to be developed over time
    2. Sort information into categories that describe the condition of each area
    3. Link layers to raw data, transect information and photos

Forest Transect Protocols
Transect Layout

1. Identify an area on the site that typifies a particular stand condition.
    a. For line transects, determine the number of sample points necessary to provide an accurate picture of the variability found along the transect.
    b. For belt (areal) transects, determine an appropriate length and width that will be necessary to monitor changes in features such as plant cover and species over time.
    c. Determine the locations of any sub-plots (areal quadrats) that will be associated with the main transect. The locations of sub-plots should planned so as to be capable of measuring additional details about specific aspects of soils, plant community, etc. along the main transect. The location of each sub-plot will have to be recorded either by a rule, or by individual descriptions.
2. Record the site location with an azimuth bearing and the distance from a distinctive reference point such as an obvious geological feature, survey marker or bend in a road to the start of the transect. Record the location on a GPS unit.
3. Mark the beginning and end location of the transect with 2-foot long rebar or pipe driven into the ground 30 meters apart (leave 3 inches exposed if rocks are available to place around it otherwise make these flush with the surface).
4. Place a numbered metal tag on the nearest sound tree near ground level or other long lived landmark (rock outcrop, boulder, large stump). Record the azimuth bearing and distance from the tag to the beginning of the transect sheet and also record the location with a narrative description.

Data Gathering

1. Lay a meter tape or rope on the ground along the transect. On the map draw trees, snags and woody debris > 3” diameter within 3 meters of the transect. Number each tree.
2. Fill in the assessment sheet with the following information:
    a. Tree species (note if these are snags).
    b. Percent cover of species growing.
    c. Use an increment borer to age a trees that occur along the transect by 6-inch diameter classes.
    d. Measure the height of all trees to an even multiple of inches.
    e. Measure the DBH of all trees over 6 inches DBH and tally those under 6 inches DBH.
    f. Determine the percent live crown.

    g. Record defects such as sweep, pistol butt, crook, double top, broken top, etc.
    h. Note insect activity and note the species, whether they are active or not and resultant tree mortality.
    i. Note other pathogens, such as dwarf mistletoe and Elytroderma.
    j. Note wildlife utilization.
    k. Note other pertinent information in comments.
3. Dig a soil pit down to the subsoil or slightly beyond rooting depth and record:
    a. Compaction: 0 = none, 1=slight, 2=moderate, 3=severe.
    b. Rock % = percentage of > 1-inch rock (divide into size categories such as 1-2 inch, 2-6 inch, 6-12 inch, 12-36 inch, slabs).
    c. Moisture content (dry, moist or wet; depth to standing water).
    d. Rooting depth of the majority of plants.
    e. Coarse woody debris (> 3 inches diameter; 0 = none, 1 = light, 2 = moderate, 3 = heavy).
    f. Needle and duff depth.
    g. Depth of top and bottom of A, B and C soil layers
    h. Soil type or description.
4. Record at least two sets of photos for each transect. Each set should consists of one photo at each end of the transect and any additional photos of quadrats. A reader board is helpful for recording each shot.

Prescription and Monitoring Form (Sample)

MP
TWP Rg Sec Month Year

SWA MANAGEMENT PRESCRIPTION

Management Unit Name:	Date:
Author/Title	

ACTIVITIES

Controlled Burn ☐ Timber Harvest ☐ Non-commercial Thin ☐

Planting ☐ Weed Control ☐ Other

PROJECT SUMMARY

Objective Overview:

Township	Range	Section (s)	Acreage

(reference as A, B, etc.)

Attachments	
Aerial Photo Reference: A Date:	**GIS Map** Reference: Date:
Topographic Map Reference: Date:	**Soil Map** Reference: Date:

PHYSICAL FEATURES (include photo documentation and/or delineate on on aerial photo)

1 Roads or trails Photo/Map Reference:	8 Fire Breaks (constructed) Photo/Map Reference:
2 Fences Photo/Map reference:	9 Fire Breaks (natural) Photo/Map:
3 Ponds/Lakes ☐ Seasonal ☐ Permanent Photo/Map Reference:	10 Streams ☐ Seasonal ☐ Permanent Photo/Map Reference:
4 Wetlands ☐ Seasonal ☐ Permanent Photo/Map Reference:	11 Erosion ☐ Active ☐ Inactive Photo/Map Reference:
5 Structure Photo/Map Reference:	12 Archeological Site Photo/Map Reference:
6 Agricultural Area Photo/Map Reference:	13 Fallow Agricultural Area Photo/Map Reference:
7 Gradient > 35% ☐ Photo/Map Reference:	14 Other Photo/Map Reference:

Physical Feature Summary

Description:

Physical Feature Narrative Attachments (Reference as PF- A, B, etc.)

Reference(s)

SOILS

☐ Fine (Clay or Silt Soil) ☐ Loamy Photo/Map Reference:	☐ Thin < 6” Photo/Map Reference:
☐ Intermediate (Silty to Fine Sand) ☐ Loamy Photo/Map reference:	☐ Moderate > 6” < 18” Photo/Map:
☐ Coarse (Coarse Sand to Gravelly ☐ Loamy Photo/Map Reference:	☐ Deep > 18” ☐ Seasonal ☐ Permanent Photo/Map Reference:

Soil Summary

Description: **Concerns:**

Soils Descriptive Narrative Attachments (Reference as S- A, B, etc.)

Reference(s)

VEGETATIVE COVER

Cover Type	Seral Stage	Photo/Map Reference	Acreage
1 Marsh			
2 Riparian Shrub			
3 Riparian Hardwood			
4 Mesic Aspen			
5 Xeric Aspen			
6 Riparian Conifer			
7 Steppe			
8 Shrub Steppe			
9 Ponderosa Pine Savanna			
10 Ponderosa Pine Woodland			
11 Ponderosa Pine Forest			
12 Ponderosa Pine/Douglas-fir Woodland			
13 Douglas-fir/Ponderosa Pine Woodland			
14 Ponderosa Pine/Douglas-fir Forest			
15 Douglas-fir/Ponderosa Pine Forest			
16 Douglas-fir Forest			

Vegetation Summary

Description:

Concerns:

Vegetation Narrative Attachments (Reference as V- 1-16, etc.)

Reference(s)

HABITAT

Habitat Type	Present Condition OK	Poor	Enhancement Activity Yes	No	Reference
1 Spring Ephemeral	☐	☐	☐	☐	
2 Spring	☐	☐	☐	☐	
3 Stream Intermittent	☐	☐	☐	☐	
4 Stream Year Round	☐	☐	☐	☐	
5 Stream Fish Bearing	☐	☐	☐	☐	
6 Pond Ephemeral	☐	☐	☐	☐	
7 Pond Permanent	☐	☐	☐	☐	
8 Lake	☐	☐	☐	☐	
9 Marsh	☐	☐	☐	☐	
10 Riparian Shrub	☐	☐	☐	☐	
11 Riparian Hardwood	☐	☐	☐	☐	
12 Xeric Aspen	☐	☐	☐	☐	
13 Riparian Conifer	☐	☐	☐	☐	
14 Steppe	☐	☐	☐	☐	
15 Shrub Steppe	☐	☐	☐	☐	
16 Ponderosa Pine Savanna	☐	☐	☐	☐	
17 Ponderosa Pine Woodland	☐	☐	☐	☐	
18 Ponderosa Pine Forest	☐	☐	☐	☐	
19 Ponderosa Pine/Douglas-fir Woodland	☐	☐	☐	☐	
20 Douglas-fir/Ponderosa Pine Woodland	☐	☐	☐	☐	
21 Ponderosa Pine/Douglas-fir Forest	☐	☐	☐	☐	
22 Douglas-fir/Ponderosa Pine Forest	☐	☐	☐	☐	
23 Douglas-fir Forest	☐	☐	☐	☐	

Habitat Summary

Description: **Concerns:**

Habitat Condition Attachments (Reference as HC - 1-23)

Reference(s)

PERMANENT MONITORING / PHOTO POINTS

Permanent Monitoring/Photo Points (reference PMPP – TRS – year established)

Twp R Sec ¼ of ¼	Lat Long	Reference Directions

TREATMENTS

1 Controlled Burn ☐ **2 Timber Harvest** ☐ **3 Non-commercial Thin** ☐

4 Planting ☐ **5 Weed Control** ☐ **6 Other**

Treatment Summary

Activity(s)
Objective(s)

Treatment Attachments (Reference as T – 1-6)

Reference(s)

OUTCOMES (Reference O_- (MP#) and Date

Reference(s)

Expected Impacts	Positive	Negative	Positive	Negative
Post T				
1 yr				
2 yr				
5 yr				
10 yr				

Unxpected Impacts	Positive	Negative	Positive	Negative
Post T				
1 yr				
2 yr				
5 yr				
10 yr				

Outcome Summaries

Existing Condition(s)
Desired Future Condition(s)

Post Treatment Conditions
Monitoring Date **Observations:**