

**Whitebark and Limber Pine (Five Needle Pine)
Management Guidelines for Wyoming BLM.
Attachment 1.**

These guidelines are developed to provide direction on how to manage both whitebark pine and limber pine found on BLM lands in Wyoming. The silvicultural prescriptions are to be used as guidelines to meet the objectives of the maintenance and restoration of five needle pine on the landscape. The objectives are: 1- to maintain these stands on the landscape in the face of changing climate and insect (mountain pine beetle – MPB) and disease (white pine blister rust – WPBR) epidemics that are severely impacting these species, 2- to maintain genotypic diversity on the landscape and. 3- to provide both the source and opportunity for these species to naturally migrate or change their species ranges as climatic conditions change in the future. Field Offices need to evaluate the objectives of projects that involve five needle pines to ensure that the long term objectives of maintaining these sensitive species on the landscape are appropriately evaluated along with other management objectives.

Reference materials that can be used for documentation of potential management actions can be found at: <http://web.wy.blm.gov/930/forestry/pines/index.htm>

Wyoming BLM is working with Utah State University to develop Stand Density Index Charts for both whitebark and limber pine. When these are completed they will be valuable tools with which to manage these stands. All Stand Density Index (SDI) materials can be found at: <http://web.wy.blm.gov/930/forestry/SDI/index.htm>

General Guidelines:

Cone (Seed) Collection: There are significant regional whitebark and limber pine seed collection efforts underway to identify white pine blister rust (WPBR) resistant trees. The cone collection efforts are central to five needle pine restoration for three reasons: 1- blister rust resistance testing, 2- restoration plantings, and 3-*ex-situ* gene conservation.

Preliminary seed tree selection involves finding and marking trees that are nearly free of both WPBR and mountain pine beetle (MPB) infestation. Trees need to be marked and located with a Global Positioning System (GPS) so that they can be relocated for further collections if testing determines that these trees are WPBR resistant. This information will be stored on a GIS data layer at the District level. The entire process, from cone collection to rust resistance determination, takes approximately five years, so these trees need to be protected from both natural and human disturbance until the determination is made. If the testing shows WPBR resistance, these trees will be permanently marked and used as a seed source. These trees are identified as “plus” trees. All trees either tentatively or positively identified as “plus” trees need to be protected by pheromones or insecticides (see next page).

Whitebark pine seed collection procedures can be found in the on- line five needle pine references. Limber pine, because of its different cone structure, does not normally require the caging that whitebark pine does and can be collected as soon as the seed is ripe. In high pine mortality areas (limited seed source), where there is significant predation from squirrels and birds caging of both species is necessary.

Collections for both species is normally done, dependent on site and climatic conditions, in late August or early September when their embryo cavities are found to be at least 80 percent full.

Because of the workload associated with identification of potential “plus” trees as well as the seed collection, it is recommended that Field Offices develop BPS submissions in conjunction with the “Seeds for Success” program assist in funding these activities.

Seedling Planting: Seedlings from these trees have a fairly low survival rate ranging from less than 30 to approximately 70 percent. Seedlings should be planted in the autumn, to avoid summer drought stress, at approximately 200-250 seedlings per acre with the goal to have a three to five year survival of 85-100 trees per acre. There should be no overstory competition within 20 feet. The planting design should be a patchy pattern with densities similar to that of nearby stands. Microsite placement is critical. The transplants should be placed in a protected microsite in moist to the touch soil on the north side of a log, rock, or stump. Gophers feed on roots and bury trees, so avoid planting the seedlings in areas of deep soils and swales where they burrow. Competing vegetation such as grasses and sedges should be removed from the immediate vicinity of the planted seedling. Avoid planting seedlings within two feet of bear grass (*Xerophyllum tenax*). On more mesic sites, grouse whortleberry (*Vaccinium scoparium* Leib. ex Coville) appears to be beneficial to establishment when growing in association with whitebark pine and should be retained. Lower elevation xeric sites may not have these vegetative components. Current recommendations for planting with WPBR resistant seedlings include, 1- sites where WPBR mortality exceeds 20 percent and, 2- WPBR infection is more than 50 percent.

Pheromone Usage: Pheromones, especially verbenone, can be used to protect against MPB attack. Recent work in Idaho on whitebark pine shows a 20 percent increase in survival over a control population when verbenone is used. Because of costs, this use is only feasible in high value recreation/visitor areas or on trees either tentatively or positively identified as plus trees.

Insecticide Usage: Carbaryl is commonly used to provide protection from MPB. This insecticide when properly applied by spraying can provide almost 100 percent protection from MPB attack for up to two years. Trees must be accessible to compressor driven spray equipment, limiting this application to trees in close proximity to roads.

Pruning: Pruning can be used to extend the life of a five needle pine. Pruning should be done by hand, leaving the branch collar (swollen base of the limb) intact. This should only be used on limbs where the WPBR canker is more than 4 inches from the bole (trunk) of the tree. Because pruning is labor intensive it should only be used to: 1- to protect high value individual trees in high visibility sites such as recreational/ski areas or, 2- in a small isolated stand with few cone bearing trees and no existing seed source for regeneration. Pruning will not change the WPBR resistance of an individual tree or stand, but will extend the life span and potential reproductive life of the tree.

Range Management Applications: The historic bison range in Wyoming closely approximates the range of lower treeline limber pine in Wyoming. The Nature Conservancy along the Front Range has used the

following range management technique to replicate bison/limber pine interactions with success. Where feasible, this technique can be used on Wyoming BLM lands.

Place water developments and salt stations in close proximity to limber pine stands. This will provide thermal cover for livestock. Their usage of the limber pine stands will raise the crown heights due to rubbing, reduce ground cover including tree reproduction, and reduce flammable fuels within the stand. The long term objective (50 + year) is to approximate an open limber pine stand that resembles historic bison/limber pine interactions.

Wildland Fire Management: Wildland fire has been an integral component of the five needle pine ecosystem. At high elevations, low to moderate intensity fires reduce competing vegetation and reduce fuel loadings. Small areas of high intensity fires create open areas for Clark's nutcracker seed caching activities and therefore create areas where whitebark pine can regenerate naturally. However, when subalpine fir has expanded extensively into, and provides a closed canopy fuel load below them, these stands can burn large areas of five needle pine habitat and reduce or eliminate the available seed source. The potential for natural reseeding of these stands *via* the Clark's nutcracker is subsequently reduced. Some researchers have found a 40 year lag time between fire and the re-establishment of whitebark pine on these high elevation areas.

Less is known about the wildland fire effects on the lower elevation five needle pines: Information available suggests fire return intervals ranging from 100 to 1,000 years and most fires were probably low to moderate intensity.

At high elevations wildland fire should be allowed to play a role in maintaining these high elevation five needle pine ecosystems. A combination of mechanical thinning and prescribed fire can also be used to create the patchy mixed severity fire effects in these stands, replicating natural fires. Altering the mixed conifer stands below these high elevation stands may be necessary to break up and reduce the canopy cover by creating patches of younger aged (less flammable stands), and reducing the basal area/SDI of the mature mixed conifer stands to reduce fire behavior before it burns into the high elevation stands. Because many of the Wyoming BLM high elevation whitebark and limber pine exist in small isolated stands, careful evaluation of fire potential must be done to ensure that these disjunct stands are not eliminated from the landscape.

At lower elevations, prescribed and wildland fire can be used at low to moderate intensities to reduce accumulated fuels and thin the stands. The best description of this is to "take some and leave some", so that the stand can remain on the landscape and provide for gene conservation and ecosystem services.

General Silvicultural Information for Five Needle Pine Stands:

Whitebark and limber pine occur over a range of ecological gradients and vegetative associations. This enables the forester to select from a variety of silvicultural prescriptions that will meet desired goals for the management of these species. It is important to remember that both species of five needle pines

are very slow growing, often requiring 50 or more years to reach maturity and produce a cone crop. Small size is a poor indicator of recent establishment.

The five needle pines generally do not show strong apical dominance. Because of this, different types of thinning around these trees can influence their growth form. Thinning on all four sides will encourage a more spread out, multi-forked tree, while thinning on two or three sides will encourage a straighter less forked tree. In mixed stands thinning on two or three sides would encourage the tree to have a straighter, taller growth form to allow it to get higher in the canopy and access more light for growth. In more open monoculture stands thinning around all four sides of either single or multi-stemmed trees would encourage a more open branching crown, increasing cone production.

Important factors in any silvicultural practice are the identification of potential WPBR resistant trees and building the on-site prescription around them. Individual stands also vary in their resistance to WPBR due to local genetic material. WPBR often takes 25-35 years to kill a mature tree and but only five years to kill a sapling. WPBR severely reduces cone crop production, often eliminating a living tree from the reproductive pool by killing the cone producing limbs long before the tree actually dies.

These five needle pines are among the least resistant to the MPB, so often the best strategy may be to manage them to reduce the mortality risk. Thinning to reduce the potential for widespread MPB mortality also has the advantage of reducing the competition among the remaining trees and increasing resource availability. Field observations have documented MPB attacking 3" to 5" diameter trees. In cases of severe MPB infestations, it may be necessary not only to remove of all infested five needle pines but also any mature uninfected overstory to reduce the MPB habitat (larger diameter trees) and reduce the numbers of MPB surviving on site. This may be the only way to protect the advanced reproduction so that the reproduction survives on site to provide for future trees and seed source. This will reduce the Basal Area (BA) and/or Stand Density Index (SDI) below the guidelines in the specific silvicultural operations described below.

Elevational Differences: Limber pine grows across the widest elevational range of any conifer in the Rocky Mountains, ranging from approximately 5,250 feet (1600 m) to almost 11,000 feet (3300 m). The 8,500 foot elevation was selected as the dividing point between high elevation/upper treeline and low elevation/lower treeline limber pine because of its usage in the only peer reviewed document that established elevational differences in limber pine as a research criteria. It is possible that stands meeting the meaning of "high elevation/upper tree line", i.e. subalpine ridge and mountain tops can be found below 8,500 feet and expert field opinion must be used to determine which category best fits the stand. Whitebark pine generally grows above 8,000 feet in elevation, but potentially can be found at lower elevations. All guidelines for whitebark pine should be used without regard to actual elevation of the stand but rather, the associated species.

Specific Silvicultural Operations, Treatments and Prescriptions for Five Needle Pine Stands:

Stand Type: High elevation/upper treeline predominately whitebark and limber pine stands (Generally found above 8,500 ft. in the subalpine zone).

Desired Conditions/Functions: Maintain and/or restore these stands on the landscape to fill their hydrologic, wildlife and other related ecosystem services. Stand structure will be as resistant as possible to MPB infestations. Maintain WPBR resistant individuals on site and use their seed source for interplanting to maintain five needle pine stands.

Existing Conditions: These stands are severely impacted by both WPBR and MPB. They are also being encroached on by mixed conifer species, especially subalpine fir. These stands range from patchy open woodlands to a more closed canopy structure.

Silvicultural Treatments/Prescriptions:

- 1- Removal of subalpine fir from the stand to reduce competition for resources. If it is not possible to remove all the subalpine fir, remove the fir in a radius of 20 feet around large five needle pines (or clumps) and remove fir in a radius of at least 10 feet from seedling/sapling five needle pines. Because the five needle pines are very slow growing, evidence of release may not be exhibited for five (5) plus years. The relative densities should range between 10 and 25 percent of the maximum SDI for newly treated stands and should not exceed 40 percent maximum SDI.
- 2- Thin stands to make them more resistant to MPB attacks in areas with incipient MPB infestation or threat, reduce the Basal Area of the trees to approximately 40-45 ft². Slash must be disposed of by burning within one year or less or by mastication to eliminate the risk of pine beetles currently in the removed trees to survive in the slash. In areas infected with WPBR preferentially thin the trees exhibiting the greatest amount of infection. Attempt to leave different ages and sizes of trees within the stand, but, dependent on proximity to MPB, preferentially leave five needle pine trees of less than 6 inches DBH. The relative densities should range between 10 and 25 percent of the maximum SDI for newly treated stands and should not exceed 40 percent of maximum SDI.
- 3- Use prescribed fire and natural ignitions where feasible at low to moderate intensities to create openings in the stands for Clark's nutcracker seed caching, to reduce competition from other conifers and to reduce fuel loadings. Ensure that small disjunct stands are protected from high intensity crown fire to prevent their elimination from the landscape when feasible.
- 4- Identify, monitor and collect seeds from potential "plus" trees to provide for a future seed source.
- 5- Use locally collected seed from "plus" trees to inter-plant these stands when WPBR reaches the break points listed above in Seedling Planting section above and there is an absence of uninfected advanced regeneration in the understory.

Stand Type: Mixed conifer stands with a five needle pine component (Generally found above 8,500 ft. and directly below the subalpine zone):

Desired Conditions/Functions: Maintain five needle pine component in the mixed conifer systems. Maintain an appropriate mix of species to maximize whitebark pine seed caching by squirrels for grizzly bear food source. Pine species (lodgepole and five needle pine) densities are low enough to minimize MPB epidemics and keep MPB at endemic levels. Maintain WPBR resistant individuals on site and use their seed source for in-planting to maintain five needle pine stands.

Existing Conditions: These stands are characterized by multiple tree species including lodgepole pine, Engelmann spruce, and subalpine fir and the five needle pines. New, unpublished research presented at the High 5 Symposium in 2010 shows a positive symbiotic relationship between the red squirrel, lodgepole pine, five needle pines, and grizzly bears in Canada and the Yellowstone area.

Silvicultural Treatments/Prescriptions:

- 1- When working in these stands, reduce the five needle pine Basal Area to approximately 25 ft² and reduce the lodgepole pine Basal Area to approximately 40 ft². Preferentially remove the spruce and fir to accomplish other vegetative management objectives. The reduction of pine (five needle and lodgepole) Basal Area to the 60-65 ft² range will inhibit the spread of MPB. The relative densities should range between 15 and 25 percent of the maximum SDI for newly treated stands and should not exceed 40 percent of the maximum SDI to inhibit the spread of MPB.
- 2- Remove competing woody vegetation around existing five needle pines to provide for release.
- 3- Identify, monitor and collect seeds from potential "plus" trees to provide for a future seed source.
- 4- Use locally collected seed from "plus" trees to interplant these stands when WPBR reaches the break points listed above in Seedling Planting section above.
- 5- Most of these stands have a long fire return intervals that are a mixed severity to stand replacement types. Prescribed fire should be targeted to those areas (south facing slopes, lower elevations) where the vegetation indicates a mixed severity shorter fire return interval. North facing mesic sites with a crown replacement fire regime should only be spot treated (i.e. removal of slash accumulations/piles) and small openings created in the overstory.

Stand Type: Limber pine growing in association with ponderosa pine and/or Douglas fir, aspen, and mountain shrub (Generally found below 8,500 ft. /lower treeline).

Desired Conditions/Functions: Maintain healthy forest conditions with an appropriate limber pine component to fulfill ecosystem services and to provide a seed source for post disturbance early seral limber pine establishment to serve as a nurse plant and to provide ecological modification of the site to allow for other species to re-establish.

Existing Conditions: In many cases the limber pine in these stands is an early seral species and will be outcompeted by the ponderosa pine and Douglas fir. Limber pine serves an important function in these landscapes as a nurse tree species and as a site modifier to enable other species to establish. MPB is the primary agent of limber pine mortality in these stands.

Silvicultural Treatments/Prescriptions:

- 1- Thin stands to make them more resistant to MPB attacks. Reduce Basal Area in pine dominated stands to less than 60 ft². Leave a scattering of limber pine in the understory to provide for a seed and genetic source. Emphasize limber pine on exposed slopes and ridges. Maintain maximum SDI of between 25 and 40 percent.
- 2- In Douglas fir dominated sites, keep some residual limber pine on site for a seed and genetic source after a disturbance. Maintain maximum SDI of between 25 and 40 percent (total SDI for all species).
- 3- In aspen stands where there is a viable limber pine stand in close proximity to the aspen stand, it is permissible to remove the limber pine from the aspen stand as part of an aspen regeneration/wildlife project. Limber pine that predates the establishment of the aspen stand should be retained for diversity.
- 4- Limber pine grows in association with mountain shrubs, often being a nurse tree for the mountain shrub community. When needed, thin the limber pine to a tree crown cover of approximately five percent (or a five to ten percent of the maximum SDI) to allow the tree to remain on site to provide for a seed and genetic source while opening up the stand to encourage mountain shrub production. Leave multi-age cohorts on site wherever feasible.
- 5- Identify, monitor and collect seeds from potential "plus" trees to provide for a future seed source.
- 6- Use locally collected seed from "plus" trees to inter-plant these stands when WPBR reaches the break points listed above in Seedling Planting section above.
- 7- Prescribed fire can be used in these stands. Primary objectives of prescribed fire will often be reduction of fuels and re-introducing fire for the benefit of other later seral woody species. Low to moderate intensity fire will assist in maintaining limber pine on site, and should not be directed at limber pine stand eradication.

Stand Type: Limber pine stands growing in riparian areas (Generally found below 8,500 ft.).

Desired Conditions/Functions: Restore or maintain a fully functioning riparian/wetland area as measured by Proper Functioning Condition (PFC, and/or other site specific resource objectives).

Existing Conditions: In some riparian/wetland areas there has been an expansion of upland vegetation including limber pine, Douglas fir, juniper and sagebrush into these systems. This expansion is detrimental to the functions of the riparian/wetland areas as determined by the Standards for Healthy Rangeland (WY BLM). Limber pine in these areas tends to be faster growing than in upland areas and

can impact, in conjunction with the other upland species, the functioning conditions of riparian/wetland areas. Impacts from MPB and WPBR vary widely in these stands, ranging from areas of very high mortality to stands that are just beginning to be impacted. Future outlook is for increasing MPB mortality and increasing WPBR infection/mortality as well as continued expansion into the riparian/wetland areas.

Silvicultural Treatments/Prescriptions:

- 1- Limber pine does play a significant role in the hydrology of the watershed. It should be left on the landscape in the upland areas away from the riparian zone. Management of these upland stands should follow the silvicultural treatments and prescriptions in the stand type “Lower treeline limber pine stands either in association with juniper species or a monoculture” described below.
- 2- In areas where PFC or other monitoring studies, assessments, or evaluations indicate: 1- an excess of upland vegetation exists in the riparian/wetland area, and 2- conifer expansion is identified as one of the casual factors affecting the functionality of the system, it is permissible to remove some of the limber pine. The removal of limber pine and other upland vegetation within the riparian/wetland system will assist in meeting or making progress towards meeting the Standards for Healthy Rangelands (BLM, Wyoming), and/or other site specific objectives. Because the ecology of limber pine is not fully understood, a “leave some take some” approach should be implemented in the riparian/wetland zones as in upland areas.

Stand Type: Lower treeline limber pine stands either in association with juniper species or a monoculture (Generally found below 8,500 ft. in ecotones).

Desired Conditions/Functions: Preserve and maintain these stands on the landscape as woodlands and savannas, with density levels commensurate with reduced risk of widespread MPB mortality. Allow these stands the flexibility to move on the landscape in response to changing climatic and other environmental conditions.

Existing conditions: There has been a lack of research on these stands, and very little is known about the ecosystem services provided. These often occur on steeper, rocky, exposed slopes and have shown movement downslope in the past 100-200 years. MPB is found in these stands at increasing levels of infestation and mortality. WPBR infections and MPB infestations vary widely in these stands, ranging from areas of very high mortality from one or both WPBR and MPB to stands that are just beginning to be impacted. Future outlook is for increasing MPB mortality and increasing WPBR infection/mortality.

Silvicultural Treatments/Prescriptions:

- 1- Thin stands to make them more resistant to MPB attacks. Stands should be thinned to a Basal Area of 40-45 ft² where they form a fairly continuous canopy cover. Preferentially remove juniper species (Utah and Rocky Mountain) to allow for release and to open up the understory for grass and forb establishment and growth. Maintain Maximum SDI of between 25 and 40 percent.
- 2- On deeper soils at the bottom of slopes and drainages, when needed, thin the limber pine to a tree crown cover of approximately five percent (or a five to ten percent of the maximum SDI) to allow the tree to remain on site as an open woodland and to provide for a seed and genetic source. If maintenance of a higher density woodland is desired, maintain Maximum SDI of between 25 and 40 percent. Leave multi-age cohorts on site wherever feasible.
- 3- Use the Range Management Application described above to assist in creating an open woodland stand of limber pine.
- 4- Identify, monitor and collect seeds from potential "plus" trees to provide for a future seed source
- 5- Use locally collected seed from "plus" trees to inter-plant these stands when WPBR reaches the break points listed above in Seedling Planting section above.
- 6- Use low to moderate intensity prescribed and natural fire to assist in thinning of the stands. The best description of this is to "take some and leave some", so that the stand can remain on the landscape and provide for gene conservation and ecosystem services.

Stand Type: Lower treeline limber pine stands growing in sagebrush areas such as former sagebrush meadows and otherwise suitable sage-grouse habitat (Found below 8,500 ft. in ecotones).

Desired Conditions/Functions: Restore open sagebrush flats and meadows for suitable sage-grouse habitats and to protect important habitats from extreme fire behavior.

Existing Conditions: In some transitional sagebrush areas there has been observed expansion, and in some cases invasion, of coniferous vegetation including limber pine and juniper into habitats managed for Sage-grouse. This noted expansion is detrimental to the overall functionality of important Sage-grouse habitats as measured by the Habitat Assessment Framework and associated Standards for Healthy Rangeland (WY BLM). The expansion of Limber pine and other coniferous species in these areas may increase risk for high severity wildland fire and threaten reduction of important Sage-grouse habitat functionality.

Silvicultural Treatments/Prescriptions:

- 1- Conifer removal efforts must consider and observe the concurrent goals and objectives of the sensitive species of limber pine management and maintain adjacent limber pine sites for local seed source. Projects would be conducted following the silvicultural treatment prescriptions in the stand type "Lower treeline limber pine stands (below 8,500 ft.) either in association with juniper species or a monoculture" described above.
- 2- In areas where long-term sagebrush steppe and sage-grouse habitat management objectives would require removal of encroaching conifer species, including limber pine, it is permissible to remove conifers from important sagebrush steppe habitats in an effort to support maintain and improve conservation of habitat for Sage-grouse and other sagebrush obligate species.

Stand Type: Limber pine stands growing in surface disturbance areas such as rock/gravel quarries and other mining activity (Generally found below 8,500 ft., but can occur at other elevations dependent on mineral locations).

Desired Conditions/Functions: Reclamation of disturbed limber pine sites including the planting of limber pine seedlings using local seed source and other mitigation methods determined to be acceptable.

Existing Conditions: The development of surface disturbing activities can eliminate all or portions of limber pine stands. These activities may occur in any of the limber pine types, but will be concentrated in the "Limber pine growing in association with ponderosa pine and/or Douglas fir, aspen, and mountain shrub" and the "Lower treeline limber pine stands either in association with juniper species or a monoculture" types. MPB and WPBR vary widely in these stands, ranging from areas of very high mortality from one or both WPBR and MPB to stands that are just beginning to be impacted. Future outlook is for increasing MPB mortality and increasing WPBR infection/mortality.

Silvicultural Treatments/Prescriptions:

- 1- Limber pine within the project boundaries that are not in the disturbed area will be managed as per the appropriate silvicultural treatments/prescriptions listed above as partial mitigation of the disturbance.
- 2- Disturbed areas will be planted with local seed source seedlings from project area or adjacent stands as per the seedling planting guidelines.
- 3- If an entire stand is within the disturbance area, off-site mitigation in the form of appropriate silvicultural treatments of adjacent stands, collection of seed, identification of "plus" trees or other acceptable mitigations will be done to offset the loss of a stand in addition to replanting limber pine on the reclaimed area.