United States Department of the Interior

FISH AND WILDLIFE SERVICE
334 Parsley Boulevard
Cheyenne, Wyoming 82007

In Reply Refer to:

January 17, 2023

Memorandum

To: Assistant Regional Director, U.S. Fish and Wildlife Service, Ecological Services, Lakewood, Colorado

From: *for* Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, Wyoming NATHAN DARNALL

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Subject: Standing Analysis for Effects to Whitebark Pine (*Pinus albicaulis*) from Low Effect Projects and Whitebark Pine Restoration and Recovery Activities within Montana and Wyoming

On December 15, 2022, the U.S. Fish and Wildlife Service (Service) published a final rule to list the whitebark pine (*Pinus albicaulis*) as threatened under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq*.) (87 FR 76882). The attached Standing Analysis was developed to expedite the consultation process for ongoing maintenance and management actions, new development or construction projects that will damage or kill small numbers of live whitebark pine, and for activities that are beneficial for the restoration or recovery of whitebark pine within Montana and Wyoming. The Standing Analysis considers the range-wide status of the species, the status of whitebark pine within Montana and Wyoming, including threats and the impact of ongoing activities and conservation efforts. The Standing Analysis evaluates these factors and the effects to whitebark pine from recovery activities and other actions considered to have low effects, along with cumulative effects. Based on the Standing Analysis, we developed a determination key to be used in the Service's online Information for Planning and Consultation (IPaC) system.

Federal agencies or their designated representatives may use the determination key in IPaC for consultation. Information submitted online (e.g., project description and location, responses to questions about the project) is evaluated by a determination key in IPaC to ensure that projects fall within the scope of what is analyzed in the Standing Analysis. The Standing Analysis provides the basis for Service concurrence with "may affect but not likely to adversely affect" determinations. The Standing Analysis documents the Service's analysis for a wide variety of small effect actions and activities, and the Standing Analysis can be readily updated with new information.

The determination key in IPaC will be used to evaluate potential effects to whitebark pine from individual projects. Based on the information provided in IPaC, the determination key may confirm that a project either (1) is not anticipated to have any effect on the whitebark pine, or (2) "may affect but is not likely to adversely affect" the whitebark pine. Projects falling into these categories will receive a response either acknowledging the "no effect" determination or concurring with the "may affect but is not likely to adversely affect" determination. Projects that fall outside the bounds of the Standing Analysis and projects that "may affect and are likely to adversely affect" whitebark pine, even if they are addressed in the Standing Analysis, are not part of the online determination key in IPaC at this time.

No Effect (NE) Determination

Based on the Standing Analysis, projects within the area of influence (species range) but for which whitebark pine are not present and projects involving only dead trees (no live seedling, sampling, or mature trees) will have no effect (NE) on whitebark pine. Concurrence from the Service is not required for NE determinations; however, IPaC will deliver a letter documenting the outcome of the determination key.

May Affect, Not Likely to Adversely Affect (NLAA) Determination

The Standing Analysis concludes that projects occurring more than 10 meters (33 feet) from any live whitebark pine trees (seedling, sapling, and mature trees) will result in insignificant, discountable, or wholly beneficial effects to the whitebark pine, resulting in a "may affect, not likely to adversely affect" (NLAA) determination (more specifically described in the Standing Analysis). We also anticipate that agencies will implement the appropriate conservation measures from the Standing Analysis and adhere to the most recent best management practices to minimize impacts to whitebark pine.

It is the federal agency's responsibility to make a final effect determination for potential impacts resulting from actions they conduct or permit and to confirm that the project is consistent with the determination key's questionnaire and output. This letter only addresses whitebark pine. If other listed species or critical habitat occur within a project area or may be affected by a project, a separate consultation with the Service may be necessary.

Questions regarding this memo or responsibilities under the Act should be directed to the Wyoming Ecological Services Field Office at the letterhead address, by email at WyomingES@fws.gov, or by phone at (307) 772-2374.

STANDING ANALYSIS

Standing Analysis for Effects to Whitebark Pine (*Pinus albicaulis*) from Low Effect Projects and Whitebark Pine Restoration and Recovery Activities within Montana and Wyoming

2023

Prepared by:
U.S. Fish and Wildlife Service
Wyoming Ecological Services Field Office

January 17, 2023

NATHAN DARNALL

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Date: 2023.01.17 14:40:06 -07'00'

Wyoming Ecological Services Field Office
Deputy Project Leader, Nathan Darnall

EXECUTIVE SUMMARY

On December 15, 2022, the U.S. Fish and Wildlife Service (Service) published the final rule to list the whitebark pine (WBP) (*Pinus albicaulis*) as a threatened species (87 FR 76882) under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 et seq.). The Service also published a final 4(d) rule for WBP that identified actions necessary for the conservation and recovery of the species and included prohibited acts as well as a limited number of exceptions to the prohibited acts (87 FR 76882). Previously, on December 2, 2020, the Service published a proposed rule to list the WBP as threatened with a proposed 4(d) rule under the Act (85 FR 77408). No critical habitat was proposed for WBP. Section 4(d) rules cannot and do not absolve federal agencies of their consultation requirements under section 7 of the Act.

This Standing Analysis provides a basis for section 7 consultation for activities that are not prohibited by the 4(d) rule (see Appendix A for more information on the 4(d) rule). The analysis in this Standing Analysis (SA) evaluates effects to WBP from a variety of actions across Montana and Wyoming, including ongoing maintenance and management actions, new development or construction projects that will damage or remove no more than 125 total WBP trees (seedlings, saplings, and mature trees combined), livestock grazing, right-of-way maintenance, and activities that are beneficial for the restoration or recovery of WBP. Specifically, activities considered in the framework include:

a. Livestock management and range improvements: livestock management and range infrastructure improvements (*e.g.*, grazing, gathering and moving, fencing, stock ponds and tanks, and spring development);
b. Infrastructure actions: infrastructure maintenance, upgrades, and replacement activities for <u>existing</u> pipelines, communication towers, utility lines, renewable energy facilities, trails, and highway infrastructure (*e.g.*, to roads, bridges, culverts, bike and pedestrian facilities, fencing, lighting, and all other distinct aspects of a highway project); construction of <u>new</u> pipelines, communication towers, utility lines, renewable energy projects, and highway infrastructure;
c. Mineral and conventional oil and gas exploration and development: maintenance of <u>existing</u> locatable and leasable mining and conventional oil and gas projects; <u>new</u> development of existing mineral and conventional oil and gas leases; and <u>new</u> development of new mineral and conventional oil and gas leases;
d. Vegetation management actions: vegetation (forest) management activities that take into account age class prescriptions, genetic variability within and among WBP populations, and activities that may impact the adaptive potential and the forest trajectories of WBP (salvage harvests and pest control that remove dead and diseased trees and encourage natural WBP recruitment and are not in existing WBP restoration areas); timber harvest projects, hazardous fuel removal (in Wildland Urban Interface (WUI) areas), and precommercial thinning and group selection projects;
e. Recreation activities: maintenance of existing trail systems (hiking and biking specifically); maintenance of existing recreational development projects (*e.g.*, ski resorts and campgrounds), and other recreational activities (*e.g.*, off-highway vehicles (OHV) and over-snow vehicles (OSV) use); upgrades, replacement, expansion, or new construction outside the existing disturbance footprint of existing recreation projects, and outfitter and guide permit programs;

f. Recovery and research actions: permanently marking WBP trees in a manner that does not damage the tree to the extent that disease is introduced, resulting in death of the tree; monitoring and recovery activities that are beneficial to WBP (including collection of WBP cones, seeds, scion, and pollen; screening trees for genetic resistance of white pine blister rust; and establishing seed orchards); and propagated, screened, and planted blister rust-resistant seedlings, regardless of anticipated damage or removal to any age class of WBP.

Our analysis concludes that the individual effects of removing a small number of WBP for new development and construction actions and vegetation management, and of conducting WBP restoration activities, will have an – in aggregate – a minimal or beneficial effect to WBP. Further, pruning, trampling, or removing WBP (regardless of anticipated damage or removal of any age class of WBP) for the activities as described above will not jeopardize the continued existence of the species. The primary stressors to WBP are white pine blister rust (*Cronartium ribicola*); mountain pine beetle (*Dendroctonus ponderosae*); large, severe wildfires; and the synergistic effects of climate change.

Project types and scales that are excluded from this SA are those that are expected to affect more than 125 total (seedlings, saplings, and mature trees combined) WBP trees; excluding livestock management, existing infrastructure activities and vegetation management, which have analyzed impacts to unlimited numbers of trees) or are not entirely recovery or research focused. Projects that are outside the scope of the analysis within this SA must be independently analyzed under section 7 of the ESA for their impacts on WBP. Examples of projects or activities that are not evaluated or covered in this SA are projects that remove or kill more than 125 live WBP trees (regardless of their age class), prescribed fire within WBP habitat, and emergency wildfire consultations.

The intent is for section 7 consultation on WBP to be implemented through digital submission of project information (*e.g.*, project location, response to questions about the project) entered by federal agencies in the Service’s Information for Planning and Consultation (IPaC) portal that will be evaluated by a determination key to ensure that individual projects fall within the scope of what is analyzed in this SA. This SA provides the basis for a Service concurrence with effects of individual projects as they are analyzed in IPaC. We will re-evaluate and update this SA regularly.

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I. Glossary

Term	Definition
Aeciospore	A spore produced by the fruiting body or sporocarp of a rust fungi.
Elite tree	A whitebark pine (WBP) tree confirmed to have genetic resistance to white pine blister rust.
Plus tree	A WBP tree identified as potentially white pine blister rust-resistant.
Seed	A fertilized ovule containing an embryo which forms a new WBP plant upon germination. Seeds are produced in female cones and may take 2 years or more (up to 11 years) to germinate. The limits of project actions described in the Standing Analysis (SA) apply to seedlings, saplings, and mature trees; the limits do not apply to seeds or cones.
Seedling	Age class of WBP after a WBP seed germinates. Seedlings are usually detectable between 8 and 10 centimeters (cm) (3 to 4 inches) (in.) tall with a 13 to 18 cm (5 to 7 in.) taproot, and with 7 to 9 cotyledons (embryonic first leaves). WBP seedlings are generally between one and 29 years of age and are up to 1.37 m (4.5 ft) tall, which is the height assessed at diameter at breast height (dbh).
Sapling	Age class of WBP that are non-reproductive trees greater than 1.37 m (4.5 ft) in height and generally between 29 and 40 years of age, though reproduction can occur as early as 20 years and start as late as 60 years of age.
Mature tree	Age class of WBP that are reproductive, and typically over 40 years of age. Large stone crops are not typically produced until between 60 and 80 years of age. WBP trees require two summers of suitable temperatures and precipitation for fertilized cones to mature, and typically have high seed production every three to five years (mast years), after which nitrogen and phosphorous resources are depleted. Mature trees rely on Clark's nutcrackers for seed distribution. WBP trees can live between 500 and 1,000 years.

WBP STANDING ANALYSIS

1. Purpose and Organization of this Standing Analysis

This whitebark pine (WBP) (*Pinus albicaulis*) Standing Analysis (SA) will facilitate the consultation process for a particular set of projects listed below, and agencies can receive their consultation response through a Determination Key offered through the U.S. Fish and Wildlife Service Ecological Service's (Service) Information for Planning and Consultation (IPaC) system. The SA will provide an analysis for the following types of activities:

- Where the effects of implementing these projects result in "no effect" to WBP (project activities avoid damaging or removing live WBP seedlings, saplings, mature trees, and project activities inside the WBP area of influence but that do not impact WBP); an automated response is provided through the Determination Key.

- Where the effects of implementing these projects result in a "may affect, not likely to adversely" affect the WBP (project activities that are wholly beneficial (*i.e.*, no adverse effects to WBP); project activities that result in insignificant effects or effects are discountable (*i.e.*, WBP unlikely to occur in the project area); project activities that only remove dead WBP and will not affect live WBP seedlings, saplings, and mature trees; and project activities that will not remove live limbs, prune or remove live trees; an automated response is provided through the Determination Key.

- The SA also evaluates activities that "may affect, likely to adversely affect" the WBP (project activities that limb or prune live WBP, project activities that disturb the soil of WBP seedlings saplings and mature trees, remove live WBP or cause substantial damage to live WBP); however, projects and activities that are likely to adversely affect WBP are not part of the online Determination Key in the IPaC planning tool at this time. Projects that do not fit within the bounds of this SA process may be covered by a separate consultation with the Service's Field Offices.

While not included at this time in our online Determination Key in IPaC, projects that "may affect, likely to adversely affect" the WBP must undergo formal consultation. In accordance with the requirements of the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 et seq.) and its implementing regulations, the formal consultation process culminates in the Service's issuance of a biological opinion that sets forth the basis for a determination as to whether the proposed federal action is likely to jeopardize the continued existence of a listed species (jeopardy) or destroy or adversely modify critical habitat (adverse modification). The regulatory definitions of jeopardy and destruction or adverse modification are provided at 50 CFR 402.02, and the description of the formal consultation process is provided at 50 CFR 402.14.

If a proposed federal action is not likely to jeopardize the continued existence of a listed species but is likely to cause incidental take of the species, then the Service identifies that take and exempts it from the take prohibitions under section 9 of the Act through an Incidental Take Statement. Sections 7(b)(4) and 7(o)(2) of the Act do not apply to the incidental take of federally listed plant species. However, limited protection of listed plants is provided to the extent that it is unlawful under the Act to (a) import any such species into, or export any such species from, the United States; (b) remove and reduce to possession any such species from areas under federal jurisdiction; (c) deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever and in the course of a commercial activity, any such species; (d) sell or offer for sale in interstate or foreign commerce any such species; or (e) violate any regulation pertaining to such species or to any threatened species of plants listed pursuant to section 4 of this Act and promulgated by the Secretary pursuant to authority provided by this Act of federally listed threatened plants. The definition of plant in the Act is "any member of the plant kingdom, including seeds, roots, and other parts thereof."

In accordance with policy and regulation, the jeopardy analysis in this SA relies on four components:

- *Status of the Species* - the range-wide condition of WBP, the factors responsible for that condition, and its survival and recovery needs;
- *Environmental Baseline* - the condition of WBP in the action area, without the consequences to the listed species caused by the proposed action(s);
- *Effects of the Action* - are all consequences to WBP that are caused by the proposed action(s), including the consequences of other activities that are caused by the proposed action(s) if it would not occur but for the proposed action(s) and it is reasonably certain to occur; and
- *Cumulative Effects* - the effects of future non-federal activities that are reasonably certain to occur within the action area(s) of the federal action(s) subject to consultation.

The jeopardy determination is made by adding the effects of the action(s) and cumulative effects to the environmental baseline, and in light of the status of the species, formulating the Service's opinion as to whether the proposed action(s) reasonably would be expected to reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species.

This SA is organized to include a detailed description of the proposed action, action area, and actions that fall within the scope of the SA in Section 2. The SA then addresses each of the four components listed above: Section 3 describes the *Status of the Species*, with a more detailed description in Appendix C; Section 4 describes the *Environmental Baseline*; Section 5 describes the *Effects of the* Action; and Section 6 describes the *Cumulative Effects.*

2. Description of the Proposed Action

As defined in the Act Section 7 regulations (50 CFR 402.02), "action" means "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas." The "action area" is defined as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action."

2.a. Action Area

For the purposes of this SA, we have defined the action area to include the WBP range within the states of Montana and Wyoming (Figure 1). The action area is located within portions of the following WBP analysis units (established in the species status assessment (SSA) (USFWS 2021) including areas or individual trees not previously documented): Northern Rockies, Middle Rockies, and US Canadian Rockies analysis units (Figure 2). All maps in this SA were created from data sets used in the SSA for WBP, using the most up to date information on potential and known habitat from federal, state, and private agencies. If future survey data about the extent of WBP habitat expands in the future, the action area may change.

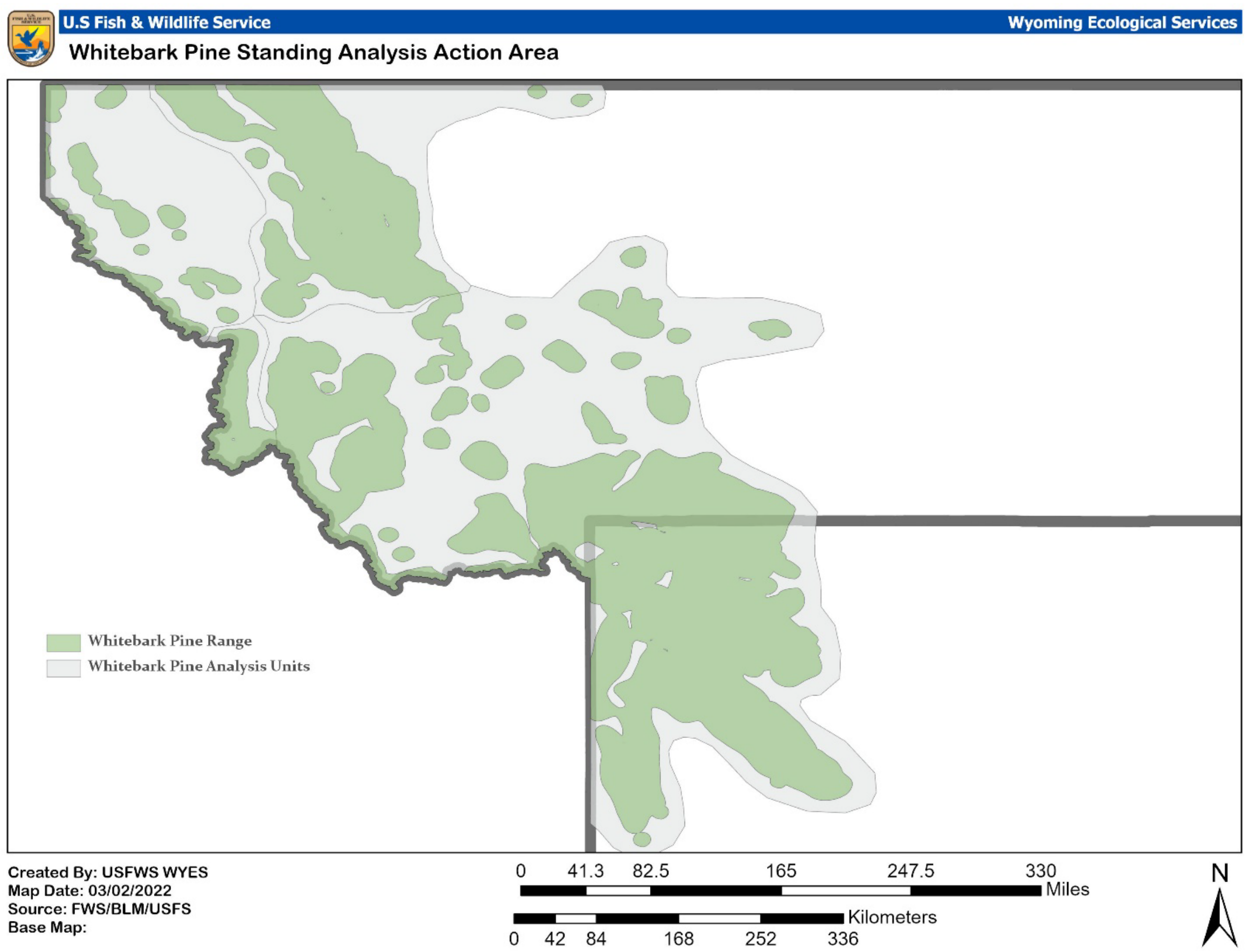

Figure 1. WBP Standing Analysis Action Area

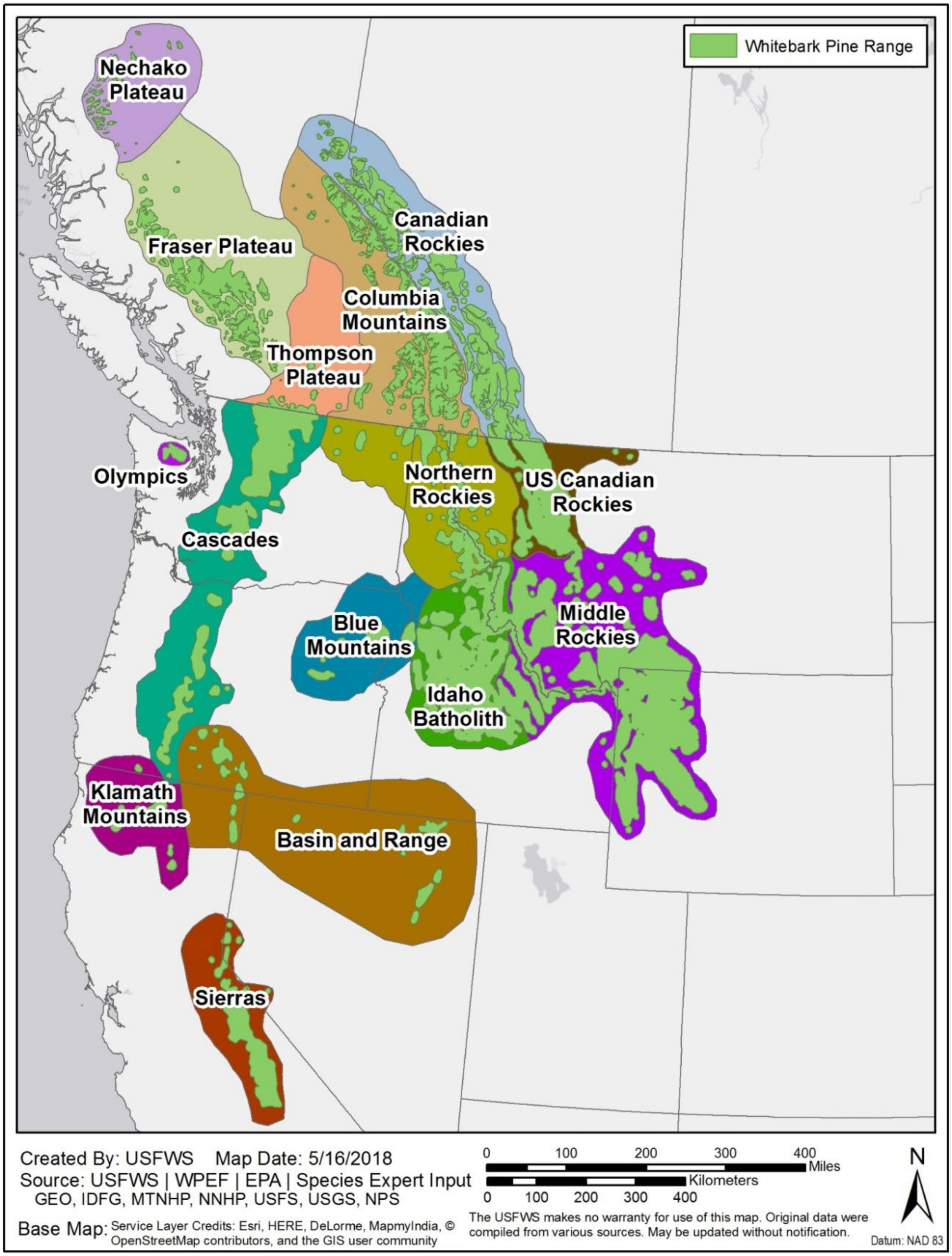

Figure 2. WBP Analysis Units (USFWS 2021)

2.b. Actions that fall within the scope of the Standing Analysis

As described in the WBP species status assessment (SSA), the primary threats to WBP are the non-native fungus that causes white pine blister rust, mountain pine beetle, altered fire regimes, and climate change (USFWS 2021). WBP is not a commercial species, and other human activities (*e.g.*, recreation and grazing) are not a threat to the species (USFWS 2021). To proactively address the consultation needs of federal agencies such as the Bureau of Land Management (BLM), the Federal Communications Commission (FCC), the Federal Energy Regulation Commission (FERC), Bonneville Power Administration, National Park Service (NPS), and the U.S. Forest Service (USFS), the Service has developed this SA for WBP. This SA is intended to cover activities that are considered ongoing maintenance actions, new development or construction that will only remove or damage no more than 125 live WBP trees regardless of their age class, and activities that are beneficial for the restoration and recovery of WBP.

The following actions are analyzed in this SA in accordance with section 7 of the Act. This SA has analyzed project actions that will have no impacts, have insignificant or discountable impacts, are maintenance or ongoing activities within existing infrastructure, range and range improvement, or will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and mature trees) per project. The limits of project actions described in the SA apply to seedlings, saplings, and mature trees; the limits do not apply to seeds or cones.

The following actions fall within the scope of the SA:

- Livestock Management and Range Improvements
  - Livestock management (*e.g.*, grazing, gathering and moving livestock) and range improvements (*e.g.*, fencing, stock ponds and tanks, spring development) regardless of anticipated damage or removal of any age class of WBP.

- Infrastructure Actions
  - Maintenance, upgrades, and replacement activities for existing pipelines, communication towers, utility lines, renewable energy facilities, trails, and highway infrastructure (*e.g.* to roads, bridges, culverts, bike and pedestrian facilities, fencing, lighting, and all other distinct aspects of a highway project) regardless of anticipated damage or removal of any age class of WBP. (**Note:** this does not include expansion of existing highway infrastructure that is considered a new project as is subject to the damage or kill no more than (125) live WBP regardless of their age class (seedling, sapling, and mature trees) limits).
  - Vegetation management activities along existing pipelines, communication tower sites, microwave beam paths, utility/transmission lines, renewable energy facilities, highway infrastructure, and associated rights-of-way regardless of anticipated damage or removal of any age class of WBP.
  - Construction of new pipelines, communication towers, utility lines, renewable energy projects, and highway infrastructure that will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and adult trees).
- Mineral and conventional oil and gas exploration and development

    - Maintenance of existing locatable and leasable mining and conventional oil and gas projects that will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and mature trees) per project.
    - New development of existing mineral and conventional oil and gas leases that will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and mature trees) per project.

- Vegetation (Forest) Management Actions
    - Vegetation (forest) management activities that take into account age class prescriptions, genetic variability within and among WBP populations and activities that may impact the adaptive potential and the forest trajectories of WBP (Six *et al.* 2021) or do not damage live seedling, sapling, and mature WBP (*e.g.*, salvage harvests, and pest control that remove dead and diseased trees encouraging natural WBP recruitment; and implementation of the conservation measures in the project design that avoids impacts to WBP seedling, sapling, and mature trees).
    - Timber harvest projects, hazardous fuel removal (in WUI), and precommercial thinning and group selection projects occurring in WBP habitats that will damage or kill no more than 125 live WBP regardless of their of their age class (seedling, sapling, and mature trees); including projects where the removal of surface and ladder fuels through hand cutting, piling of project generated materials, and burning the piles is being done with the purpose of increasing stand resilience to fire.

- Recreation Development and Activities
    - Maintenance of existing trail (hiking and biking specifically) systems regardless of anticipated damage or removal of any age class of WBP.
    - Maintenance of existing recreational development projects (*e.g.*, ski resorts and campgrounds), and other recreational activities (*e.g.*, off-highway vehicles (OHV) and over-snow vehicles (OSV) use), that will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and mature trees).
    - Upgrades, replacement, expansion, or new construction outside the existing disturbance footprint of existing recreation projects that will damage or kill no more than 125 live WBP regardless of their age class (seedling, sapling, and mature trees).
    - Outfitter and guide permit programs regardless of anticipated damage or removal of any age class of WBP.

- Recovery and Research Actions
    - Monitoring and recovery activities that are beneficial to WBP. Permanently marking WBP trees that does not damage the tree to the extent that disease is introduced to the tree resulting in death of the tree. These activities include collection of WBP cones, seeds, scion, and pollen; screening them for genetic resistance of white pine blister rust; and establishing seed orchards. The recovery of an unlimited number of damaged, unhealthy, or extirpated WBP trees and stands will use propagated, screened, and planted blister rust-resistant seedlings (known superior parentage of seedling stock confirmed to have genetic blister rust resistance).
    - Research activities that further our understanding of WBP biology and ecology in an effort to bolster recovery of the species.

2.c. Actions that fall outside the scope of the Standing Analysis

Project types and scales that are excluded from this framework analysis are those that are expected to affect more than 125 total WBP trees (seedlings, saplings, and mature trees combined) or are not entirely restoration and recovery-focused. Some examples of projects or activities that are not covered under this SA are new development projects that remove or kill more than 125 live WBP trees regardless of their age class, use prescribed fire for a vegetation management project in WBP habitat, and emergency wildfire consultations. Projects that are outside the scope of the analysis within this SA must be independently analyzed under section 7 of the ESA for their impacts on WBP.

2.d. Underlying Principles for the WBP Standing Analysis Removal Threshold

To develop a threshold for whether the removal of WBP for small development projects can be covered by this SA, we considered the following:

- WBP occurs on an estimated 32,616,422 hectares (ha) (80,596,935 acres (ac) in western North America or about 56,418,000 ac in the western United States (USFWS 2021). Densities of WBP are variable, but one estimate is 32 trees/clumps per ac, though seedlings occur at higher densities (Fryer 2002). While WBP can live up to 1,000 years (USFWS 2021), assuming an average lifespan of 500 years, approximately 3.6 million WBP trees die each year under natural conditions (56,418,000 x 32 / 500).
- WBP generally occurs at higher elevations and high latitudes (occurring from a southern extent of approximately 36° north in California to 55° north latitude in British Columbia, Canada), away from most human activities, and it is not a commercial tree species.
- Between 10 and 40 percent of WBP are resistant to white pine blister rust (USFWS 2021).
- While there is a range of resistance to blister rust, we will use the higher number to be more conservative and assume that for every 100 trees damaged or killed by project actions, 40 were resistant to blister rust, though we recognize only 10 or fewer may have been rust-resistant.
- Over the last 20 years, an average of 50,000 blister rust-resistant trees were planted annually in Montana and Wyoming (Hendrix 2022, pers. comm.).
- To add an additional level of precaution, we recommend at least 10 rust-resistant trees should be planted for every potentially blister rust-resistant tree damaged or killed.
- Using the 10:1 ratio and dividing the average number of blister rust-resistant trees planted per year (50,000) by 10 equates to 5,000 presumed blister rust-resistant trees, and assuming 40 percent of trees on the landscape have natural resistance to blister rust, a total of 12,500 WBP could be removed (killed or damaged) annually for small projects across the range of WBP in Montana and Wyoming.
- In reviewing the number of small development projects within the range of WBP in recent years, we would expect no more than 100 small projects per year; we will track projects to monitor this threshold.

- Therefore, as long as a small project does not result in the damage or removal of more than 125 total WBP (seedling, sapling, and mature trees), the project can be covered by this SA.
- While 12,500 trees in Montana and Wyoming may seem like a large number, is it small when compared to the up to 3.6 million WBP trees that die naturally each year throughout the western U.S.
- Impacts to the ground or soil within 10 m (33 ft) of a live WBP may be harmful to that individual (USFWS 2015), and these effects are included in the 125-tree threshold.

2.e. Monitoring and Reporting

To ensure project activities are covered by the parameters of this SA, any project that damages or removes live WBP trees must be reported annually to the appropriate Ecological Services Field Offices. *Reporting*: In order to document the review process and improve understanding of the effectiveness of the Conservation Measures and other measures, the action agency will complete an annual report for their projects that used the WBP Standing Analysis Determination Key into IPaC by including the following:

- A quantitative number of live WBP trees or acreage of WBP removed in the project area. If this is not possible, provide the acreage and density calculations of an estimate of WBP tree removal;
- A quantitative estimate of the natural WBP regeneration occurring within the project area;
- If there other five-needle pines in the action area and it is difficult to discern the actual number of WBP individuals being damaged or removed by project activities, include a note that other five-needle pine species are included in these removal/damage estimates and name the species;
- If quantitative values for tree removal and regeneration are not available, qualitative descriptions of impacts can be provided with interpretations of impacts;
- Compliance monitoring showing the effectiveness of the conservation measures implemented and appropriate Conservation Recommendations applied in the project design;
- Non-compliance of Conservation Measure, such as the removal of plus or elite trees; and
- Description of restoration efforts that were applied to project design.

Because the number of projects can vary per year and recognizing that not all projects from the recent past were reported, our analysis includes some uncertainty about the true number of small projects that might result in the removal of WBP. Therefore, we will track the annual number of small development projects in IPaC and will re-evaluate this analysis as we learn more. In addition, agencies almost always initiate consultation many months prior to actual project implementation, so we will be able to identify whether we are approaching the annual limit of 100 small projects for that year (currently totaling removal of 12,500 WBP (seedling, sapling, and mature trees)), and initiate conversations with action agencies if needed. Because small projects to be included under this category involve no more than 125 trees, it should be possible for agencies to accurately enumerate the number of trees affected by a small development project. We may also opt to track the total number of trees removed, recognizing some projects may remove no more than 125 trees, thus providing an additional buffer. However, we will continue to evaluate development projects that remove more than 125 WBP trees separately (outside of this SA), even if the aggregate number of trees removed per year is less than 12,500 (of which, 5,000 are assumed to be rust-resistant). We anticipate the recovery efforts (*e.g.*, planting rust-resistant trees) will either remain the same or are likely to increase after the species has been listed under the Act; however, we will continue to use the approach described above and its thresholds rather than increasing the number of projects and trees. We will re-evaluate this SA at least annually and will reconsider its application, use, thresholds, and efficacy at a minimum of five years after implementation.

2.f. Conservation Measures

To fully understand the extent of the effect that individual project activities analyzed by the SA will have on WBP trees (seedlings, saplings, and mature trees), and to avoid and minimize these impacts, the SA provides a detailed list of successfully-implemented conservation measures from which project applicants can choose. We consider the damage of a WBP to include, but is not limited to, soil tilling, disking, plowing, excavating, raking, sod rolling, soil compaction, soil disturbance, weed management, revegetation, crushing, bumping, and scraping WBP, root damage, mycorrhizal damage, nicks and opening wounds on WBP bark, and pruning.

The following conservation measures are considered part of the actions under the SA. The commitments and implementation of the following conservation measures and exploration of additional opportunities to reduce impacts made by the federal action agencies will reduce adverse effects of the proposed actions to the WBP. These conservation measures will become commitments by federal action agencies where appropriate and practicable. Many of these conservation measures are to be applied throughout the action area, though others specify the location or distance from WBP trees for application. Not all conservation measures are applicable or reasonable for all actions that are covered under this SA. The Determination Key includes a section where project applicants must select which of the following conservation measures they plan to implement as part of their action, which will be repeated back to the applicant in our IPaC generated response letter or memo:

General

CM 1. Conduct pre-project surveys to identify WBP individuals of all age classes. If not feasible, conduct surveys using appropriate agency protocols to estimate the number of WBP individuals of all age classes.

CM 2. When marking is appropriate, all mature WBP trees or clusters of other age class trees will be marked in a manner that does not cause damage to the tree or introduce disease.

CM 3. Damaging or killing a plus, elite, or phenotypically resistant tree will only occur in situations where human health and safety are at risk or when restoration actions such as pruning are occurring.

CM 4. Avoid ground disturbance from heavy equipment within WBP stands and within 10 m (33 ft) of known WBP trees, which will protect the roots and soil within the drip line of large, mature trees.

CM 5. If using heavy equipment in WBP stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests.

CM 6. Avoid off road motorized travel in WBP habitat (including using over snow vehicles in thin snowpack), and do not use live WBP trees as trail markers.

CM 7. Trail and other infrastructure maintenance activities should avoid removing mature WBP trees where possible and focus on pruning trees to acceptable heights to maintain cone bearing branches and allow for continued seed production.

CM 8. When working in WBP stands, ensure work does not introduce or spread *Ribes* species that are an alternate host for white pine blister rust.

CM 9. Herbicide spot treatments for trail maintenance and other infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from a WBP tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from the trunk of a WBP tree.

Training and Education

CM 10. Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description.

CM 11. Educate back country users (e.g., skiers, climbers, hikers, campers) about WBP ecology, importance, protection, and recovery.

Avoidance

CM 12. Avoid removing or damaging healthy, unsuppressed WBP trees, particularly those that are potentially resistant to blister rust or determined to be plus or elite trees.

CM 13. Avoid or limit cutting of mature whitebark pine trees in areas where there is sufficient cone-bearing WBP habitat based on best available science to support Clarks' nutcracker use of the area.

CM 14. Unless the objective is restoration of WBP, avoid timber cutting or ground disturbing activities that may damage or kill WBP individuals of all age classes, especially in stands with evidence of natural regeneration or reproductive WBP individuals.

Livestock Activities

CM 15. Grazing permits, corresponding Allotment Management Plans and Annual Operating Instructions will adopt relevant avoidance measures, including but not limited to avoiding removal of whitebark pine when determining placement of additional infrastructure and designating campsites and avoiding, to the extent possible, concentrating livestock in whitebark habitat, especially in regenerating stands.

Soil Conservation

CM 16. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. Use of ground-based equipment will adhere to regional standards (e.g., the USFS Region 1 standard limits work on slopes to 40% grade).

CM 17. Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).

CM 18. Avoid placing skid trails within 10 m (33 ft) of WBP to prevent soil compaction, and to minimize crushing and destroying undetected WBP seeds, and removal of WBP seedlings and saplings.

Genetic Collection & Restoration Activities

CM 19. If damage or removal of potential or known plus or elite WBP trees cannot be avoided, collect genetic material (e.g., cones, scion, or pollen) prior to damage or removal, as directed by authorities responsible for the selective breeding program, and making every reasonable effort to avoid removing or damaging healthy, unsuppressed WBP trees.

CM 20. If genetic material collection cannot occur, the action agency will contact the Service to explore additional options, which may include replanting in accordance with current WBP replanting guidelines or best practices, or suitable alternative with WBP seedlings or seeds stock of known superior parentage (plus or elite WBP). WBP used for replanting should be of the same seed zone as the mature trees that were removed.

CM 21. Consider using Verbenone, Carbaryl, or other chemical treatments on high-value WBP trees (e.g., plus, elite, or close to recreation sites) to prevent mountain pine beetles from successfully infesting the tree.

CM 22. Consider WBP restoration areas adjacent to mosaic habitats that specifically include moderate levels of Douglas fir habitat to maintain adequate food sources for Clark's nutcracker populations.

CM 23. Restoration projects will maintain mature WBP trees during project activities. Restoration projects will avoid crushing and damaging live WBP seedlings and saplings to the extent possible. Maintaining some dead trees (this does not apply to mountain beetle infested trees) in the project area can provide habitat for wildlife.

3. Status of the Species

This SA provides a general background on the status of the species and its habitat, relying on the Service's 2021 SSA (USFWS 2021, entire). No critical habitat has been designated for this species. A detailed status of the WBP's biology, range, habitat, needs, stressors, and conservation can be found in Appendix C.

The WBP is a five-needle conifer species placed in the subgenus *Strobus,* which also includes other five-needle white pines. Recent phylogenetic studies (Liston *et al.* 1999; Syring *et al.* 2005, 2007; as cited in Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2010) showed no difference in monophyly (ancestry) between subsection *Cembrae* and subsection *Strobi* and merged them to form subsection *Strobus.* No taxonomic subspecies or varieties of WBP are recognized (COSEWIC 2010). Based on this taxonomic classification information, we recognize WBP as a valid species (USFWS 2021).

There are four stages in the life cycle of the WBP: seed, seedling, sapling and mature trees, also referred to as reproductive adults. Seeds are produced in female cones and once on the ground may take two years or more, up to 11 years in some cases, to germinate. Germinated seeds become seedlings that are between 3 to 4 inches tall (8 and 10 centimeters) with a taproot that can measure between 5 to 7 inches (13 to18 centimeters), with 7 to 9 cotyledons, also known as the embryonic first leaves, as documented by (Arno and Hoff 1989). WBP seedlings may persist for multiple years, depending on growing conditions, until reaching the sapling stage of the life cycle. WBP saplings persist for few to many years, depending on growing conditions, until they produce male and female cones. Mature reproductive WBPs contain both female and male cones, which is known as monoecious reproduction, and can survive on the landscape for hundreds of years. This slow-growing long-lived tree with a life span between 500 years and 1,000 years (Arno and Hoff 1989; Perkins and Swetnam 1996), provided it is located in an area with lower competition, such as a more open canopy with low litter depth and high rock cover (Maloney 2014). Therefore, in addition to the four general needs for all life stages, mature WBP trees require a more open canopy, dispersal of seeds by Clark's nutcracker, two summers of suitable temperatures and precipitation for pollinated cones to mature, as well as levels of nitrogen and phosphorus that are adequate to restore values after being depleted in masting year (USFWS 2021).

The WBP is a five-needle pine that lives in windy, cold, high-elevation or high-latitude environments across the western United States and southern Canada. The WBP pine has a broad range both latitudinally, occurring from a southern extent of approximately 36° north in California to 55° north latitude in British Columbia, Canada, and longitudinally, occurring from approximately 128° in British Columbia, Canada to an eastern extent of 108° west in Wyoming. It also occurs in scattered areas of the warm and dry Great Basin. As a result, many stands are geographically isolated as documented by (Arno and Hoff 1989).

Most current management and research focus on producing and planting white pines (including WBP) with genetic resistance to white pine blister rust, but also include natural regeneration (e.g., those areas identified in Appendix B, Tables A, B, and C) and silvicultural treatments, such as appropriate site selection and preparation, pruning, and thinning (Zeglen *et al.* 2010).

Major threats to WBP include mortality from disease that is caused by the non-native white pine blister rust and predation by the native mountain pine beetle. White pine blister rust is a disease of five-needle pines (*Pinus spp.*) caused by a nonnative fungus, *Cronartium ribicola* (Geils *et al.* 2010). While white pine blister rust occurs throughout the entire WBP range, not all trees are infected and infection rates vary widely. The white pine blister rust fungus has a complex life cycle. It does not spread directly from one tree to another, but alternates between primary hosts (*i.e.*, five-needle pines) and alternate hosts. Alternate hosts in western North America are typically woody shrubs in the genus *Ribes* (gooseberries and currants) but also may include herbaceous species of the genus *Pedicularis* (lousewort) and the genus *Castilleja* (paintbrush) (McDonald and Hoff 2001; McDonald *et al.* 2006).

The mountain pine beetle is recognized as one of the principal sources of WBP mortality (Raffa and Berryman 1987; Arno and Hoff 1989). Mountain pine beetles feed on WBP and other western conifers and to successfully reproduce the beetles must kill host trees (Logan and Powell 2001; Logan *et al.* 2010). Upon locating a suitable host (*i.e.*, large diameter tree with sufficient resources for brood production success), adult female mountain pine beetles emit pheromones that attract adult males and other adult females to the host tree. This attractant pheromone initiates a synchronized mass attack for the purpose of overcoming the host tree's defenses to mountain pine beetle predation. Once a tree has been fully colonized, the beetles produce an anti-aggregation pheromone that signals to incoming beetles to pass on to nearby unoccupied trees. Almost all host trees, even stressed individuals, will mount a physiological defense against these mass attacks. However, given a sufficient number of beetles, even a live tree's defensive mechanisms (*e.g.*, oleoresin and volatile organic compounds emission, mobilization of resin flow, additional formation of resin directed towards the sites of beetle activity (Bohlmann, 2012)) can be exhausted (Raffa and Berryman 1987).

This species also faces major threats from climate change, habitat loss from past and ongoing fire suppression activities, and the combined negative effects of these individual threats. Fire is one of the most important landscape-level disturbance processes within high-elevation WBP forests (Agee 1993; Morgan and Murray 2001; Spurr and Barnes 1980) and is relevant to WBP both as a stressor that can cause mortality of all life stages of WBP and as a mechanism that may affect forest succession (Arno 2001; Shoal *et al.* 2008; Keane and Parsons 2010). Fire regimes in WBP systems are often characterized as being of mixed severity (Arno *et al.* 2000; Arno 2001, Campbell and Antos 2003; Larson *et al.* 2009).

Habitat loss is anticipated to occur across the WBP range, with current habitats becoming unsuitable for the species as a result of both direct and indirect impacts from climate change (Bartlein *et al.* 1997; Hamann and Wang 2006; Schrag *et al.* 2007; Warwell *et al.* 2007; Aitken *et al.* 2008; Loehman *et al.* 2011; Rice *et al.* 2012; Chang *et al.* 2014). Researchers have hypothesized that there will be significant habitat loss as (1) temperatures become so warm that they exceed the thermal tolerance of WBP and the species is unable to survive, (2) warmer temperatures favor other species of conifer that currently cannot compete with WBP in cold high-elevation habitats, and (3) climate change alters the frequency and intensity of disturbances (*e.g.*, fire, disease) to such an extent that whitebark cannot persist. In summary, the pace of predicted climate change will outpace many plant species' abilities to respond to the concomitant habitat changes. WBP is potentially particularly vulnerable to warming temperatures because it is adapted to cool, high-elevation habitats (USFWS 2021).

As a result of these threats, it is estimated that as of 2016, 51 percent of all standing WBP trees are dead (Goeking and Izlar 2018). In addition to the detailed assessment of the rangewide status of the species in Appendix C, an action area-specific analysis of the status of the species and threats affecting it is included in the Environmental Baseline, below.

4. Environmental Baseline

Under the provisions of section 7(a)(2), when considering the "effects of the action" on listed species, the Service is required to consider the environmental baseline. Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline. While the environmental baseline focuses on the condition of the listed species only within the action area, we will consider the status of the species, including all mortality within the range of WBP in the action area, in the jeopardy analysis. The action area is the WBP range within Montana and Wyoming (Figure 1).

This section presents the environmental baseline of the past and present impacts and analyzes the effects of the proposed actions on the WBP within the states of Montana and Wyoming.
The action area contains 17,264,826 ha (42,662,316 ac) of the current distribution of WBP (this is a coarse scale distribution of WBP provided by multiple data sources and expert knowledge) (USFWS 2021). The three major threat factors have impacted a total of 8,936,383 ac (21 percent) of WBP within the action area, as discussed below:

1,439,015 ha (3,555,884 ac) infected by white pine blister rust,
244,040 ha (603,036 ac) burned in high intensity wildfires between 1984 and 2016, and
939,510 ha (2,321,579 ac) impacted by mountain pine beetles.

4.a. White Pine Blister Rust

Researchers have used various sampling methods to assess the effects of white pine blister rust on WBP and the amounts of infection present; therefore, exact comparisons between studies are not possible. Trends strongly indicate that white pine blister rust infections have increased in intensity over time and are now prevalent even in trees living in cold, dry areas formerly considered less susceptible (Tomback and Resler 2007; Smith-Mckenna *et al.* 2013), such as the Greater Yellowstone Ecosystem (Middle Rockies AU) (Table 5).

While numerous studies have reported the incidence of white pine blister rust on WBP and subsequent mortality, until relatively recently few have reported on rates of change. In western

Montana, mortality rates from white pine blister rust averaged 2.1 percent per year from 1971 to 1991 (Keane and Arno 1993). In parts of the Greater Yellowstone Ecosystem, surveys indicate that the proportion of infected WBP (greater than 1.4 m tall) has remained relatively static at an estimated 20 to 30 percent over the survey period from 2004 to 2011 (Shanahan *et al.* 2014). This apparently static infection rate likely reflects a combination of several factors including (1) some individual WBP show genetic resistance to white pine blister rust and (2) prevailing environmental conditions have not been favorable for the spread of white pine blister rust in the areas surveyed (Shanahan *et al.* 2016). However, as stated previously, favorable conditions need to occur only occasionally for white pine blister rust to eventually spread and intensify (Zambino 2010). This fact is important to note, given that white pine blister rust maintains a significant presence in the area with 81 percent (2004 through 2007) and 86 percent (2008 through 2011) of the transects surveyed containing the pathogen (Shanahan *et al.* 2014). In addition, by the end of the 2011 monitoring period, 20 percent of white pine blister rust infections occurred on the trunk of infected trees. This is more of a concern than infection in the canopy because trunk infection compromises the longevity and reproduction of those trees (Shanahan *et al.* 2014).

Table 5. Percentage of live trees with white pine blister rust infection on plots/transects from recent surveys (adapted from Schwandt 2006)

GEOGRAPHIC REGION – NUMBER OF REPORTS (CITATION)	ANALYSIS UNIT(S)	RANGE OF INFECTION (%)	MEAN (%)
Northern Rocky Mountains (United States and Canada) (Smith *et al.* 2008)	Canadian Rockies, US Canadian Rockies	0-100	43.6
Greater Yellowstone Ecosystem (GYWPMWG 2006)	Middle Rockies	0-100	25.0
Intermountain West (Idaho, Nevada, Wyoming, California (Smith and Hoffman 2000)	Idaho Batholith, Blue Mountains, Basin and Range, Middle Rockies, Sierra, Klamath Mountains	0-100	35.0
Northern Divide Ecosystem, western Montana (Fiedler and McKinney 2014)	Northern Rockies, Middle Rockies, US Canadian Rockies	--	92.0
Greater Yellowstone Ecosystem (Shanahan 2020)	Middle Rockies	--	70.0

We assessed the current impact of white pine blister rust on WBP by evaluating data from a modeled dataset developed by the USFS in 2011 for the United States. This modeled dataset is based on white pine blister rust infection information from the Whitebark and Limber pine Information System (WLIS) database combined with environmental variables from Daymet data (Daily Surface Weather and Climatological Summaries, https://daymet.ornl.gov/) (Figure 3). This represents the most comprehensive collection of data on white pine blister rust infection levels to date. Every analysis unit within WBP's range is currently affected by the disease. The average white pine blister rust infection level within each WBP AU in the action area ranges between 2.29 percent and 29.38 percent (Table 1).

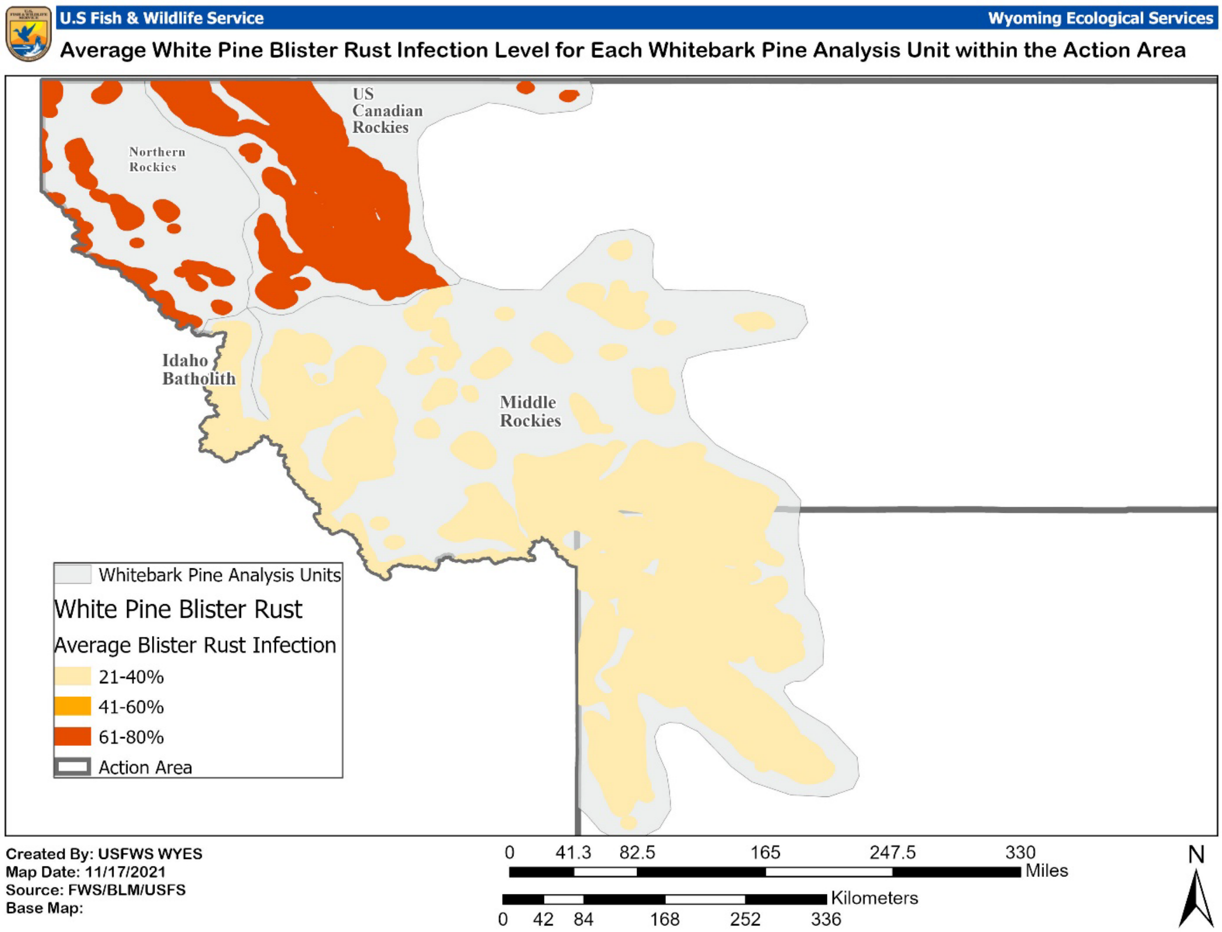

Figure 3. Average white pine blister rust infection level for each analysis unit. (Adapted from the WBP SSA, USFWS 2021).

Table 1. White pine blister rust infection levels by analysis unit (AU) in Montana and Wyoming.

Analysis Unit (AU)	Total hectares of WBP range within AU	Estimated hectares infected	Percent of WBP Range infected within each AU
Middle Rockies	9,008,418	2,646,540	29.38%
Northern Rockies	1,704,834	73,604	4.31%
US Canadian Rockies	2,153,185	730,058	33.9%
Idaho Batholith	4,621,881	105,682	2.29%

4.b. High Intensity Fires

To assess the current impact of wildfire on WBP, we examined burn data collected from 1984 to 2016 (Monitoring Trends in Burn Severity [MTBS] https://www.mtbs.gov; GeoMac, https://www.geomac.gov/)(Figure 4), focusing on areas of high burn severity that could potentially negatively impact the species. However, the high burn severity data only covers the United States' portion of the range (MTBS https://www.mtbs.gov). It should be noted that the range maps used for this analysis also include potential WBP habitat that may or may not currently be occupied by WBP. In instances where high severity fires have burned in potential habitat totally or predominantly occupied by competing tree species (*e.g.*, subalpine fir), a desirable outcome for WBP would be realized. Consequently, because there is a widespread lack of fine-scale presence/absence data for WBP throughout its potential range, at this time we assume that all mapped habitat is in fact occupied by WBP for our analysis of high intensity fire effects to WBP.

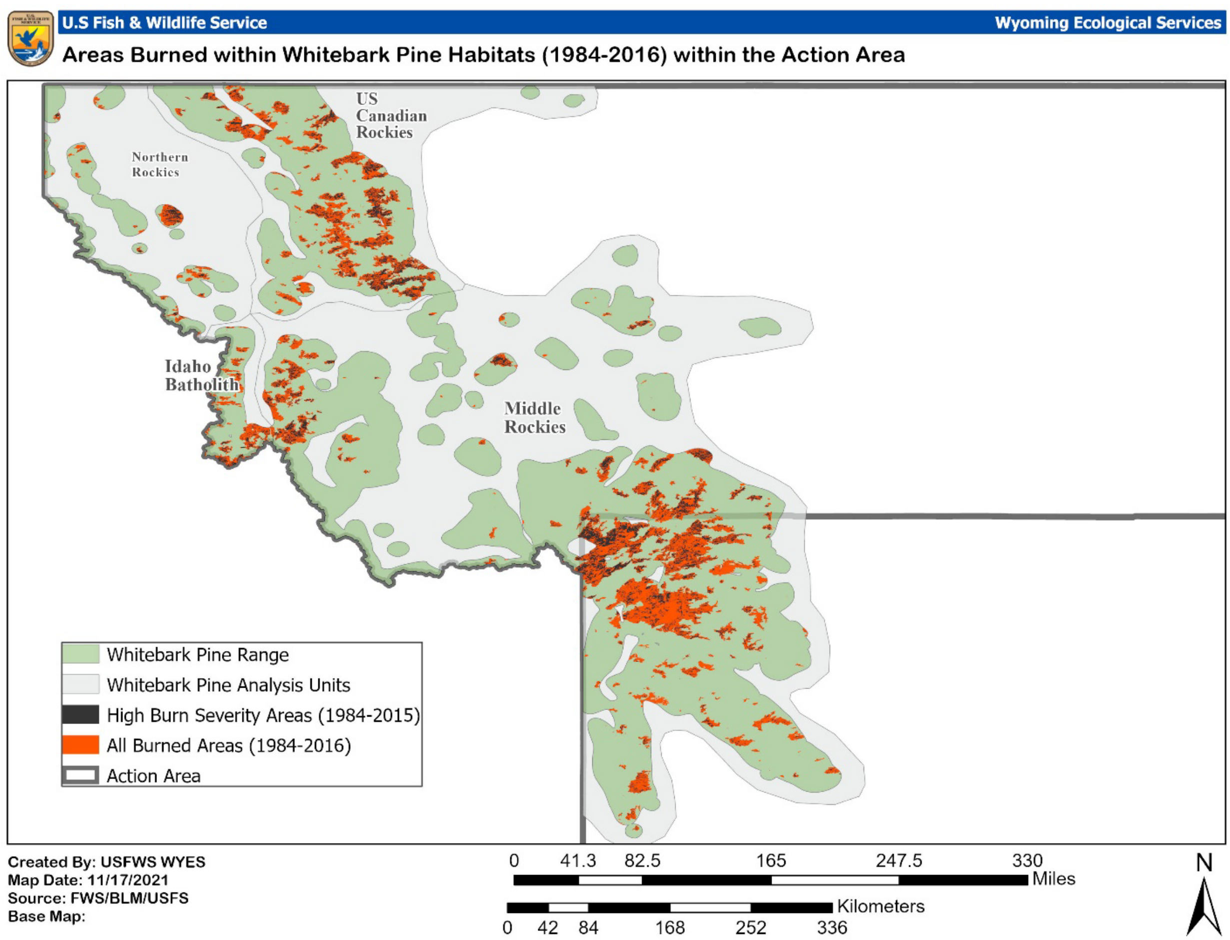

Figure 4. Areas burned within WBP's range from 1984-2016. Areas in red have burned at least once in the last 33 years. Areas in black indicate only high burn severity fires. (Adapted from the WBP SSA, USFWS 2021).

The 33-year period covered by this dataset provides the most comprehensive information for burns across all analysis units in the WBP range; data collected before this period were likely more incomplete and opportunistic. For analysis units within the United States, we were able to differentiate between low/moderate or high severity fires. High severity fires can be detrimental and kill all life stages of WBP. Although high severity fires may also create ideal growing conditions for WBP seedlings due to reduced competitive pressures, we view the immediate large-scale loss of existing WBP trees, and the corresponding loss of seed sources and potential reduction of genetic diversity, as the predominant effect of high severity wildfire.

From 1984 to 2016, between 1.12 percent and 8.0 percent of each analysis unit burned, with a total of 17 percent of WBP range within the action area burned in a high severity fire (Table 2). The majority of fires (83 percent) were classified as low to moderate severity of the WBP range within the action area. Overall, approximately 17 percent of the WBP's range in Montana and Wyoming burned during this time period.

Table 2. Burn data from 1984-2016 for WBP (WBP) analysis units (AUs) in Montana and Wyoming.

Analysis Unit	Total hectares of WBP range within AU	Total ha of WBP Range Burned 1984-2016	Percent of WBP range with high severity burn
Middle Rockies	9,008,418	379,425.89	4.21%
Northern Rockies	1,704,834	19,144.87	1.12%
US Canadian Rockies	2,153,185	173,871.29	8.00%
Idaho Batholith	4,621,881	30,594.63	3.76%

4.c. Mountain Pine Beetle

We assessed the current impact of mountain pine beetle on WBP by aggregating Aerial Detection Survey (ADS, United States) data from 1991 through 2016 across the range (ADS, https://foresthealth.fs.usda.gov; AOS, https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health) (Figure 5). The WBP range is mapped at a coarse scale but encompasses the known distribution of species occurrence. Aerial surveys are not appropriate for estimating the number of individual WBP trees killed by mountain pine beetles within the WBP range; however, they are very useful for determining a minimum number of hectares within the WBP range that have been impacted by mountain pine beetle over time (*i.e.*, recorded areas of beetle kill during surveys). Since mountain pine beetles only attack mature trees, the effects of mountain pine beetle attacks observed during aerial surveys can be interpreted as the loss of seed-producing mature trees. From 1991 through 2016, approximately 13.27 percent (2,321,579 ha) of WBP habitat was impacted by mountain pine beetle in the action area (Table 3). WBP stands in the action area's analysis units have seen severe reductions in reproduction and regeneration.

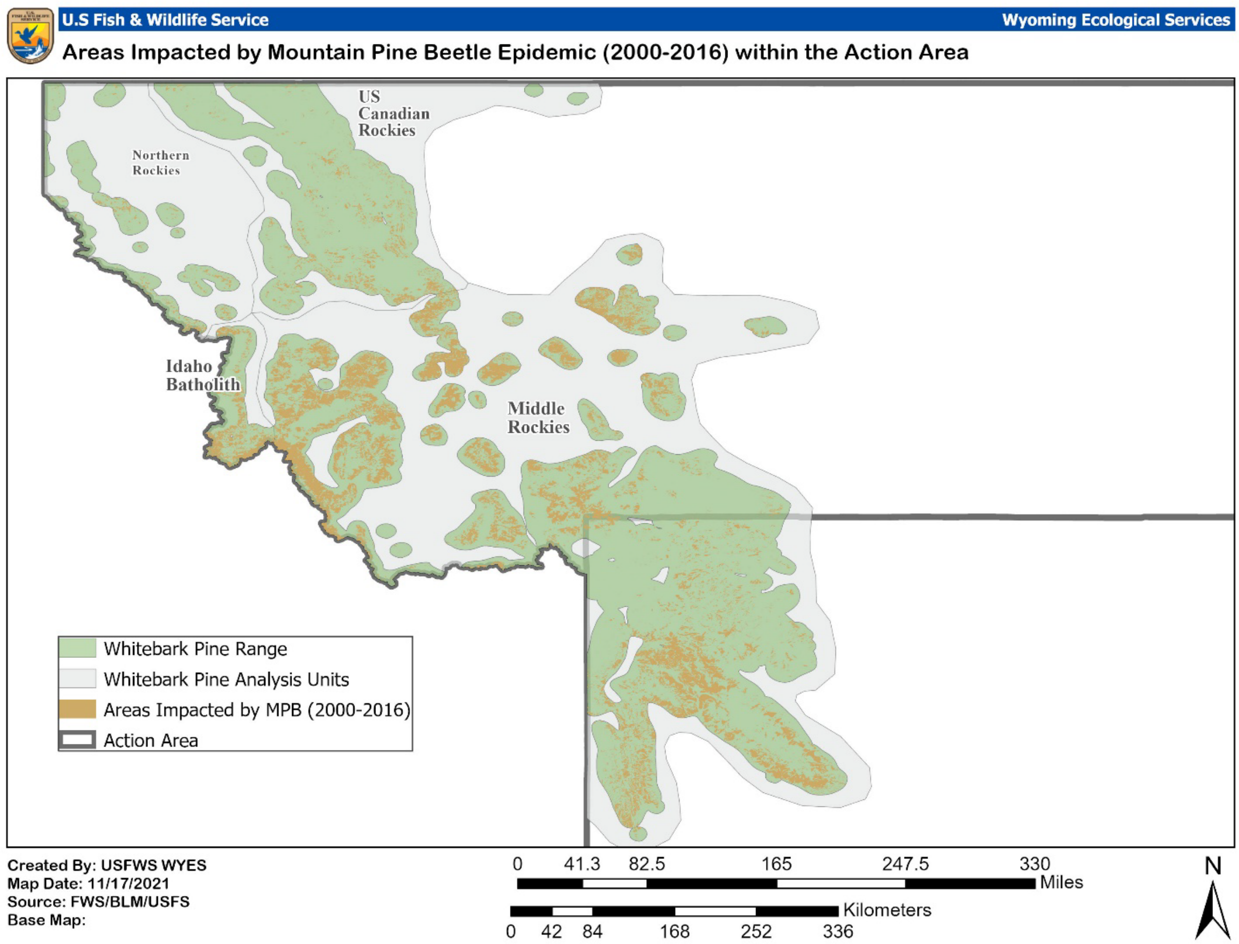

Figure 5. Areas impacted by the most recent mountain pine beetle (MPB) epidemic (1991-2016) within the WBP range. (Adapted from the WBP SSA, USFWS 2021).

Table 3. Estimated hectares of WBP range impacted by mountain pine beetle (MPB) in the most recent epidemic (1991-2016) in Montana and Wyoming.

Analysis Unit (AU)	Total hectares of WBP range within AU	Hectares of WBP range impacted	Percent of WBP range impacted within each AU
Middle Rockies	9,008,418	1,854,207	20.58%
Northern Rockies	1,704,834	184,103	10.80%
US Canadian Rockies	2,153,185	144,747	6.72%
Idaho Batholith	4,621,881	138,522	3.00%

While regeneration has occurred following historical mountain pine beetle epidemics like those of the 1930s, 1940s, and 1970s, the current best available science indicates WBP recovery following the most recent epidemic has been hindered due to the following factors: (1) the nearly ubiquitous presence and intensification of white pine blister rust; (2) severe wildfire resulting from land management, climate change, and the interaction between the two; and (3) successional replacement of WBP by competitors as a result of all the above stressors combined.

As a result, millions of large, cone-bearing WBP have been removed from vast areas of the landscape since the 1990s. In areas hardest hit by the recent epidemic, only the smaller trees not targeted by the mountain pine beetle remain for regeneration and replacement of WBP stands. Unfortunately, in large portions of the range, these remaining smaller trees are subjected to white pine blister rust. Although white pine blister rust is not selective and infects all age and size classes of WBP, seedlings have been shown to be more vulnerable to white pine blister rust infection and mortality (Mahalovich 2017; Shanahan *et al.* 2016). Thus, in the current environment, seedlings that escape mountain pine beetle mortality are still susceptible to white pine blister rust, and the possibility of regeneration following mountain pine beetle epidemics is uncertain in many areas.

Within the action area, project activity in the state of Wyoming involved salvage harvests (removing trees killed by insects and disease), prescribed fire (hazardous fuels reduction), and timber harvest (vegetation management and fuels management). These projects took place in WBP habitat; however, the treatment may have included mixed conifer species such as spruce and fir, lodgepole pine, Douglas fir, and limber pine, in addition to WBP. Between 1991 and 2019, 603 ha (1,490 ac) of WBP habitat were treated by salvage harvests as a result of beetle killed trees; 1,011 ha (2,497 ac) of WBP habitat underwent prescribed fire; and 7,402 ha (18,291 ac) of WBP habitat were treated by timber harvest (Table D of Appendix C).

The prescribed fire burns occurred over 790 ac in the state of Montana, conducted between 2009 and 2020 (Table D of Appendix C), were focused on WBP restoration and included the following activities: selection and care of superior/elite trees, which can include insect prevention and control (also called leave tree protection); seed collection from plus trees; pollen and scion collection from elite trees; seed orchard establishment/improvements; seed orchard operations; seed orchard collection; genetic evaluation plantation establishment and operations; genetic test maintenance; and evaluation plantation examination/measurement.

In addition, the Greater Yellowstone WBP Subcommittee has developed an adaptive action plan for WBP in the Greater Yellowstone Area (2015), which includes collecting WBP seed for rust-resistance screening and gene conservation and implementing restoration planting with propagated rust-resistant WBP seedlings. Rust-resistant (plus and elite tree identification) and WBP stands with high genetic diversity have been found on the Beaverhead-Deerlodge National Forest (Middle Rockies AU), Custer Gallatin National Forest (Middle Rockies AU), Shoshone National Forest (Middle Rockies AU), Bridge-Teton National Forest (Middle Rockies AU), Grand Teton National Park (Middle Rockies AU), Yellowstone National Park (Middle Rockies AU), Caribou-Targhee National Park (Middle Rockies AU) (Appendix B, Tables A, B, and C).

4.d. Climate Change

The area occupied by WBP in the Greater Yellowstone Ecosystem is projected to be significantly reduced with increasing temperature under various climate change scenarios (Schrag *et al.* 2007). Climate envelope modeling by the USFS using the A2 scenario (global average surface warming of +6.1 °F (+3.4 °C)) projects that by 2090, a temperature increase of 9.1 °F (5.1 °C) would cause WBP suitable climate to contract to the highest elevation areas in the northern Shoshone National Forest and Greater Yellowstone Ecosystem or WBP to be extirpated from these areas

(Rice *et al.* 2012). Using a model to assess climate change and wildfire patterns on WBP in Glacier National Park, Loehman *et al.* 2011 also project a decline in WBP. The decline was an indirect result of climate change-altered distributions of competing tree species and an increased frequency and size of wildfires. Under nine climate models and two emissions scenarios examined by Chang *et al.* 2014, the distribution of WBP suitable habitat also declined, with only small, fragmented islands of habitat remaining. The above studies all suggest that the area currently occupied by WBP will be severely reduced in the future.

A more comprehensive modeling effort was recently undertaken (Keane *et al.* 2017, entire), using a spatially explicit, ecological process model, Keane *et al.* (2017) examined scenarios where levels of climate change, management approaches (thinning, planting, prescribed burning), and degrees of fire exclusion were varied. Response variables included WBP basal area and the proportion of the landscape dominated by WBP given the different scenarios explored. The results indicate that WBP will decline, regardless of any potential negative climate change impacts, as a result of disease and predation (Keane *et al.* 2017). However, results also indicate that timely management intervention (*i.e.*, planting potentially rust-resistant seedlings and targeted, proactive restoration treatments) will benefit the species such that it could persist on the landscape, although at lower levels, in the future.

5. Effects of the Action

The implementing regulations for section 7 define "effects of the action" as all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (50 CFR 402.02). This SA evaluates the effects of the following actions, each of which are described in more detail in their individual sections, and summarized with applicable conservation measures in Table 4: livestock management and range improvements, infrastructure actions, mineral and conventional oil and gas exploration and development, forest vegetation management, recreation development and activities, and recovery and research activities.

Table 4. Summary of programs, actions, limits to numbers of WBP analyzed in this SA, and applicable conservation measures included in this SA.

Programs	Actions	Number of WBP*	Conservation Measures
Livestock Management and Range Improvements	Grazing, gathering, moving livestock, range improvement (fencing, stock ponds, and tanks, spring development)	No Limit	CM 1-10, 12-17, and 19-21
Infrastructure	Maintenance, upgrades, and replacement activities for existing pipelines, communication towers, utility	≤125	CM 1-10, 12-14, and 16-21

Programs	Actions	Number of WBP*	Conservation Measures
	lines, renewable energy facilities, trails, and highway infrastructure (*e.g.* to roads, bridges, culverts, bike and pedestrian facilities, fencing, lighting, and all other distinct aspects of a highway project)		
	Vegetation management activities along existing pipelines, utility/transmission lines, highway infrastructure, and associated rights-of-way	No Limit	CM 1-10, 12-14, and 16-21
	Construction of new pipelines, communication towers, utility lines, renewable energy projects, and highway infrastructure	≤125	CM 1-10, 12-14, and 16-21
Leasable and Locatable Mining and Conventional Oil and Gas Exploration and Development	Maintenance of existing locatable and leasable mining and conventional oil and gas projects	≤125	CM 1-10, 12-14, and 16-21
	New development of existing mineral and conventional oil and gas leases	≤125	CM 1-10, 12-14, and 16-21
Vegetation (Forest) Management	Vegetation (forest) management activities that take into account age class prescriptions, genetic variability within and among WBP populations and activities that may impact the adaptive potential and the forest trajectories of WBP (salvage harvests, and pest control that remove dead and diseased trees encouraging natural WBP recruitment)	≤125	CM 1-10, 12-14, and 16-21
	Timber harvest projects, hazardous fuel removal (in WUI), and precommercial thinning and group selection projects	≤125	CM 1-10, 12-14, and 16-21

Programs	Actions	Number of WBP*	Conservation Measures
Recreation	Maintenance of existing trail (hiking and biking specifically) trail systems	No Limit	CM 1-10, 12-14, and 16-21
	Maintenance of existing recreational development projects (*e.g.*, ski resorts and campgrounds), and other recreational activities (*e.g.*, off-highway vehicles (OHV) and over-snow vehicles (OSV) use	≤125	CM 1-10, 12-14, and 16-21
	Upgrades, replacement, expansion, or new construction outside the existing disturbance footprint of existing recreation projects	≤125	CM 1-10, 12-14, and 16-21
	Outfitter and guide permit programs	No Limit	CM 1-14, and 16-21
Recovery and Research	Monitoring and recovery activities that are beneficial to WBP	No Limit	CM 1-10, 12-14, and 16-23
	Permanently marking WBP trees that do not damage the tree to the extent that disease is introduced to the tree resulting in death of the tree. These activities include collection of WBP cones, seeds, scion, and pollen; screening them for genetic resistance of white pine blister rust; and establishing seed orchards	No Limit	CM 1-10, 12-14, and 16-23
	Research actions directed at furthering the recovery of WBP	No Limit	CM 1-10, 12-14, and 16-23
	Propagated, screened, and planted blister rust-resistant seedlings	No Limit	CM 1-10, 12-14, and 16-23

* Number of WBP seedlings, saplings, and adults that may be damaged or killed per project, based on the SA.

5.a. Livestock Management and Range Improvement Actions

The SSA for WBP did not analyze the effects of livestock management (*e.g.*, grazing, gathering, and trailing activities) and range improvements (*e.g.*, fencing, stock ponds, spring development) on WBP, because these activities were not considered to be a driver of population dynamics at a range-wide or species scale (USFWS 2021). However, the analysis in Appendix B of the SSA suggested that mature WBP were not impacted by livestock farming or ranching (USFWS 2021). In reviewing the scope of potential impacts to WBP as a result of livestock management and range improvements, there are currently 797 livestock grazing allotments totaling 3,356,048 ha (8,292,974 ac) within WBP habitat on USFS lands and 45 BLM grazing allotments totaling 157,206 ha (157,206 ac) within Montana and Wyoming. This comprises approximately 20 percent of the total WBP range in Montana and Wyoming.

While mature WBP are not known to be impacted directly by livestock grazing at a range-wide or species scale, young and regenerating individuals can be trampled, especially under periods of overutilization while grazing or during gathering and trailing activities; improper timing of grazing, or poor distribution of livestock where young and regenerating WBP occur. Though WBP itself is not palatable, the seeds are highly nutritious (Lanner and Gilbert 1994), and understories of WBP stands often provide valuable forage for wildlife and livestock alike. As assessed in the SSA, other impacts resulting from livestock grazing and management include soil disturbance and compaction, destruction of microsites for cached seeds, interruptions in draining, limitations to tree rooting, and direct damage to seedlings. Impacts to WBP individuals resulting from livestock grazing, gathering, and trailing can be minimized by locating these activities outside of regenerating WBP stands. Livestock may utilize mature WBP trees for rubbing and as shade and bedding cover (Lillybridge *et al.* 1995), but we have no information on how this might affect WBP individuals. There are no known wild horse HMAs in WBP habitat in Montana and Wyoming; however, if individual horses were in WBP habitat it is likely that wild horses present similar concerns for WBP, particularly for young and regenerating individuals. Furthermore, heavy grazing by livestock or wild horses can substantially reduce natural fire occurrence in WBP habitats that are characterized by grassy fine fuels (Murray *et al.* 1998). The SSA suggested that the scope effects from livestock farming and ranching to be negligible, with less than 1 percent of individuals impacted, and a severity of impacts between 1 and 10 percent (USFWS 2021).

Range improvements such as fencing, stock ponds, and spring development may also cause impacts to all life stages of WBP through direct removal of individuals for construction and development. While these types of range improvements were not analyzed specifically in the SSA, we know that they will not occur at the tops of ridges similar to communications towers (which was classified as having negligible impact and negligible scope (less than 1 percent) and extreme severity (71 to 100 percent) (based on IUCN threats summary for WBP in Canada); USFWS 2021) and will more likely fall within the range of stressors assessed under agriculture and aquaculture, human intrusion and disturbance, and recreational activities (all three stressors were classified as negligible in impact and scope (less than 1 percent) and slight severity (1 to 10 percent (based on IUCN threats summary for WBP in Canada); (USFWS 2021). Construction of fences within the range of WBP may also cause similar impacts to those associated with roads and railroads (negligible scope (less than 1 percent) and extreme severity (71 to 100 percent)) or utility and service lines (negligible scope (less than 1 percent) and moderate severity (11 to 30 percent) (based on IUCN threats summary for WBP in Canada); USFWS 2021), though at a much smaller scale and with potentially higher flexibility to avoid individual WBP trees. It is possible that lower elevation WBP trees within existing grazing allotments will be removed for the purposes of installing fencing, stock ponds, or the development of springs to improve the rangeland for livestock; however, these types of projects are likely to be infrequent and at such a small scale that zero to only a few trees would be removed.

Livestock management and range improvements may reduce the grasses capable of carrying frequent low severity fire in WBP habitats. We understand that survivability of WBP seedlings is highly variable, and ranges between 56 percent survival in the first year to 25 percent survival in the fourth year (Tomback 1982). Higher WBP seedling density has been correlated with higher densities of nearby mature live WBP, the presence of intermediate amounts of vegetation cover, and lower solar radiation (Leirfallom *et al.* 2015). Livestock grazing may reduce this competition to seedlings and reduce fine fuel loads that may burn during wildfires (see the treatment of fire and fire exclusion and the interaction with other stressors in the SSA: USFWS 2021).

In summary, livestock management and range improvements are not considered to be a driver of WBP population dynamics on a range-wide or species scale, and the foreseeable impacts of these types of activities are considered to be negligible in the SSA, as described above. While we expect that livestock management and range improvements will occur within the range of WBP, we are not limiting the amount of WBP removal for livestock management and range improvements regardless of anticipated damage or removal of any age class of WBP. We anticipate these are likely to be infrequent, small, on the periphery of the range, and in lower elevations. We also expect that a number of conservation measures (*e.g.,* CM 1-10, 12-17, and 19-21), can be implemented to avoid and minimize impacts to individual WBP trees.

5.b. Infrastructure Actions

Infrastructure development activities include pipelines, communication towers, road construction, utility lines, oil and gas pipelines, and renewable energy projects. Approximately 1,995 km (1,240 mi) of roads and trails on USFS and BLM lands occur within WBP habitat. Highway construction has removed about 312 ac (126 ha) of WBP in Wyoming and 130 ac (53 ha) in Montana (Table D of Appendix C), which is based on a federal partner estimate of acres affected by project activities. The USFS, BLM, and NPS have 118 km (76 mi) of transmission lines in Wyoming and 1,421 km (883 mi) in Montana within WBP habitat. Additionally, two wildfire weather station towers, two communication towers, and three hydro-electric power plants occur within WBP habitat. In Montana, six wind powered generators and 59 meteorological evaluation towers (MET) occur in WBP habitat. Three ski resorts occur within 1,348.33 ha (3,331.8 ac) of WBP habitat in Montana and Wyoming.

5.b.i. Existing Development

Within existing utility corridors (*e.g.*, pipelines, power lines) and along existing roadways, vegetation must be removed periodically to avoid damage to the infrastructure or to address human health and safety (removal of mature trees in the highway clear-zone which is necessary to protect the travelling public). If left unchecked, roots can disrupt pipelines and crack pavement, and trees will grow into power lines resulting in outages and potential wildfires. Vegetation management in utility rights-of-way will reduce the risk of wildfires by avoiding electrical arcing that can occur during rain and high winds. WBP do not mature and start producing seeds until at least 40 years of age, and in most cases the removal of undesirable vegetation occurs at more frequent intervals (*e.g.*, 10 to 15 years); therefore, seedlings and saplings will be removed most frequently. Occasionally, a mature tree could be at risk of falling into a power line or onto a roadway; however, we expect removal of mature trees to happen infrequently and will typically involve dead or dying trees that have no or little reproductive potential.

Where possible, pruning trees to acceptable heights and not entirely removing cone bearing branches and the entirety of the mature trees will allow for the continued production of seeds, which will minimize adverse effects to WBP during maintenance activities. Operation of construction equipment used for pipeline, transmission line, and road maintenance may cause soil disturbance and compaction, and may destroy microsites for cached seeds, interrupt drainage, limit tree rooting, introduce and/or spread invasive species, and damage or excavate seedlings. Construction maintenance activities may also be beneficial to WBP, because they could remove conifer species that are competing with WBP. The reduction in competition, change in the canopy cover, and reduction of competition for water resources, could increase vigor and reproductive fecundity of WBP. Implementing conservation measures (*e.g.*, CM 1-10, 12-14, and 16-21) will reduce impacts from soil compaction and erosion, reduction in the injury and removal of mature WBP, and allow trees to continue to produce seed and propagate seedlings. In addition, we recommend replanting with blister rust-resistant seedlings in areas outside of rights-of-way to further the recovery of WBP.

Resort developments have resulted in a permanent loss of WBP habitat through the development of permanently groomed ski runs, lift termini, buildings and roads, and general resort infrastructure. These existing ski resorts periodically prune or remove vegetation encroaching into ski runs to maintain the integrity of the runs and to protect skiers. Snow making and lift maintenance activities in the ski runs may damage WBP found in the stands between ski runs. Similar to utility corridors, existing ski resorts and other developed areas on federal lands (*e.g.*, visitor centers, campgrounds, communication towers) will occasionally remove seedling, saplings or prune or remove mature trees that could damage existing development and other infrastructure or that pose a hazard to employees and visitors.

Because WBP occurs primarily at higher elevations, the number of existing utility corridors and developed areas that overlap WBP habitat is small, though there are considerable miles of existing dirt roads and trails. Removal of trees at existing facilities will involve primarily seedling and saplings encroaching into utility and road corridors, not seed-producing mature trees. Occasionally, seedling, saplings, and mature trees may be removed or pruned at other developed areas. If mature trees are removed, most are likely to be dead or dying or likely to die (*e.g.*, uprooted when falling into roadway). The overall impact of removing a limited number of trees at existing development and along existing utility corridors is unlikely to have a population level effect. In addition, vegetation management along utility corridors is likely to have a beneficial effect by reducing the likelihood of wildfires.

5.b.ii. New Development

New land and realty development activities could include anything from expansion of an existing facility to the construction of new projects and the size of those activities could range from small additions at existing facilities to construction of large utilities across many miles or acres of WBP habitat. As stated earlier, projects that remove more than 125 live WBP trees will not be covered by this SA but instead will be evaluated on an individual basis. Examples of small projects include:

- expansion of a ski run or addition of a building at a ski resort,
- constructing a new highway passing lane,
- adding a new cathodic protection system for a pipeline, or
- rerouting a section of hiking trail to avoid a hazard.

Smaller projects can often be designed or redesigned to avoid adverse effects to WBP. For example, agencies can potentially avoid the need to remove WBP by selecting an alternative location nearby without WBP or shifting the location of structures on a site to avoid WBP. Implementing best management practices to minimize creation of dust, limit soil disturbance and compaction, and measures to properly control runoff can further avoid adverse effects. For these projects, potential adverse effects will be insignificant or discountable. However, it will not be possible for all small new development to avoid all adverse effects to WBP, including the removal of mature trees. For example, adding two new wheelchair accessible parking spots next to a restroom may require removal of WBP to position the parking spots in close proximity to the restroom.

5.b.iii. Summary of Effects from Infrastructure

Within existing utility corridors (*e.g.*, pipelines, power lines) and adjacent to existing roadways, all WBP may be removed periodically to avoid damage to the infrastructure or to address human health and safety and to reduce the risk of wildfires. At other existing development (*e.g.*, visitors center, rest stop, cell tower), WBP will occasionally need to be removed or pruned to avoid damage to the infrastructure or to address human safety. We are not limiting the amount of WBP removal for existing infrastructure projects within existing infrastructure corridors regardless of anticipated damage or removal of any age class of WBP. Because WBP occurs primarily at higher elevations, few development projects occur within WBP habitat, and in most cases seedlings and saplings are removed rather than cone-bearing, mature trees. Removing and pruning vegetation can further reduce the risk of wildfires, and some maintenance activities could be beneficial to WBP by removing competition, etc. Given the small number of projects, the age of trees most affected, and the potential benefits, removing WBP at existing developments is not expected to have population level impacts.

We have elected to use 125 WBP of all age classes (seedlings, saplings, adults) as a threshold for "small" development projects, including new infrastructure development projects, based on our understanding of the stressors to WBP, the level of ongoing restoration efforts, and our commitment to track and re-evaluate project impacts and restoration efforts for the life of the SA. While small development projects will result in adverse effects to WBP, these should not result in population level effects for the reasons described above.

5.c. Mineral and conventional oil and gas exploration and development

Mineral and conventional oil and gas exploration and development could occur in WBP habitat in Wyoming and Montana. These types of activities include, but are not limited to, seismic activities, conventional oil and gas exploration and development, sand and gravel mines, other mineral development, and the maintenance, abandonment, and reclamation activities associated with these types of developments. There are approximately 164,813 ha (407,264 ac) of federal (USFS and BLM) conventional oil and gas leases within WBP habitat in the action area, which is approximately 1.0 percent of the action area. More specifically, 241 wells, one compressor station, and one substation are constructed within WBP habitat in Wyoming and Montana. We do not know how much habitat has already been impacted by the other types of mineral and energy development, but it is likely less than the 1 percent impacted by conventional oil and gas.

Approximately 21 percent of whitebark habitat in the action area has already been impacted by known stressors; wildfires, white pine blister rust, and the mountain pine beetle. By comparison, approximately 96 percent (158,381 ha; 391,366 ac) of federal conventional oil and gas leases in WBP habitat have already been impacted by wildfires, white pine blister rust, and the mountain pine beetle, resulting in only 4 percent live WBP habitat remaining in those leased areas. Mineral and energy development operators would have the opportunity to avoid WBP trees when siting or developing their projects or conducting maintenance of existing projects, though it is possible that some WBP trees could be removed. While we anticipate tree removal to be minimal or non-existent, construction and maintenance activities could cause some soil disturbance and compaction, destroy microsites for cached seeds, interrupt drainage, limit tree rooting, or damage seedlings. Roads associated with this type of development could provide greater access for recreational activity in areas where access was previously limited. Some projects might remove conifer species that are competing with WBP, and this could have a beneficial effect on WBP as well. The reduction in canopy cover and the reduction of competition for water resources would increase vigor and reproductive fecundity of WBP.

According to the SSA, mineral and energy exploration and development activities are not considered to be threats to WBP in the action area (USFWS 2021) and impacts from future actions associated with these activities will be negligible. Mineral and energy development has a limited potential to occur in WBP habitat or impact individual trees, because only one percent of the action area is affected by oil and gas leases and much of that habitat has already been impacted by other stressors, and because operators have some flexibility in the project planning and siting process. New mineral development actions may impact WBP, and we have limited this SA to cover individual projects that damage or kill no more than 125 live WBP of all age classes. In addition, we expect federal action agencies will implement conservation measures (*e.g.*, CM 1-10, 12-14, and 16-21) to conserve WBP, which will further help to avoid and minimize impacts to individual trees.

5.d. Forest (Vegetation) Management Actions

Forest (vegetation) management includes a variety of methods and techniques used to manage healthy forests, and known previous projects that fall within this action type are summarized in Table D of Appendix C. These types of forest management activities include timber harvest (using chainsaws and using machinery which may create skid trails) and management/hazardous fuels reduction (using chainsaws and using machinery which may create skid trails, to remove dead and dying trees and understory vegetation that may carry wildfire), salvage harvest (removing dead trees either by hand or using machinery which may create skid trails), pest control (use of Verbenone or Carbaryl insecticide), precommercial thinning (thinning trees that are too small for a commercial timber harvest), silviculture stand improvement projects (using a planned set of treatments such as thinning, harvesting, planting, pruning, prescribed burning, and site preparation designed to change the current stand structure and composition to one that meets a management goal), and silvicultural reforestation activities (planning for natural regeneration or tree planting).

Forest management related road construction, maintenance, and use may also be part of vegetation management projects. Harvest of WBP has not been well tracked as records often group it with other species and incorrectly identify it as another species. Silviculture approaches create a system that excludes regeneration opportunities and increases competition by planting faster-growing species, and consequently, stands that contain WBP prior to harvest are not routinely replanted with WBP.

Projects that implement resetting the successional stage of the forest stands need to be carefully thought out and planned to increase WBP recruitment. Campbell and Antos (2003) noted that successional patterns in WBP forests are more complex than others have reported, finding that subalpine fir readily established after fire in their British Columbia study areas, and although subalpine fir density was increasing in older WBP stands with relatively open canopies, they estimated that succession to subalpine fir would take more than 500 years. Campbell and Antos (2003) reported that WBP in their study area was stress-tolerant (able to persist under conditions that restrict production), was capable of surviving long periods of suppressed growth, and was able to release upon reaching the main canopy after more than 150 years of low growth rates. The results of these studies indicate that the loss of WBP due to succession to subalpine fir and Engelmann spruce in some areas may be an extremely slow process and that WBP may be more shade-tolerant and resilient to suppression than previously suggested. Further, thinning and timber harvest projects intended to improve WBP recruitment may increase WBP susceptibility to mountain pine beetle infestation, if the beetles do not have their preferred food sources during outbreak years. The densification of and succession of subalpine fir and Engelmann spruce co-occurred with WBP mortality caused by bark beetle outbreaks and/or blister rust; therefore, disentangling the effects of blister rust- and bark beetle-mortality on succession from the effects of fire suppression in these studies is difficult (Hartwell *et al.* 1997; Arno *et al.* 1993 in Keane *et al.* 1994; Flanagan *et al.* 1998).

Projects including those in WUI, salvage harvests, and pest control efforts remove dead and diseased trees, and may encourage natural WBP recruitment. In large acreages of dead trees, salvage harvest and firewood cutting projects can be designed to avoid damaging or killing live

WBP, which may be resistant to blister rust. Projects where the removal of surface and ladder fuels through hand cutting, piling of project generated materials, and burning the piles with the purpose of increasing stand resilience to fire may also be beneficial for the recruitment of WBP. Felling trees and creating skid trails for salvage harvests may damage or kill WBP seedlings and saplings and compress the soil and undetected seeds. Implementation of the conservation measures (*e.g.*, CM 1-10, 12-14, and 16-21) in the project design that avoid impacts to WBP seedlings, saplings, and live mature trees, and that minimizes soil disturbance and compaction that may destroy microsites for cached seeds, interrupts drainage, and limits tree rooting will have beneficial long-term impacts to WBP.

Vegetation management includes many project types (*e.g.*, WUI, salvage harvest of dead trees, harvest of Christmas trees, pest control, firewood collection) and sizes (less than 1 acre to thousands of acres). In this SA, we evaluated the effects of smaller forest management projects that damage or kill fewer than 125 live WBP of all age classes. Effects of larger project will be addressed by a standalone consultation or may be covered by a future standing analysis. We have elected to use a limit of 125 WBP of all age classes as a threshold for forest (vegetation) management projects, based on our understanding of the stressors to WBP, the level of ongoing restoration efforts, and our commitment to track and re-evaluate project impacts and restoration efforts for the life of this SA. While forest management projects will result in adverse effects to WBP, these should not result in population level effects for the reasons described above.

5.e. Recreation Development and Activities

The following recreational activities commonly occur in WBP habitat: construction and maintenance of hiking trails and roads (analyzed in the Infrastructure section); motorized use of trails year-round; (snow machines, all-terrain vehicles (ATV), utility task vehicles (UTV), motorcycles, electric bikes, and mountain bikes); operation of facilities (snow making, lift chairs analyzed in the Infrastructure section); firewood consumption; special use permits (hunting, photography); and horseback riding.

There are 91 recreation sites within WBP habitat in the action area, including developed campsites, horse corrals, trail heads, parking areas, toilets, staging areas, scenic overlooks, and primitive campsites. Back country campers and hikers may burn WBP for campfires, cause ground compression, climb on trees, or remove WBP when clearing trails. Motorized recreation activities, hiking, use of pack animals, and construction equipment used for trail maintenance and construction, may cause soil disturbance and compaction, destroy microsites for cached seeds, interrupt drainage, limit tree rooting, and damage seedlings. Over snow vehicles (OSV) could break the tops of trees or could damage branches or seedlings and saplings. We acknowledge that there may be some damage and death to WBP seedlings and saplings from authorized and unauthorized off-road motorized recreation activities which could affect individuals or local areas. Overall, impacts from all recreation activities could affect less than one percent of the species wide range (based on IUCN threats summary for WBP in Canada) (USFWS 2021) and are not considered a significant threat to WBP.

We conclude that, while not all adverse effects can be avoided, the implementation of the conservation measures (*e.g.*, CM 1-14, and 16-21) will minimize impacts to WBP and that recreation activities will not have population level effects. Agencies should educate the public about the role of WBP in the high elevation forest community, minimize (and prevent where possible) damage and removal of WBP by backcountry recreationists, and allow trees to continue to produce seed and propagate seedlings. We have elected to use a limit of 125 WBP of all age classes as a threshold for recreation activities, namely off highway and OSV trail upgrades, replacement or new construction outside of existing disturbance, as well as existing recreation development areas (ski resorts and campgrounds). The maintenance of existing hiking and biking trails and the outfitter and guide permitting program may be implemented regardless of the anticipated damage and removal of any age class of WBP. Based on our understanding of the stressors to WBP, the level of ongoing restoration efforts, and our commitment to track and re-evaluate project impacts and restoration efforts for the life of the SA, the impacts from the projects described above should not result in population level effects for the reasons described above.

5.f. Recovery and Research Actions

The 4(d) rule excludes forest management, restoration, and recovery activities from prohibitions, and so no permit under section 10 of the Act is needed for these types of activities. These types of activities may be authorized for qualified individuals by the appropriate land management agency, where necessary. Because many restoration activities are covered under the *V.iv Forest (Vegetation) Management Actions* section, this section focuses on recovery and research actions. This section analyzes the effects of known, current methods of recovery and research actions, and therefore newly-developed efforts should be reviewed for applicability and effectiveness.

In regions where blister rust infection has led to high WBP mortality over decades, the only way for functional WBP to return to or be maintained will be by planting WBP seedlings and seeds from trees that have been screened and proven to have moderate to high genetic resistance to blister rust (Tomback 2021). Proactive management in areas where WBP is still alive includes gene conservation collections to capture genetic diversity (tissue and seeds from individual trees, tagged and georeferenced) for archiving and genetic screening of cone-producing trees to determine frequency and distribution of white pine blister rust resistance (Tomback 2021). Gene conservation includes the collection of WBP cones, seeds, scion, and pollen, screening them for genetic resistance, and establishing seed orchards.

The BLM, NPS, USFS, research scientists, American Forests, and the WBP Ecosystem Foundation, will continue to inventory existing WBP stands to determine where to most effectively direct conservation and recovery efforts by monitoring plus trees for overall health and vigor, cone production, encroachment from competitor tree species, response to treatments, post fire response, and annual survivorship of plantings and map the results of the inventories. WBP stands with live, seed source trees with genetic resistance will be protected from mountain pine beetle outbreaks and high severity fire events. The recovery of damaged, unhealthy, or extirpated WBP trees and stands will use propagation, screening, and planting of blister rust-resistant seedlings. Reoccupied and enhanced habitats (e.g., those identified in Appendix B, Tables A, B, and C) will be managed and protected to maintain and expand suitable habitat for the WBP, particularly within and adjacent to occupied areas, especially those with live stands and plus trees.

To monitor the health of WBP stands, surveys are conducted routinely on the ground and in the air. We anticipate no impact to WBP as a result of aerial survey work. However, for on-the-ground work, occasional trampling of unknown seedlings may occur, though the chance of injuring a small tree is very low due to them typically occurring within protective microsites such as rocks and logs where Clark's nutcrackers stashed their seeds.

Genetic assignment activity generally involves removal of material from live trees. Removing cones, scion, and pollen may reduce natural propagation of WBP. Tree climbers may accidentally damage WBP trees while climbing trees for cone collection. These activities can be done without damaging the tree (*i.e.*, climbing without spurs and with soft-soled shoes), and using orchard ladders and custom-made tree-tongs (Davies and Murray 2006)). Further, cognizance of friction from ropes, handling branch tips carefully, avoiding breaking live branches, and not climbing the same trees every year can minimize the effects of this important genetic collection work. Non-invasive genetic work includes marking of plus and elite trees with indicator paint, which protects these trees, though may result in trampling of unknown seedlings nearby.

Using cones, scion, and pollen materials to intentionally propagate WBP rust-resistant trees in a controlled nursery environment and through the establishment of seed orchards (which are in facilities outside of the project area) will ensure genetic diversity and provide rust-resistant seedlings that may be planted in areas where the natural propagation of WBP may take several years or decades because of the vast amount of dead and dying trees surrounding the live trees. Planting WBP in orchards is likely to have no effect to existing WBP, though we anticipate some loss of propagated individuals that are susceptible to disease or maladapted to the planting site. Insecticide application has the potential to protect important WBP trees, but the application may damage trees through trampling of seedlings or directly applying the insecticide to the outside of the WBP tree. Due to the inherent challenges involved in utilizing carbaryl insecticide, it has only been used on a limited number of occasions in the past to protect "plus" trees on the Custer-Gallatin and Shoshone National Forests. However, verbenone has been used much more extensively by the USFS, BLM, and NPS due to its relative ease of use and ability to be deployed in wilderness areas (if allowed by local management guidelines). Plus trees are treated with verbenone to protect the important rust-resistant trees from loss to mountain pine beetle. The use of Verbenone (stapling the packet of verbenone to WBP trees) to prevent mountain pine beetles from attacking a WBP tree will damage the tree as a result of using the staples, nails, screws, etc.; however, we conclude the benefits outweigh the potential impacts to the WBP tree.

Finally, research activities may involve some direct impacts to individual trees. These types of activities include canker studies where blister rust canker growth is monitored through inserting pins into the margins of the canker to delineate growth of the cankers over time (Hooten and Shanahan. in preparation). Other invasive research activities may include applied research topics regarding the improvement of technology for collecting and planting seeds and planting seedlings, and protecting high value trees (Keane *et al.* 2022). These types of activities may pose adverse effects to individual or small groups of trees, and we conclude again that the benefit of additional information outweighs the potential impacts to WBP.

We conclude that while not all adverse effects can be avoided during recovery (*e.g.*, inventory, monitoring, collection, orchards, planting, and use of insecticides) and research activities, the implementation of applicable conservation measures (*e.g.*, CM 1-10, 12-14, and 16-23) and adherence to the most recent best management practices will minimize impacts to WBP. Further, these types of activities will provide a long-term benefit to the recovery of WBP. This SA is intended to address the consultation needs of recovery activities in their entirety. We will use this SA to review and evaluate recovery activities and will update the SA as appropriate.

6. Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation.

The Service is not aware of any future non-federal actions reasonably certain to occur in the action area. Ongoing actions in the action area, such as recreational use, hunting, and livestock grazing on private lands, and their impacts on WBP are discussed in the Environmental Baseline section above and are expected to continue. The Service is not aware of any reasonably foreseeable circumstances that would significantly alter existing state, Tribal, local, or private activities in the action area from what is described in the environmental baseline section.

7. Conclusion

After reviewing the 2021 SSA; the current status of the WBP, including stressors and conservation needs; sources of information incorporated by reference; the environmental baseline; the proposed action for low effect projects including Conservation Measures; and the cumulative effects; it is the Service's opinion that the effects of the action, as proposed, are not likely to jeopardize the continued existence of the WBP. No critical habitat has been proposed for WBP; therefore, none will be affected. The Service has reached this conclusion by considering the following:

1. The primary stressors to WBP range-wide are the high incidence of the non-native white pine blister rust, large intense fires in WBP habitat (Keane 2001b), mountain pine beetle (Raffa and Berryman 1987 and Logan et al 2010), and the impacts of climate change. These primary stressors also act on WBP in the Northern Rockies, Idaho Batholith, US Canadian Rockies, and the Middle Rockies analysis units (Schwandt *et al.* 2010 and Tomback *et al.* 2001) within the action area. The proposed actions are not considered among the primary stressors to WBP, and they are not expected to exacerbate those stressors.
2. Many trees remain on the landscape, including trees that are resistant to white pine blister rust, the primary threat.
3. Past human activities have not had a negative impact on the persistence of WBP stands and populations.

4. Future human activities and new developments are not expected to result in the loss of large numbers of WBP, because WBP is not a commercial species and because the species' range occurs in mostly remote and inaccessible locations.
5. Many agencies and other institutions (*e.g.*, USFS, NPS, WBP Ecosystem Foundation) are undertaking recovery activities (*e.g.*, planting rust-resistant trees) to improve the species' condition, and these activities, are expected to continue.
6. The Service's commitment to ensure the natural regeneration, genetic diversity and genetic variability through the protection of mature and seed-producing trees; the collection, storage, and screening of seed for rust resistance and genetic conservation; and the recovery effort of the promotion of natural regeneration, planting nursery grown blister rust resistance seedlings, and direct seeding are incorporated into the proposed action.
7. The Service is committed to minimizing impacts to WBP through project design, including providing technical assistance to action agencies during the consultation process, and through the implementation of the conservation measures above.
8. Rangewide, WBP occurs on an estimated 32,616,422 (ha) (80,596,935 ac). The action area contains 17,264,826 ha (42,662,316 ac) of the current distribution of WBP. The anticipated level of WBP removal caused by the proposed actions under this SA will not appreciably reduce the overall population, reproduction, and distribution of WBP throughout its range. Therefore, the implementation of the projects within this SA will not cause jeopardy of WBP throughout its range.

8. Incidental Take Statement

Sections 7(b)(4) and 7(o)(2) of the Act do not apply to the incidental take of federally listed plant species. However, limited protection of listed plants is provided to the extent that it is unlawful under the Act to (a) import any such species into, or export any such species from, the United States; (b) remove and reduce to possession any such species from areas under federal jurisdiction; (c) deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever and in the course of a commercial activity, any such species; (d) sell or offer for sale in interstate or foreign commerce any such species; or (e) violate any regulation pertaining to such species or to any threatened species of plants listed pursuant to section 4 of this Act and promulgated by the Secretary pursuant to authority provided by this Act of federally listed threatened plants.

9. Conservation Recommendations

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations (CR) are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's section 7(a)(1) responsibility for the species:

CR1. Continue to identify, test, and protect both active and potential "plus" trees (WBP that are or believed to be phenotypically resistant to white pine blister rust (see Appendix B). In some instances, conservation and recovery of WBP could be aided by even single, solitary trees, whether at the stand level or the landscape level depending on how widespread stressors have impeded the health of the WBP in a particular area. Some WBP trees are phenotypically resistant to blister rust, providing viable seeds sources for natural regeneration or cone collection for site rehabilitation.

CR2. Continue to collect cones, and plant seedlings and/or directly sow WBP seeds, especially those from "plus" trees. Prioritize areas affected by the white pine blister rust, mountain pine beetle, wildfire, climate change, and natural disasters (*e.g.*, large, burned areas).

CR3. Support continued genetic research and development of WBP seed orchards. Establish long-term monitoring plots to document WBP cone production, natural disturbances (post fire response), climate change effects, and annual survivorship of restoration plantings. Continue to implement and as needed initiate long-term monitoring to measure the status and trends of WBP health across its range.

CR4. Identify, model and map future results of WBP inventories and create fine scale maps to identify and develop WBP core (*i.e.*, refugia) areas for high-impact restoration.

CR5. Conserve WBP genetic diversity (*e.g.*, protection, cone collections).

CR6. When designing and implementing projects, avoid impacts that reduce reproduction or recruitment of WBP into populations.

CR7. Protect existing live WBP trees and stands and phenotypic rust-resistant "plus" trees, seed sources, and areas of unique genetic variation from mountain pine beetle, wildland fire, and project-related disturbance.

CR7. Identify superior parentage of WBP seedling stock and ensure stocking level goals are met.

CR8. Engage with and continue to work with partners on a National Restoration Plan for WBP.

CR9. Seek new public educational opportunities concerning WBP restoration and protection.

CR10. Encourage and work with public and private land managers, including non-profit organizations and landowners, to protect, restore, enhance, and manage habitat to maintain and expand suitable habitat for the WBP, particularly within and adjacent to occupied areas.

CR11. Restore damaged, unhealthy, or extirpated WBP trees and stands using propagation, screening and planting seedlings, and removing competing conifers.

CR12. When designing and implementing projects, consider, evaluate, and carry out opportunities to mitigate and offset the effects of global and climate change.

CR13. Design fuels treatments down-slope of non-whitebark stands to minimize effects to WBP.

CR14. Prior to project implementation, inventory WBP stands and monitor populations of Clark's nutcracker (*Nucifraga columbiana*) providing the Service with signs of caching or other indications of Clark's nutcracker presence in the project area.

CR 15. Develop a monitoring program in WBP habitat to determine regeneration and recruitment success for WBP planting areas and natural regeneration areas.

CR 16. Microsites, site edaphic variables and competition from grasses and shrubs play a key role in recruitment of WBP. Consider understanding these knowledge gaps before significant resources are invested into planting.

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Appendix A. Provisions of the Final 4(d) Rule

The final 4(d) rule for WBP identified actions necessary for the conservation and recovery of the species and included prohibited acts, as well as a limited number of exceptions to the prohibited acts (December 15, 2022; 87 FR 76882). The prohibitions and the exceptions under this 4(d) rule apply to all WBP trees and any tree parts, such as cones, tree cores, etc. Section 4(d) rules cannot and do not absolve federal agencies of their consultation requirements under the Act. Section 7(a)(2) of the Act requires federal agencies, including the Service, to ensure that any action they fund, authorize, or carry out is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of designated critical habitat of such species. As a result of these provisions in the Act, if a federal action may affect a listed species or its critical habitat, the responsible federal agency (action agency) must enter into consultation with the Service. While we state in the final 4(d) rule that forest management, restoration, and research-related activities do not pose a threat to the WBP at the species level, that does not imply these activities will never affect individuals. It is possible that an activity excepted under this section 4(d) rule may affect WBP. In other words, in excepting forest management, restoration, and research-related activities in the 4(d) rule, the Service is not stating that these activities have no effect on the species under all circumstances. Thus, while we do except forest management activities from the prohibitions under the section 4(d) rule, we cannot remove the obligation of federal agencies to consult with the Service if their forest management activities may affect WBP. As a result, this SA aims to streamline the consultation process for low levels of adverse effects to WBP resulting from federal projects that involve activities excepted under the section 4(d) rule. Below, we present the final 4(d) rule:

As discussed above under Summary of Biological Status and Threats [of the Final Rule], white pine blister rust, mountain pine beetle, altered fire regimes, and the effects of climate change are affecting the status of whitebark pine. The final 4(d) rule provides for the conservation of the species by use of protective regulations, as described here. Within the United States, the vast majority of the species' range (approximately 88 percent) is located on Federal lands. Given the reductions in resiliency that have already occurred to varying degrees across the range (Service 2021, pp. 68–83), we are applying prohibitions equivalent to those of section 9(a)(2) of the Act to the whitebark pine. Specifically, this final 4(d) rule provides for the conservation of whitebark pine by prohibiting the following activities, unless otherwise authorized or permitted (e.g., allowed for in an exception or authorized in a section 10(a)(1)(A) permit):

- Import or export of the species;
- Delivery, receipt, transport, or shipment of the species in interstate or foreign commerce in the course of commercial activity;
- Sale or offer for sale of the species in interstate or foreign commerce;
- Removal and reduction to possession of the species from areas under Federal jurisdiction;
- Malicious damage or destruction of the species on any area under Federal jurisdiction; and
- Removal, cutting, digging up, or damage or destruction of the species on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law.

These prohibitions and the exceptions described below apply to whitebark pine trees and any tree parts (such as cones, tree cores, seeds, branches, needles, etc.). The final 4(d) rule only addresses Federal requirements under the Act and does not change any prohibitions provided for by State law.

The following activities are excepted from the prohibitions identified above:

- Activities authorized by a permit under 50 CFR 17.72;
- Forest-management, restoration, or research-related activities conducted or authorized by the Federal agency with jurisdiction over the land where the activities occur;
- Removal, cutting, digging up, or damage or destruction of the species on areas under Federal jurisdiction by any qualified employee or agent of the Service or State conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with the Service in accordance with section 6(c) of the Act, who is designated by that agency for such purposes, when acting in the course of official duties; and
- Collection of whitebark pine seeds from areas under Federal jurisdiction for Tribal ceremonial use or traditional Tribal consumption if the collection is conducted by members of federally recognized Tribes and does not violate any other applicable laws and regulations.

The prohibitions in this final 4(d) rule related to removing and reducing to possession and to maliciously damaging and destroying apply only to areas under Federal jurisdiction. The prohibition related to removing, cutting, digging up, or destroying the species in other areas (i.e., areas not under Federal jurisdiction) applies only if those activities are in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law. Therefore, the exceptions to these prohibitions, other than the permitting exception, only apply to areas under Federal jurisdiction. We still encourage forest-management, restoration, and research related activities on areas outside of Federal jurisdiction such as State, private, and Tribal lands within the United States or any lands within Canada; this 4(d) rule will not alter managers' ability to conduct these activities on non-Federal lands because the 4(d) rule does not prohibit these activities in the first place (unless these activities are already prohibited by State law or regulation).

We have concluded that the whitebark pine is likely to become endangered within the foreseeable future primarily due to the continued increase in white pine blister rust infection and associated mortality, synergistic and cumulative interactions between white pine blister rust and other stressors, and the resulting loss of seed source. This fungal disease is not human-spread or influenced by human activity, and few restoration methods are currently available to restore whitebark pine in areas affected by the disease. The whitebark pine is not commercially harvested, and while some human activities could potentially affect individual trees or local areas, we found no threats at the species level resulting from forest-management activities. In fact, forest-management activities can be important to maintaining the health and resiliency of forest ecosystems that include whitebark pine.

As described in the SSA report (Service 2021, pp. 125–131), most current whitebark pine management and research focuses on producing trees with inherited (genetic) resistance to white pine blister rust, as well as implementing mechanical treatments and prescribed fire as conservation tools. As part of this process, cones may be collected from trees identified as apparently resistant to white pine blister rust, or "plus" trees. Additional areas of research involve investigating natural regeneration and silvicultural treatments, such as appropriate site selection and preparation (i.e., identifying areas where restoration will be most effective), pruning, and thinning to protect high-value genetic resources, increase reproduction, reduce white pine blister rust damage, and increase stand volume (Zeglen et al. 2010, p. 361). Conservation measures for whitebark pine can generally be categorized as either protection (of existing healthy trees and stands) or restoration (of damaged, unhealthy, or extirpated trees and stands). Inventory, monitoring, and mapping of whitebark pine stands are critical for assessing the current status and implementing strategic conservation strategies. The precise nature of management, restoration, and research activities that are conducted may vary widely across the broad range of whitebark pine, as management of this species falls under numerous jurisdictions that encompass a spectrum of local and regional ecological, climatic, and management conditions and needs.

Broadly, the forest-management, restoration, or research-related activities referred to above may include, but are not limited to, silviculture practices and forest-management activities that address fuels management, insect and disease impacts, vegetation management in existing utility rights-of-way, and wildlife-habitat management (e.g., cone collections, planting seedlings or sowing seeds, mechanical cuttings as a restoration tool in stands experiencing advancing succession, full or partial suppression of fires in whitebark pine communities, allowing fires to burn, survey and monitoring of tree health status).

Because no forest-management, restoration, or research-related activities pose any threat to the whitebark pine at the species level, we purposefully do not specify in detail what types of these activities are included in this exception, or how, when, or where they must be conducted, as long as they are conducted or authorized by the Federal agency with jurisdiction over the land where the activities occur; these activities may also vary in how they are conducted across the species' wide range. Therefore, this final 4(d) rule, and any relevant future section 7 consultations Federal agencies will conduct on their activities, will likely facilitate the continuation of forest-management, restoration, and research-related activities conducted by or authorized by relevant Federal land management agencies, as long as we reach the conclusion that these activities will not jeopardize the species, because these activities pose no threat to the whitebark pine at the species level and can contribute to the species' conservation into the future; this exception, and any relevant future section 7 consultations, also allow for flexibility to accommodate specific physical conditions, resource needs, and constraints across the species' vast range. Similarly, collection of seeds by members of federally recognized Tribes for ceremonial use or traditional consumption does not present a threat to the species. The limited amount of collection Tribal members will conduct on Federal lands in certain parts of the species' range will not have species-level impacts, especially considering that many stands of whitebark pine are inaccessible for collection. Tribes within the range of the whitebark pine are important partners in the recovery of this culturally significant species; allowing Tribes to collect whitebark pine seeds for ceremonial and traditional use will only further their commitment to and participation in whitebark pine conservation.

We may also issue permits to carry out otherwise prohibited activities, including those described above, involving threatened plants under certain circumstances. Regulations governing permits for threatened plants are codified at 50 CFR 17.72, which states that that the Director may issue a permit authorizing any activity otherwise prohibited with regard to threatened species. That regulation also states that the permit shall be governed by the provisions of section 17.72 unless a special rule applicable to the plant is provided in sections 17.73 to 17.78. On August 27, 2019, we revised section 17.71 to provide that section 17.71 will no longer apply to plants listed as threatened after September 26, 2019 (84 FR 44753). We did not intend for those revisions to limit or alter the applicability of the permitting provisions in section 17.72, or to require that every species-specific 4(d) rule spell out any permitting provisions that apply to that species and species-specific 4(d) rule. To the contrary, we anticipate that permitting provisions would generally be similar or identical for most species, so applying the provisions of section 17.72 unless a species-specific 4(d) rule provides otherwise would likely avoid substantial duplication. Moreover, this interpretation brings section 17.72 in line with the comparable provision for wildlife at 50 CFR 17.32, in which the second sentence states that the permit shall be governed by the provisions of section 17.32 unless a special rule applicable to the wildlife, appearing in sections 17.40 to 17.48, provides otherwise. Under 50 CFR 17.72 with regard to threatened plants, a permit may be issued for the following purposes: for scientific purposes, to enhance propagation or survival, for economic hardship, for botanical or horticultural exhibition, for educational purposes, or for other purposes consistent with the purposes and policy of the Act. Additional statutory exemptions from the prohibitions are found in sections 9 and 10 of the Act.

We recognize the special and unique relationship with our State natural resource agency partners in contributing to conservation of listed species. State agencies often possess scientific data and valuable expertise on the status and distribution of endangered, threatened, and candidate species of wildlife and plants. State agencies, because of their authorities and their close working relationships with local governments and landowners, are in a unique position to assist us in implementing all aspects of the Act. In this regard, section 6 of the Act provides that we shall cooperate to the maximum extent practicable with the States in carrying out programs authorized by the Act. Therefore, any qualified employee or agent of a State conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with us in accordance with section 6(c) of the Act, who is designated by his or her agency for such purposes, will be able to conduct activities designed to conserve the whitebark pine that may result in otherwise prohibited activities without additional authorization.

For the reasons discussed above, we find that this rule under section 4(d) of the Act is necessary and advisable to provide for the conservation of the whitebark pine. This final 4(d) rule enhances the conservation of whitebark pine by prohibiting activities that would be detrimental to the species, while allowing the forest-management, restoration, and research-related activities that are necessary to conserve whitebark pine; these forest management, restoration, and research-related activities maintain and restore forest health on the Federal lands that encompass the vast majority of the species' habitat within the United States. Moreover, this 4(d) rule will allow activities that do not present a threat to the species to continue; specifically, it will allow Tribes to continue collecting this culturally important species for traditional or ceremonial purposes.

However, notwithstanding the provisions in this 4(d) rule, Federal agencies must comply with relevant section 7 consultation requirements for all Federal actions, including any forest-management, restoration, or research-related activities, that may affect whitebark pine, including activities that may affect individual trees or populations. Nothing in this 4(d) rule will change in any way the recovery-planning provisions of section 4(f) of the Act, the consultation requirements under section 7 of the Act, or the ability of the Service to enter into partnerships for the management and protection of whitebark pine. However, interagency cooperation may be further streamlined through planned programmatic consultations or other tools for the species between Federal agencies and the Service.

Appendix B. WBP Restoration Target Areas

Rust-resistant (plus and elite tree identification) and WBP stands with high genetic diversity have been found on the Beaverhead-Deerlodge National Forest (Middle Rockies AU), Custer Gallatin National Forest (Middle Rockies AU), Shoshone National Forest (Middle Rockies AU), Bridge-Teton National Forest (Middle Rockies AU), Grand Teton National Park (Middle Rockies AU), Yellowstone National Park (Middle Rockies AU), Caribou-Targhee National Park (Middle Rockies AU). The following tables represent locations and administrative units for restoration target areas with high genetic variability and areas where WBP shows resistance to white pine blister rust. They also represent locations of seed-zone families. These tables are not exhaustive of all potential restoration target areas, and this SA will be updated as new restoration target areas are identified.

Table A. Restoration Target Areas and Locations of Known White Pine Blister Rust-Resistant and Genetically Variable WBP in the Greater Yellowstone Ecosystem

Location Name	Administrative Unit
West Fork Cabin	Beaverhead-Deerlodge National Forest
Hellroaring	Custer Gallatin National Forest
Daisy Pass	
Little Bear	
Fish Creek	Bridger-Teton National Forest
Stewarts Draw	Grand Teton National Forest
Blue Ridge	Shoshone National Forest
Union Pass	
Bog Lakes	
Washburn	Yellowstone National Park
Sweetgrass	BLM Montana Hauvre Field Office
Windy Pass	BLM Montana Dillon Field Office
Axolotl	
Medicine Lodge	
Upper Horse Prairie	
Commissary Ridge	BLM Wyoming Kemmerer Field Office

Table B. Restoration Target Areas and Locations of White Pine Blister Rust Seed Zone-Rust-Resistant Families in the Greater Yellowstone Ecosystem

Location Name	Administrative Unit
Jackson Hole Mountain Resort	Bridger-Teton National Forest
Pine Grove	
Lake Ridge	
Two Ocean Basin	
Dry Creek	Caribou-Targhee National Forest
Indian Meadows	
Boatman Springs	

Location Name	Administrative Unit
Grand Targhee Resort	
Picket Pin Mountain	Custer Gallatin National Forest
Mica Mine	
Wheeler Mountain	
Apex Trail	Grand Teton National Park
Stewards Draw	
Union Pass	Shoshone National Forest
Sylvan Pass	Yellowstone National Park

Table C. Restoration Target Areas and Locations of White Pine Blister Rust-Resistant Areas in the Greater Yellowstone Ecosystem

Location Name	Administrative Unit
Gravelly Range B, D, F, H, and T	Beaverhead-Deerlodge National Forest
Deadline Ridge	Bridger-Teton National Forest
Fish Creek	
Flagstaff Road	
Gunsight Pass	
Jackson Hole Mountain Resort	
Labarge Creek	
Lake Ridge	
Moccasin Basin	
Pine Grove	
Pine Grove Ridge	
Split Rock Creek	
Two Ocean Basin	
Apex Trail	Grand Teton National Forest
Boatman Springs	Caribou-Targhee National Forest
East Dry Creek	
Grand Targhee Ski Area	
Indian Meadows Trailhead	
Sawtell Mountain	
Dead Horse/Taylor	Custer Gallatin National Forest
Henderson Mountain	
Little Bear	
Mica Mine	
Miller Creek	
Picket Pin Mountain	
Wheeler Mountain	
Stewarts Draw	Grand Teton National Forest
Blue Ridge	Shoshone National Forest
Bog Lake	
Union Pass	
Lake Fishing Bridge	Yellowstone National Park

Location Name	Administrative Unit
Mary Bay	
Mount Washburn	
Shoshone Point	
Sylvan Pass	
Washburn Road	

Appendix C. Status of the Species

This appendix provides a more detailed status of the species than what is included in the body of the SA. To understand the current status of the species, we must identify specific life stages: seedling, sapling, and mature WBP are described under the following definitions of their life stages. First year seedlings are those recently germinated with no mature foliage and have not experienced a winter. The *seedling stage* of WBP is detectable when a germinated seeds reach growth between 8 and 10 cm (3 to 4 in.) tall with a 13 to 18 cm (5 to 7 in.) taproot, and 7 to 9 cotyledons (embryonic first leaves) (Arno and Hoff 1990). The WBP seedling stage is generally when the trees are between 1 and 29 years of age and are up to 1.37 m (4.5 ft), which is the height assessed at diameter at breast height (dbh)) (Tomback and Pansing 2018). *Saplings* are non-reproductive trees greater than 1.37 m (4.5 ft) in height; for WBP. The average age of reproductive maturity (*mature WBP*) is 29 to 40 years of age (Tomback and Pansing 2018). Some WBP individuals are capable of producing limited amounts of seed cones at 20–30 years of age, although large cone crops usually are not produced until 60–80 years (Krugman and Jenkinson 1974, as cited in McCaughey and Tomback 2001), with average earliest first cone production at 40 years (Tomback and Pansing 2018). Therefore, the generation time of WBP is approximately 40 to 60 years (Tomback and Pansing 2018; COSEWIC 2010). Size class data should not be used as a surrogate for determining the age class of a WBP tree. Larson and Kipfmueller (2012) found small subalpine fir trees occurring below the WBP trees that visually appeared to be young saplings were more than 100 years of age.

1. Taxonomy

The WBP is a five-needle conifer species placed in the subgenus *Strobus,* which also includes other five-needle white pines. This subgenus is further divided into two sections (*Strobus* and *Parrya*), and under section *Strobus,* into two subsections (*Cembrae* and *Strobi*). *Strobus* sp have five-needled fascicles, wingless seeds, and cones that remain closed at maturity (Lanner, 1990). Stone pines are morphologically defined by wingless seeds and cones that remain closed at maturity, retaining their seeds within (Lanner, 1990). The traditional taxonomic classifications placed WBP in the subsection *Cembrae* with four other Eurasian stone pines (Critchfield and Little 1966; Lanner 1990). However, recent phylogenetic studies (Liston *et al.* 1999; Syring *et al.* 2005, 2007; as cited in Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2010) showed no difference in monophyly (ancestry) between subsection *Cembrae* and subsection *Strobi* and merged them to form subsection *Strobus.* No taxonomic subspecies or varieties of WBP are recognized (COSEWIC 2010). Based on this taxonomic classification information, we recognize WBP as a valid species.

2. Life History

There are four stages in the life cycle of the WBP: seed, seedling, sapling, and mature trees (*i.e.*, reproductive mature trees). Seeds are produced in female cones and may take 2 years or more (up to 11 years) to germinate. Germinated seeds become seedlings that are between 8 and 10 centimeters (cm) (3 to 4 inches) (in.) tall with a 13 to 18 cm (5 to 7 in.) taproot with 7 to 9 cotyledons (embryonic first leaves) (Arno and Hoff 1990). WBP seedlings are generally between one and 29 years of age and, on average, are 1.37 m (4.5 ft), which is the height assessed at dbh (Tomback and Pansing 2018). WBP seedlings have highly variable survival rates; seedlings originating from nutcracker caches ranged from 56 percent survival over the first year to 25 percent survival by the fourth year (Tomback 1982). Seedlings of WBP may persist for multiple years, depending on growing conditions, until reaching the sapling stage of the life cycle. Saplings are non-reproductive trees greater than 1.37 m (4.5 ft) in height; for WBP, the average age of reproductive maturity is 29 to 40 years of age (Tomback and Pansing 2018). Saplings of WBP persist for few to many years, depending on growing conditions, until they produce male and female cones and are considered reproductive at approximately 60 years of age. Some WBP individuals are capable of producing limited amounts of seed cones at 20 to 30 years of age, although large cone crops usually are not produced until 60 to 80 years (Krugman and Jenkinson 1974, as cited in McCaughey and Tomback 2001), with average earliest first cone production at 40 years (Tomback and Pansing 2018). Therefore, the generation time of WBP is approximately 40 to 60 years (Tomback and Pansing 2018; COSEWIC 2010). Mature WBP trees require two summers of suitable temperatures and precipitation for fertilized cones to mature (Rapp *et al.* 2013). Years with high seed production (mast years) typically occur once every three to five years; however, that time interval can vary by geographic location and health condition of the stand (McCaughey and Tomback 2001). After such a masting year, each individual WBP is depleted of nitrogen and phosphorus and so those nutrients must be replaced during the three to five years between masting events (Sala *et al.* 2012). Mature reproductive WBP trees contain both female and male cones (*i.e.*, monoecious reproduction), and can survive on the landscape for hundreds of years.

The WBP is the only stone pine (so-called for their stone-like seeds) in North America of the five species worldwide (McCaughey and Schmidt 2001). Characteristics of stone pines include five needles per cluster, indehiscent seed cones (scales remain essentially closed at maturity) that stay on the tree, and wingless seeds that remain fixed to the cone and cannot be dislodged by the wind. Because WBP seeds cannot be wind disseminated, primary seed dispersal occurs almost exclusively by Clark's nutcrackers in the avian family Corvidae (whose members include ravens, crows, and jays) (Lanner 1996; Schwandt 2006). Consequently, Clark's nutcrackers facilitate WBP regeneration and influence its distribution and population structure through their seed caching activities (Tomback *et al.* 1990).

The WBP may occur as a climax species, early successional species, or seral (mid-successional stage) codominant associated with other tree species. Although it occasionally occurs in pure or nearly pure stands at high elevations, it more typically occurs in stands of mixed species in a variety of forest community types. WBP is typically 5 to 20 m (16 to 66 ft) tall with a rounded or irregularly spreading crown shape. On higher density conifer sites, WBP tends to grow as tall, single-stemmed trees, whereas on open, more exposed sites, it tends to have multiple stems (McCaughey and Tomback 2001). Above the tree line, it grows in a krummholz form (stunted, shrub-like growth) (Arno and Hoff 1989). Production of male and female cones in mature trees will begin sometime from June to September depending on environment (McCaughey and Tomback 2001; Sala *et al.* 2012). Female cones take 2 years to fully develop (Weaver 2001). Its characteristic dark brown to purple seed cones are 5 to 8 cm (2 to 3 in.) long and grow in clusters of 2 to 4 cones at the outer ends of upper branches (Hosie 1969).

Considered a keystone, or foundation species in western North America, WBP it increases biodiversity and contributes to critical ecosystem functions (Tomback *et al.* 2001). As a pioneer or early successional species, it may be the first conifer to become established after disturbance, subsequently stabilizing soils and regulating runoff (Tomback *et al.* 2001). At higher elevations, snow drifts around WBP trees, thereby increasing soil moisture, modifying soil temperatures, and holding soil moisture later into the season (Farnes 1990). These higher elevation trees also shade, protect, and slow the progression of snowmelt, essentially reducing spring flooding at lower elevations. The WBP also provides nutritious seeds for a number of birds and mammals (Tomback *et al.* 2001).

3. Population Dynamics, Status and Distribution

The WBP has persisted in high elevation sites in western North America for the past 8,000 years (McCaughey and Schmidt, 2001). WBP has a broad range both latitudinally (occurring from approximately 36 degrees in south California to 55 degrees north latitude in British Columbia, Canada) and longitudinally (occurring from approximately 128 degrees in British Columbia, Canada to 108 degrees east in Wyoming). For the SSA, we developed an updated WBP range map based on the best available occurrence and distribution data (Figure 2 of the SA). This range map is at a coarse scale but encompasses the known distribution of the species' occurrences.

The WBP typically occurs on cold and windy high-elevation or high-latitude sites in western North America, although it also occurs in scattered areas of the warm and dry Great Basin. As a result, many stands are geographically isolated (Arno and Hoff 1989; Keane *et al.* 2010). The distribution of WBP includes coastal and Rocky Mountain ranges that are connected by scattered populations in northeastern Washington and southeastern British Columbia (Arno and Hoff 1990; Keane *et al.* 2010). The coastal distribution of WBP extends from the Bulkley Mountains in northwestern British Columbia to the northeastern Olympic Mountains and Cascade Range of Washington and Oregon, to the Kern River of the Sierra Nevada Range of east-central California (Arno and Hoff 1990). Isolated stands of WBP are known from the Blue and Wallowa Mountains in northeastern Oregon and the subalpine zone of mountains in northeastern California, south-central Oregon, and northern Nevada (Arno and Hoff 1990; Keane *et al.* 2010). The Rocky Mountain distribution of WBP ranges from northern British Columbia and Alberta to Idaho, Montana, Wyoming, and Nevada (Arno and Hoff 1990; Keane *et al.* 2010), with extensive stands occurring in the Yellowstone ecosystem (McCaughey and Schmidt 2001).

In general, the upper elevational limits of WBP decrease with increasing latitude throughout its range (McCaughey and Schmidt 2001). The elevational limit of the species ranges from approximately 900 m (2,950 ft) at its northern limit in British Columbia to 3,660 m (12,000 ft) in the Sierra Nevada (McCaughey and Schmidt 2001). WBP is typically found growing at the subalpine treeline or with other high-mountain conifers just below the treeline and subalpine zone (Arno and Hoff 1990; McCaughey and Schmidt 2001). In the Rocky Mountains, common associated tree species include lodgepole pine (*P. contorta* var. *latifolia)*, Engelmann Spruce (*Picea engelmannii)*, subalpine fir (*Abies lasiocarpa)*, and mountain hemlock (*Tsuga mertensiana)*. Common associated tree species are similar in the Sierra Nevada and Blue and Cascade Mountains, except lodgepole pine is present as Sierra-Cascade lodgepole pine (*P.*

contorta var. murrayana) and mountain hemlock is absent from the Blue Mountains (Arno and Hoff 1990; McCaughey and Schmidt 2001).

Rangewide, WBP occurs on an estimated 32,616,422 ha (80,596,935 ac) in western North America (Figure 2 of the SA). Roughly 70 percent of the species' range occurs in the United States, with the remaining 30 percent of its range occurring in British Columbia and Alberta, Canada (USFWS 2018). In Canada, the majority of the species' distribution occurs on federal or provincial crown lands (COSEWIC 2010). In the United States, approximately 88 percent of land where the species occurs is federally owned or managed (Figure 2 of the SA). The majority is located on USFS lands (approximately 74 percent, or 17,391,455 ha (42,975,220 ac)). The bulk of the remaining acreage is located on NPS lands (approximately 10 percent, or 2,275,746 ha (5,623,490 ac)). Small amounts of WBP also can be found on BLM lands (approximately 4 percent, or 1,002,152 ha (2,476,371 ac)). The remaining 12 percent of the range is under non-federal ownership, on State, private, and Tribal lands. In the United States, 29 percent of the range is designated as wilderness under the Wilderness Act of 1964 (16 U.S.C. 1131-1136). This designation limits management options and conservation efforts in those areas to some degree.

Populations are typically defined by the potential for genetic exchange among their members, to the exclusion of members of other populations (in the absence of immigration or emigration). For WBP, genetic exchange is limited by the dispersal distance of pollen, which is carried by wind, and the seed caching behavior of Clark's nutcracker (Lorenz *et al.* 2011; Keane *et al.* 2017b). Both pollen dispersal and Clark's nutcracker seed dispersal can occur at a scale of few to many kilometers (km) (*e.g.*, up to 30 km in the case of Clark's nutcracker seed dispersal). To promote a greater than 75 percent probability of occurrence of Clark's nutcracker at a site, recommended management plans that achieves landscape composition of a minimum 12,500-25,000 ha of cone bearing WBP habitat within a 32.6-km radius. The optimal Clark's nutcracker habitat mosaic includes moderate levels of Douglas-fir habitat (Douglas-fir seeds are another important food source for Clark's nutcracker in the GYE) (Schaming 2016 and Schaming and Sutherland 2020). WBP is a long-lived species that exhibits masting, where years of high seed production are synchronized within a population approximately every 3 to 5 years (McCaughey and Tomback 2001). This masting strategy is an adaption to heavy seed predation; during masting years seed consumers are satiated, resulting in excess seeds that escape predation (Lorenz *et al.* 2008). WBP populations need a certain density of reproductive individuals to produce sufficient pollen clouds that facilitate the synchronization of masting, and thus increased probability of regeneration (Rapp *et al.* 2013).

4. Conservation Actions and Restoration Strategies

Most current management and research focus on producing and planting white pines (including WBP) with genetic resistance to white pine blister rust, but also include natural regeneration (e.g., those areas identified in Appendix B, Tables A, B, and C) and silvicultural treatments, such as appropriate site selection and preparation, pruning, and thinning (Zeglen *et al.* 2010). Genetic management of white pine blister rust is actively conducted for several five-needle white pine species breeding programs (Sniezko 2016, Mahalovich 2015, Mahalovich 2010, Shelley 2016) including the USFS resistance screening programs for WBP. High-elevation pines such as WBP also present management challenges to restoration due to remoteness, difficulty of access, a perception that some WBP restoration activities conflict with wilderness values, and variable implementations of wilderness management within and amongst federal land management agencies (Schwandt *et al.* 2010). Furthermore, the vast scale at which planting rust-resistant trees would need to occur, in addition to limited funding and resources, will make it challenging to restore WBP throughout its range. One estimate indicates that if planting continues at its current pace, it will take over 5,000 years to cover just 5 percent of the range of WBP (Mahalovich, *in litt.*). Although current planting efforts may be sufficient to restore WBP at some local levels, the current rates appear to be insufficient to restore WBP on a scale large enough to ensure its continued viability.

Most current management and research focus on producing WBP with inherited (genetic) resistance to white pine blister rust, as well as implementing mechanical treatments and prescribed fire as conservation tools. Additional research investigates natural regeneration and silvicultural treatments, such as appropriate site selection and preparation, pruning, and thinning in order to protect high-value genetic resources, increase reproduction, reduce white pine blister rust damage, and increase stand volume (Zeglen *et al.* 2010). Conservation measures for WBP can generally be categorized as either protection (of existing live trees and stands) or restoration (of damaged, unhealthy, or extirpated trees and stands). Inventory, monitoring, and mapping of WBP stands are critical for assessing the current status and implementing conservation strategies. Each of these strategies is described in more detail below.

4.a. *Protection*

Protection measures are usually employed at the individual tree level to guard critical sources of rust-resistant genotypes (*i.e.*, "plus" trees) from the threats of white pine blister rust, mountain pine beetles, seed predation, and wildfire. While no measures are known to protect against white pine blister rust infection, infected branches (flagging) can be pruned from the tree to delay or prevent further infection or mortality of the tree. High-value trees can be protected from mountain pine beetle attack by application of insecticides or anti-aggregation pheromones. Carbaryl is a highly effective synthetic insecticide that is sometimes used for this purpose, but requires either locations with vehicle access, or pack animals to access more difficult to reach locations. Verbenone is a commonly used anti-aggregation pheromone that can offer short-term effectiveness for preventing mass beetle attacks on and around high value trees and has multiple delivery methods for both tree and stand level applications. However, its effectiveness can be overwhelmed during extreme epidemics (Progar 2005; Progar *et al.* 2013). Cones slated for collection from "plus" trees are routinely protected from seed predation by American red squirrels (*Tamiasciurus hudsonicus*) and Clark's nutcrackers by wrapping cone bundles in wire mesh (hardware cloth) cages early in the growing season. These must be installed by certified tree climbers, or if feasible, by a boom and bucket truck, and thus this activity can be costly and time-consuming, yet it remains highly effective and the only proven method to protect valuable natural sources of rust-resistant seed. Protecting individual trees from wildfire involves removal of ladder fuels from a specified distance around the tree (daylighting). In the past, attempts to protect individual trees by wrapping them in fire shelter material proved ineffective (Keane and Parsons 2010; Keane *et al.* 2012).

4.b. Propagation, Screening and Planting

Ensuring future generations of WBP are genetically resistant to white pine blister rust is the most critical action for achieving long-term recovery of this species (Mahalovich and Dickerson 2004; Perkins *et al.* 2016). Genetic management of white pine blister rust is actively conducted for WBP, including the USFS white pine blister rust resistance screening programs (Mahalovich 2016; Sniezko 2016). Seeds and pollen sourced from plus trees or elite trees are used for screening and selective breeding for white pine blister rust resistance (not immunity), molecular genetics studies, assessing levels of inbreeding, growing compatible rootstock for grafting in seed orchards, clone banking and gene conservation, and identifying genetic macro-refugium (Mahalovich 2016; Perkins *et al.* 2016; Sniezko 2016).

Eventually, the long-term goal is to establish WBP seed orchards in situ across the spectrum of WBP habitat to provide reliable and accessible sources of genetically resistant seed (Mahalovich 2017). Scions (*i.e.*, living branches) taken from trees with proven genetic resistance to white pine blister rust are grafted onto established root stocks, enabling them to develop the capability to produce cones much sooner than the time required for out planted seedlings to reach reproductive maturity (approximately 60 years).

Seeds from cone collections in the northwest (*i.e.*, Washington, Oregon) are now stored at the United States Department of Agriculture (USDA) National Center for Genetic Resources Preservation in Fort Collins, Colorado for long-term ex situ gene conservation (Sniezko and Kegley 2017). Seven separate white pine blister rust screening trials are occurring at the USFS Coeur d'Alene Nursery in Idaho using over 100,000 seedlings (Mahalovich 2016, 2017).

4.c. Fuel Reduction Treatment

Silvicultural practices, such as thinning, are frequently employed to treat existing stands of WBP to modify surface and ladder fuels and improve their chances of surviving fire. Table D of Appendix C describes the silvicultural and restoration activities in WBP habitat within Montana between 2009 and 2021 and Wyoming between 1991 and 2020. Most thinning treatments are designed to mimic non-lethal mixed-severity fire (Keane and Arno 2001), reduce or eliminate competition from other conifer species such as subalpine fir (*Abies lasiocarpa*), and to increase regeneration space for potentially rust-resistant seedlings. Approaches include creating openings wherein all trees except live WBPs are cut within a 1- to 5-ac opening to provide open growing space for WBP regeneration and existing WBP trees (Keane and Arno 2001; Keane and Parsons 2010); thinning of all non-WBP trees below a certain diameter (Chew 1990); and fuel enhancement treatments where other competing trees are directionally felled to modify fire behavior and reduce fire intensity (Keane and Arno 2001; Keane and Parsons 2010). Reducing tree density within WBP stands may result in increased vigor (*i.e.*, growth rate) of remaining sapling to mature-class trees (Keane *et al.* 2007; Retzlaff *et al.* 2018); however, counterintuitively, increased WBP vigor may not impart increased resistance to mountain pine beetle, as some evidence suggests that mountain pine beetles select faster growing trees for attack (Six *et al.* 2021). In addition to or in place of treating fuels within WBP stands, managers should consider conducting fuel reduction treatments in non-WBP stands adjacent to WBP, thereby reducing the intensity of fire as it moves from the adjacent stand into the WBP stand.

Table D. Previous silvicultural and restoration activities in WBP range in Montana and Wyoming. The acres listed represent the total acres for the project, not acres of WBP treated, as WBP was not the target species for these projects.

Project Type	Acres of Habitat Affected	Date	State of Occurrence
Salvage/Timber Harvest (Insects/Disease)	100	1991	WY
Salvage (Insects and Disease)	70	1993	WY
Salvage (Insects and Disease)	335	2002	WY
Prescribed Fire (Fuels Management)	52	2004	WY
Highway Construction	150	2004	WY
Timber Harvest, Noxious Weed Treatment, Prescribed Fire	4	2005	WY
Timber Harvest /Insecticide and Pheromone Application	226	2006	WY
Timber Harvest/Prescribed Fire/Salvage	985	2007	WY
Timber Harvest/Prescribed Fire (Fuels Reduction)	1795	2008	WY
Timber Harvest (Fuels Reduction)	82	2010	WY
Timber Harvest/ Prescribed Fire	893	2013	WY
Timber Harvest/Prescribed Fire	1206	2015	WY
Timber Harvest	361	2018	WY
Highway Construction	162	2018	WY
Timber Harvest/ Prescribed Fire	477	2019	WY
Timber Harvest	13,247	UNK	WY
Prescribed Fire	2,445	UNK	WY
Compacting/Crushing, Piling, and Lop and Scattering of fuels	1,881	UNK	WY
Tree Planting (multiple species)	665	UNK	WY
Precommercial thinning	2,332	UNK	WY
WBP Tree Planting	2,174	UNK	WY
Highway Construction	130	2013-2020	MT
Burning of Piled Material		2013-2020	MT
Cone Collection		2013-2020	MT
Cones, Seed, Fruit or Cutting Collection for Gene Conservation	101	2013-2020	MT
Evaluation Plantation Examination/ Measurement	44	2013-2020	MT
Fill-in or Replant Trees	111,800	2009-2012	MT
Fill-in or Replant Trees	884,900	2013-2021	MT
Genetic Evaluation Plantation Establishment	78	2013-2020	MT
Genetic Evaluation Plantation Operations	10	2013-2020	MT
Genetic Test Maintenance	1,169	2013-2020	MT
Insect Control	885	2013-2020	MT
Insect Prevention	13	2013-2020	MT

Project Type	Acres of Habitat Affected	Date	State of Occurrence
Leave Tree Protection	173	2013-2020	MT
Piling of Fuels, Hand or Machine	4,109	2013-2020	MT
Plant Trees		2013-2020	MT
Pollen Collection from Elite Trees	844	2013-2020	MT
Precommercial Thin	36	2013-2020	MT
Rearrangement of Fuels		2013-2020	MT
Scion Collection from Elite Trees	10	2013-2020	MT
Seed (Trees)		2013-2020	MT
Seed Collection from Plus/Elite Trees	14	2013-2020	MT
Seed Orchard Establishment / Improvements	86	2013-2020	MT
Seed Orchard Operations	209	2013-2020	MT
Seed Production Area Cone Collection		2013-2020	MT
Selection and Care of Plus/Elite Trees	7	2013-2020	MT
Clone Bank Establishment/Improvements	30	2013-2020	MT
Breeding Orchard Establishment/Improvements	13	2013-2020	MT
Site Preparation for Planting - Manual	15	2013-2020	MT
Slashing - Pre-Site Preparation	431	2013-2020	MT
Tree Release and Weed	147	2013-2020	MT
Two-aged Seed-tree Seed and Removal Cut (w/res) (2A/RH/FH)	1,981	2013-2020	MT
Underburn - Low Intensity (Majority of Unit)	770	2013-2020	MT
Wildlife Habitat Prescribed fire	20	2013-2020	MT
Yarding - Removal of Fuels by Carrying or Dragging		2013-2020	MT

4.d. Proactive Intervention

Many restoration approaches target stands that have already experienced high impacts from the primary stressors. However, in stands where white pine blister rust has yet to take a strong hold, proactive management may offer a means to prepare and protect existing live stands from impending impacts of white pine blister rust. This approach is premised on the concept of actively facilitating evolutionary change in WBP to improve its resiliency on the landscape in the persistent presence of white pine blister rust (Schoettle and Sniezko 2007). Strategies to improve healthy stands of WBP include managing stand composition, diversifying age class structures, increasing tree vigor, and promoting natural regeneration and introducing rust-resistant stock onto the landscape in healthy stands, utilizing some of the techniques described above (*e.g.*, thinning, burning) (Schoettle and Sniezko 2007). Healthy stands of WBP are more responsive to management actions, thereby increasing the available management options in a proactive approach (Keane and Schoettle 2011). This proactive approach has been implemented recently in the southern Rocky Mountains within the range of other high-elevation 5-needle pines that are also susceptible to white pine blister rust (Keane and Schoettle 2011). More recently, a framework has been developed to help guide implementation of this strategy in remaining live stands of WBP, particularly in the southern and southwestern portions of its range (Schoettle *et al.* 2018). As WBP has declined precipitously throughout much of its range, it will be important to implement proactive intervention in remaining live stands to retain the resiliency of the species.

4.e. Inventory, Mapping, and Monitoring

Inventory of existing WBP stands is crucial for determining where to most effectively direct conservation and restoration efforts. In the past, forest inventories were generally focused in lower-elevation commercial stands that rarely included WBP. Mapping of WBP occurrences is also an important aspect of the inventory process, particularly in light of the species' decline and outright loss in some areas of its historical range. In the past, broad-scale mapping efforts were conducted with myriad agency standards and objectives, leading to range maps that were either inaccurate or generally ambiguous. Modern modeling efforts have attempted to refine range maps based on site potential for supporting WBP, but often lack ground-truth data in some areas to corroborate or refine the modeled results. Post-fire monitoring is also important for understanding the response of WBP to increased fire frequencies and severity throughout its range. Additionally, monitoring annual survivorship of plantings can help guide adaptive restoration strategies by helping to refine out-planting techniques, identify superior parentage of seedling stock, and ensure stocking level goals are met. Permanent, long-term monitoring plots are also necessary to document and understand gradual changes in response to treatments, natural disturbances, and climate change effects in WBP habitats.

5. Stressors

5.a. White Pine Blister Rust

White pine blister rust is a disease of five-needle pines (*Pinus spp*.) caused by a nonnative fungus, *Cronartium ribicola* (Geils *et al.* 2010). While white pine blister rust occurs throughout the entire WBP range, not all trees are infected and infection rates vary widely. Furthermore, it can be difficult to detect white pine blister rust, especially if cankers occur on gnarled canopy branches where infections may remain undetected (Rochefort 2008). The fungus was inadvertently introduced into western North America around 1910 near Vancouver, British Columbia from eastern white pine nursery stock imported from Europe (McDonald and Hoff 2001). White pine blister rust initially spread rapidly through coastal and montane environments, which have environmental conditions more conducive to spread of infection, but over the last several decades, it has also spread through continental and alpine environments throughout western North America (Geils *et al.* 2010). White pine blister rust's rate and intensity of spread is influenced by microclimate and other factors (described below). Therefore, the incidence of white pine blister rust at stand, landscape, and regional scales varies due to time since introduction and environmental suitability for its development. It continues to spread into areas originally considered less suitable for infection, and it has become a serious threat, causing severe population losses to several species of western pines, including WBP, western white pine (*P. monticola)*, and sugar pine (*P. lambertiana* Dougl.) (Schwandt *et al.* 2010). Its current known geographic distribution in western North America includes all U.S. States and British Columbia and Alberta, Canada within the range of WBP. The highest incidence of white pine blister rust infection is in the northern U.S. and southern Canadian Rocky Mountains (Schwandt *et al.* 2010; Tomback *et al.* 2001).

The white pine blister rust fungus has a complex life cycle. It does not spread directly from one tree to another, but alternates between primary hosts (*i.e.*, five-needle pines) and alternate hosts. Alternate hosts in western North America are typically woody shrubs in the genus *Ribes* (gooseberries and currants) but also may include herbaceous species of the genus *Pedicularis* (lousewort) and the genus *Castilleja* (paintbrush) (McDonald and Hoff 2001; McDonald *et al.* 2006). White pine blister rust progresses through five spore stages to complete each generation: two spore stages occur on five-needled pines, and three stages occur on an alternate host. The five fungal spore stages require specific temperature and moisture conditions for production, germination, and dissemination. The spreading of spores depends on the distribution of hosts, the microclimate, and the different genotypes of white pine blister rust and hosts (McDonald and Hoff 2001). Local meteorological conditions also may be important factors in infection success, infection periodicity, and disease intensity (Jacobi *et al.* 2010).

On five-needle pines, spores enter through openings in the needle surface, or stomates, and move into the twigs, branches, and tree trunk, causing swelling and cankers to form. White pine blister rust attacks seedlings, saplings, and mature trees, initially damaging upper canopy and cone-bearing branches and restricting nutrient flows; it eventually girdles branches and trunks, leading to the death of branches or the entire tree (Tomback *et al.* 2001; McDonald and Hoff 2001). White pine blister rust can kill small trees within 3 years, and even one canker can be lethal. While some infected mature trees can continue to live for decades, their cone-bearing branches typically die first, thereby eliminating the seed source required for reproduction (Geils *et al.* 2010). In addition, the inner sapwood moisture decreases, making trees prone to desiccation and secondary attacks by insects (Six and Adams 2007). Death to upper branches results in lower or no cone production and a reduced likelihood that seed will be dispersed by Clark's nutcrackers (McKinney and Tomback 2007). Similar to a total loss of cone production, even when cone production is low there could be a loss of regeneration for two reasons: (1) Clark's nutcrackers abandon sites with low seed production and (2) the proportion of seeds taken by predators becomes so high that few seeds remain for regeneration (COSEWIC 2010).

Because its abundance is influenced by weather and host populations, white pine blister rust also is affected by climate change. If conditions become moister, white pine blister rust will likely increase; conversely, where conditions become both warmer and drier, it may spread more slowly. Because host infection occurs through the stomates, whatever affects the stomates affects infection rates (Kliejunas *et al.* 2009). Stomates close in drought conditions and open more readily in moist conditions. In general, weather conditions favorable to the intensification of white pine blister rust occur more often in climates with coastal influences than in dry continental climates (Kendall and Keane 2001). White pine blister rust now infects WBP populations throughout all of its range.

5.b. Fire Regimes

Fire is one of the most important landscape-level disturbance processes within high-elevation WBP forests (Agee 1993; Morgan and Murray 2001; Spurr and Barnes 1980) and is relevant to

WBP both as a stressor that can cause mortality of all life stages of WBP and as a mechanism that may affect forest succession (Arno 2001; Shoal *et al.* 2008; Keane and Parsons 2010). Although WBP has been described as fire-adapted, there is uncertainty surrounding the specifics of these adaptations, including the species' ability to survive fires of differing intensity, the role of low-severity fire, and how fire suppression interacts with fire return intervals to affect forest succession across the range of WBP.

Fire regimes in WBP systems are often characterized as being of mixed severity (Arno *et al.* 2000; Arno 2001, Campbell and Antos 2003; Larson *et al.* 2009). However, some WBP systems are dominated by high-severity fire events (Romme 1982; Campbell and Antos 2003). Low-severity surface fires may also occur in WBP stands, particularly at higher elevations (Barrett 1994). Clark's nutcracker ecology provides further insight into the typical fire regime in WBP ecosystems. The Clark's nutcracker serves as the main dispersal agent for WBP (Tomback *et al.* 2001). Eighty-five percent of the WBP seeds cached are above ground in the trunks of live trees. In most cases Clark's nutcracker avoids caching seeds in forest openings (Brodin and Clark 2007; Lorenz 2011; Lorenz et al 2012. Clark's nutcrackers have been found dispersing seeds farther than the wind-dispersed seeds of other conifers, allowing for the establishment of WBP seedlings in the interior of large patches of high severity fire effects and over broad geographic areas (McCaughey *et al.* 1985; Tomback *et al.* 1990, 1993 in Keane and Parsons 2010). To promote a greater than 75 percent probability of Clark's nutcracker occurrence at a site containing WBP, the landscape composition must contain a minimum 12,500 to 25,000 ha cone bearing WBP within a 32.6-km radius (Schaming and Sutherland 2020). Clark's nutcrackers feed equally on Douglas-fir seeds and WBP seeds, so the optimal habitat mosaic includes moderate levels of Douglas-fir habitat (Schaming 2016).

Although some experts have suggested that WBP is phenotypically adapted to survive low-intensity fire, Stevens *et al.* (2020) found that WBP had relatively thin bark compared to other conifer species and, based on a systematic ranking of numerous traits associated with fire resistance in western conifers, WBP was found to have one of the lowest fire resistance scores of the 29 conifers examined in the study. Others have also observed that WBP trees can be sensitive to bole (main steam of the tree) scorching, resulting in cambium injury or death, even from low-intensity fire (Hood *et al.* 2008). Keane *et al.* (2020) noted several recent reports of prescribed fire and low-intensity fire killing WBP trees, despite pre-fire site preparation activities implemented to reduce or modify surface and ladder fuels and protect the residual WBP trees. Keane and Parsons (2010) studied the effects of seven different fuel treatment combinations on WBP at five treatment sites in Montana and Idaho and found that WBP mortality from low-intensity fire was comparable to subalpine fir under all treatment combinations. As a result, empirical evidence shows that low-intensity fire in WBP can result in higher-severity fire effects. In summary, although it is clear that WBP individuals are capable of surviving some low-intensity fire, based on the presence of multiple fire scars in some areas, the biotic and abiotic (*i.e.*, terrain, weather, and fuel) conditions under which the species is most likely to survive such fires remain largely unknown.

Determining if periodic fire is necessary to maintain ecosystem integrity in WBP systems may be as important as understanding the conditions under which WBP trees are most likely to survive fire. Experts have suggested that, without periodic low-severity fire in some subalpine forests where WBP co-occurs with subalpine fir and Engelmann spruce, successional pathways can lead to climax communities dominated by these shade-tolerant conifers and the loss of WBP (Arno 1980; Arno 2001; Keane et l. 2017; Keane and Parsons 2010; Flanagan *et al.* 1998). It has further been suggested that, in these WBP systems, fire suppression policies over the past 90 years have resulted in WBP declines due to succession to subalpine fir and Engelmann spruce (Arno 1980; Arno 2001; Keane *et al.* 2017; Keane and Parsons 2010; Flanagan *et al.* 1998). This is supported by the presence of multiple fire scars in WBP trees at some locations, which shows they are capable of surviving repeated low-intensity fires and maintaining dominance or co-dominance in stands for long-periods of time when these fires are occurring periodically (Morgan and Bunting 1990, Barrett 1994). Additional support for the successional theory is based on documented densification of subalpine fir and Engelmann spruce in stands where WBP was once prevalent (Hartwell *et al.* 1997; Arno *et al.* 1993 in Keane *et al.* 1994; Flanagan *et al.* 1998). However, in these studies, the authors noted that the densification of and succession to subalpine fir and Engelmann spruce co-occurred with WBP mortality caused by bark beetle outbreaks and/or blister rust; therefore, disentangling the effects of blister rust- and bark beetle-mortality on succession from the effects of fire suppression in these studies is difficult.

The idea that fire suppression in some whitebark systems has resulted in densification and loss of WBP has been a predominant theory in the WBP literature (Arno 1980; Arno 2001; Keane *et al.* 2017; Keane and Parsons 2010; Flanagan *et al.* 1998). However, some have recently called into question the idea that fire suppression has led directly to forest succession and the loss of WBP. For example, Larson and Kipfmueller (2012) suggested there is uncertainty in the effects of fire suppression on WBP and a relative lack of data supporting the hypothesis. Larson and Kipfmueller (2012) noted that age structure data in their study showed that many of the small subalpine fir trees occurring below the WBP, trees that visually appeared to be young saplings, were more than 100 years of age, suggesting that size class data should not be used as a surrogate for tree age or to determine the rate of succession. Campbell and Antos (2003) also noted that successional patterns in WBP forests are more complex than others have reported, finding that subalpine fir readily established after fire in their British Columbia study areas, and although subalpine fir density was increasing in older WBP stands with relatively open canopies, they estimated that succession to subalpine fir would take more than 500 years. Campbell and Antos (2003) reported that WBP in their study area was stress-tolerant (able to persist under conditions that restrict production), was capable of surviving long periods of suppressed growth, and was able to release upon reaching the main canopy after more than 150 years of low growth rates. The results of these studies indicate that the loss of WBP due to succession to subalpine fir and Engelmann spruce in some areas may be an extremely slow process and that WBP may be more shade-tolerant and resilient to suppression than previously suggested.

The broad range of fire return intervals in WBP ecosystems further complicates theories that fire suppression has caused succession in WBP systems. Fire history studies in WBP forests have identified fire return intervals ranging from 33 years (Morgan and Bunting 1990) to greater than 400 years (Campbell and Antos 2003). Several authors have noted that mean fire return intervals in subalpine forests that include WBP can be much longer than contemporary fire suppression policies (Dolanc *et al.* 2013; Meyer and North 2019; Sibold *et al.* 2006). Over an 80-year period, Dolanc *et al.* (2013) documented an increase in the number of small diameter trees, including WBP, in subalpine forests of the central Sierra Nevada. However, Dolanc *et al.* (2013)

attributed the densification of small trees in their study areas to climate warming, which they suggested may be moderating extreme temperatures and reducing snowpack, thereby providing better growing conditions for small trees. Dolanc *et al.* (2013) did not attribute the observed densification of small trees to fire suppression, because fire suppression policies have only been in effect for 75 to 100 years, which was a relatively short period of time compared to the fire return intervals of subalpine forests in their study areas (Dolanc *et al.* 2013). Moreover, despite the presence of late successional species in the WBP stands, Larson *et al.* (2009) found that the time since the last widespread fire and stand age structure in two of the three WBP stands in their study area were within the historical fire return interval for the sites. Thus, although fire suppression undoubtedly impacts WBP stands, it is unclear under what conditions fire suppression begins to negatively affect WBP systems and the rate at which succession occurs in those systems.

Despite adaptations that allow WBP to recolonize areas that experience high-severity fire effects, the ability of WBP to regenerate and reestablish following high-severity fire has been disrupted by white pine blister rust in many areas. This novel stressor makes the species more vulnerable to the impacts of fire. Blister rust has killed many mature WBP trees, effectively reducing or eliminating WBP seed sources. The presence of blister rust also reduces WBP seedling survival, which significantly reduces the species' ability to regrow in fire-created openings that were formerly ideal for seedling establishment.

5.c. Mountain Pine Beetle

WBP trees are fed upon by a variety of insects; however, none has had a more widespread impact than the native mountain pine beetle. The mountain pine beetle is recognized as one of the principal sources of WBP mortality (Raffa and Berryman 1987; Arno and Hoff 1989). Mountain pine beetles feed on WBP and other western conifers and to successfully reproduce the beetles must kill host trees (Logan and Powell 2001; Logan *et al.* 2010). Upon locating a suitable host (*i.e.*, large diameter tree with sufficient resources for brood production success), adult female mountain pine beetles emit pheromones that attract adult males and other adult females to the host tree. This attractant pheromone initiates a synchronized mass attack for the purpose of overcoming the host tree's defenses to mountain pine beetle predation. Once a tree has been fully colonized, the beetles produce an anti-aggregation pheromone that signals to incoming beetles to pass on to nearby unoccupied trees. Almost all host trees, even stressed individuals, will mount a physiological defense against these mass attacks. However, given a sufficient number of beetles, even a live tree's defensive mechanisms (*e.g.*, oleoresin and volatile organic compounds emission, mobilization of resin flow, additional formation of resin directed towards the sites of beetle activity (Bohlmann, 2012)) can be exhausted (Raffa and Berryman 1987). Following the pheromone-mediated mass attack, male and female mountain pine beetles mate in the phloem (living vascular tissue) under the bark of the host tree. Females subsequently excavate vertical galleries where they lay eggs. Larvae hatched from these eggs feed on the phloem, pupate, and emerge as adults to initiate new mass attacks of nearby suitable trees (Gibson *et al.* 2008). Mountain pine beetle development is strongly linked to temperature. The entire mountain pine beetle life cycle (from egg to adult) can take between 1 and 2 years depending on ambient temperatures. Warmer temperatures promote a more rapid development that facilitates a 1-year, or univoltine, life cycle (Amman *et al.* 1997; Gibson *et al.* 2008).

Beetle activity in the phloem mechanically girdles the host tree, disrupting nutrient and water transport and ultimately killing it. Additionally, mountain pine beetles carry symbiotic blue stain fungi on their mouthparts, which are introduced into the host tree upon feeding. These fungi also inhibit water transport and further assist in killing the host tree (Raffa and Berryman 1987; Keane *et al.* 2012).

Mountain pine beetles are considered an important component of natural forest disturbance regimes (Raffa *et al.* 2008; Bentz *et al.* 2010). At endemic, or more typical levels, mountain pine beetles remove relatively small areas of trees, changing stand structure and species composition in localized areas. However, when conditions are favorable (abundant hosts and favorable climate), mountain pine beetle populations can erupt to epidemic levels and create stand-replacing events that may kill 80 to 95 percent of suitable host trees (Berryman 1986 as cited in Keane *et al.* 2012). Such outbreaks are episodic, can have a magnitude of impact on the structure of western forests greater than wildfire (the other major component of natural forest disturbance), and are often the primary renewal source for mature stands of western pines (Hicke *et al.* 2006; Raffa *et al.* 2008; Six *et al.* 2014). Mountain pine beetle outbreaks typically subside only when suitable host trees have been exhausted or temperatures are sufficiently low to kill larvae and adults (Gibson *et al.* 2008).

The range of the mountain pine beetle completely overlaps with the range of the WBP, and mountain pine beetle epidemics affecting WBP have occurred throughout recorded history (Keane *et al.* 2012). Recent outbreaks occurred in the 1930s, 1940s, and 1970s, and numerous ghost forests of dead WBP still dot the landscape as a result (Arno and Hoff 1989; Perkins and Swetnam, 1996, Ward *et al.* 2006). The most recent mountain pine beetle epidemic began in the late 1990s and continues to be a measurable but much reduced source of mortality for WBP (MacFarlane *et al.* 2013; Mahalovich 2013; Shelly 2014) (Figure A).

Figure A Greater Yellowstone Area in 2009 during the peak of the most recent mountain pine beetle outbreak. Photo credit J. Pargiter.

However, unlike previous epidemics, the most recent mountain pine beetle outbreak has had a significant range-wide impact on WBP (Logan *et al.* 2003; Logan *et al.* 2010; MacFarlane *et al.* 2013). The reported mortality rates of mostly mature trees (*i.e.*, large-diameter trees) have been as high as 96 percent or more in stands across the range (Gibson *et al.* 2008; Kegley *et al.* 2011). In 2007 alone, WBP trees on almost 202,342 ha (500,000 ac) were impacted (4 percent of the range). By 2009, an estimated 809,371 ha (2,000,000 ac) were impacted (16 percent of the range) (Service 2010). The USFS estimates that over 5.8 million individual WBPs were killed by mountain pine beetle between 1999 and 2015 on over 401,448 ha (992,000 ac) in portions of western Montana and northern Idaho (Shelly 2016). The USFS also estimates 5.7 million trees were killed on over 404,686 ha (1,000,000 ac) from 2000 through 2015 in portions of Idaho, Wyoming, and Nevada (USFS 2016).

Warming trends have resulted in not only intensified mountain pine beetle activity in high elevation WBP forests but have also resulted in mountain pine beetle range expansion into more northern latitudes and higher elevations (Logan and Powell 2003; Carroll *et al.* 2003 in Gibson *et al.* 2008; Raffa *et al.* 2008; Logan *et al.* 2010; Sidder *et al.* 2016). Winter temperatures are now warm enough for winter survival of all mountain pine beetle life stages and for maintenance of the 1-year life cycle that promotes epidemic mountain pine beetle population levels (Bentz and Schen-Langenheim 2007; Logan *et al.* 2010; Buotte *et al.* 2016; Buotte *et al.* 2017) across much of their range. Along with warmer winter conditions, summers have become drier, with droughts occurring through much of the range of WBP (Bentz *et al.* 2010). Mountain pine beetles frequently target drought-stressed trees, which are more vulnerable to attack; drought-stressed trees are less able to mount an effective defense even against less-dense mass attacks by mountain pine beetles (Bentz *et al.* 2010).

Current management and research continue to explore methods to control mountain pine beetle, mainly with the use of the pesticide Carbaryl and the anti-aggregation pheromone called Verbenone (*e.g.*, Eglitis 2015). Both methods can be effective for limited time periods (Progar 2007). However, use of either control method can be prohibitively expensive and challenging given the scale of mountain pine beetle outbreaks (*i.e.*, millions of acres) and the inaccessibility of much of WBP habitat. Currently, these methods are mostly being suggested for use in targeted protection of high-value trees (*e.g.*, individuals resistant to white pine blister rust, stands in recreational areas) rather than as a large-scale restoration tool (Keane *et al.* 2012). Therefore, these control methods are not currently sufficient to protect the species as a whole from mountain pine beetle predation.

5.d. Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2014). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (*e.g.*, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (*e.g.*, habitat fragmentation) (IPCC 2014).

The National Fish, Wildlife and Plants Climate Adaptation Strategy (National Fish, Wildlife and Plants Climate Adaptation Partnership [NFWPCAP] 2012) observes and projects ecological changes from the effects of climate change on forests. Changes in precipitation can result in longer fire seasons, severe wildfire, changes in biomass growth and accumulation (*e.g.*, fuels), and exacerbate both wetter and drier conditions. Increasing temperatures are predicted to increase forest pest damage, increase fire frequency, size and intensity, lengthen the growing season, and increase drought stress. The increases in drought conditions can result in increased fire frequency and intensity, decreased productivity, and increased tree mortality. Therefore, the consequences of climate change, if current projections are realized, are likely to exacerbate the existing primary stressors to WBP, and climate change has been of high interest to forest managers. However, the question of how climate change will directly or indirectly impact any species is complex and researchers have taken several approaches to gain a better understanding of how climate change will impact WBP.

Habitat loss is anticipated to occur across the WBP range, with current habitats becoming unsuitable for the species as a result of both direct and indirect impacts from climate change (Bartlein *et al.* 1997; Hamann and Wang 2006; Schrag *et al.* 2007; Warwell *et al.* 2007; Aitken *et al.* 2008; Loehman *et al.* 2011; Rice *et al.* 2012; Chang *et al.* 2014). Researchers have hypothesized that there will be significant habitat loss as (1) temperatures become so warm that they exceed the thermal tolerance of WBP and the species is unable to survive, (2) warmer temperatures favor other species of conifer that currently cannot compete with WBP in cold high-elevation habitats, and (3) climate change alters the frequency and intensity of disturbances (*e.g.*, fire, disease) to such an extent that whitebark cannot persist.

In summary, the pace of predicted climate change will outpace many plant species' abilities to respond to the concomitant habitat changes. WBP is potentially particularly vulnerable to warming temperatures because it is adapted to cool, high-elevation habitats. Therefore, current and anticipated warming is expected to make its current habitat unsuitable for WBP, either directly or indirectly as conditions become more favorable to WBP competitors, such as subalpine fir or mountain hemlock. The rate of migration needed to respond to predicted climate change will be significant (Malcolm *et al.* 2002; McKenney *et al.* 2007). It is not known whether WBP is capable of migrating at a pace sufficient to move to areas that are more favorable to survival as a result of climate change. It is also not known the degree to which Clark's nutcracker could facilitate this migration. In addition, the presence of significant white pine blister rust infection in the northern range of WBP could serve as a barrier to effective northward migration. WBP survives at high elevations already, so there is little remaining habitat for the species to migrate to higher elevations in response to warmer temperatures. Adaptation in response to a rapidly warming climate could also be unlikely as WBP is a long-lived species with a long generation time.