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**Pacific Southwest Region**
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# *Fuels and Vegetation Treatments: a Natural Combination*

***Target Audience*: Forest Vegetation and Fuels Managers**

The health of California's forests and watersheds are at a critical point. Increasing frequency and severity of drought and a century of fire suppression resulting in high stand densities and excessive fuel loading has led to more stand replacing wildfires and bark beetle outbreaks. Just since 2000 California has experienced several landscape scale tree mortality events associated with drought, bark beetles and overly dense forests as well as the loss of hundreds of thousands of forested acres to stand replacing wildfire.

Large scale tree mortality events have occurred throughout the state but most notably in southern California, where over 4.6 million trees were killed by drought and bark beetles in 2003-2004, and in the south Sierra Nevada range where mortality has exceeded 100 million trees since 2010. Overall, an estimated 147 million trees died statewide between 2010 and 2018 due to a combination of extreme drought, high stand densities, and bark beetle infestation, including more than 62 million trees in 2016 alone. The cost for abating the high number of hazard trees in and around communities and campgrounds and along roads, trails and power lines is overwhelming. Additional work to reduce fuel loads and begin to restore decimated forests will take decades at great expense.

A larger number of wildfires are burning more acres at high severity across the state. The Mendocino Complex, McNally, Moonlight, Rim, King, Reading, Rough, Pier, Carr and Camp Fires are just a few examples of large fires since 2000 that resulted in the loss of numerous lives and thousands of acres of conifer forest. Conifer forests in the 257,000 acre Rim Fire burned at nearly 40% high severity, and at approximately 57% high severity in the 65,000 acre Moonlight Fire. The cost of fighting California wildfires and the post-fire restoration efforts add up to hundreds of millions of dollars annually.

The need to create resilient forests at the landscape scale has never been more critical. We must be able to work faster over a much larger area to achieve meaningful change on the landscape before more acres are lost to disturbance. This will require collaboration with multiple stakeholders and the strategic use of Farm Bill authorities such as the Good Neighbor Authority and the categorical exclusion for restoration treatments in identified insect and disease high risk areas. We also need to think strategically and prioritize treatment areas based on risk to bark beetle outbreaks and stand replacing wildfire.

Treatment locations will continue to be important - prioritizing areas within the wildland urban interface and including at-risk recreation areas and important infrastructure. Designing larger projects may provide more funding opportunities and result in more contiguous acres that can better withstand drought, bark beetles and wildfire.

Thinning and prescribed fire are tools that can help achieve resilient forests. Thinning projects primarily target a reduction in ladder fuels, stand density and crown closure and are highly variable in their design, objectives and implementation, from hand-thinning only small diameter trees for fuels reduction to mechanical harvest of sawtimber for density management, or a combination of both. Prescribed fires target a reduction in surface and ladder fuels to restore a more natural disturbance regime. Both thinning and prescribed fire can be very effective in increasing forest resiliency. However, without consideration of forest insects and diseases and their role in forest ecosystems, unintended and negative outcomes can result from otherwise well-planned treatments. For example, fuels treatments that remove only smaller diameter trees and brush can reduce the risk of stand replacing wildfire but are insufficient in reducing stand density to levels that increase the health and vigor of individual trees. These fuels treated stands can remain highly susceptible to bark beetles during drought, leading to high levels of tree mortality. Prescribed burns conducted in overly dense stands can actually increase the risk to bark beetle attack. Both scenarios would negate any short-term decrease in fuel loading. Forest insect and disease issues should always be addressed when designing and implementing fuels reduction treatments to better meet multiple objectives, resulting in more sustainable and resilient forest ecosystems.

Insects, pathogens, drought and fire play important ecological roles in forest ecosystems. These disturbance agents, interacting dynamically, are among the most important regulators of forest density, composition and structure. The conditions created by one agent directly affects the conditions for another. **It is important to consider the current and potential future effects from several disturbance agents when designing treatments aimed at reducing wildfire risks:**

- Failure to reduce forest susceptibility to insects and diseases can lead to large-scale tree mortality that may affect forest management objectives, alter fire behavior, or require additional costly fuel reduction measures and hazard tree abatement.
- Fuel reduction thinning can actually increase the impacts from insects and diseases, by providing slash or stumps for insect or pathogen buildup.
- Silvicultural treatments other than thinning or burning may be needed to meet management objectives, for example when vegetation clearing is needed to restore shade intolerant tree species or to control a disease.
- Treatments are more likely to be cost-effective and accomplish broader, long-term forest health goals when multiple agents of change are considered prior to project implementation.

## Potential issues and mitigations

The necessity of reducing wildfire risks should also be guided by the over-arching goal of improving forest health and resiliency. The consideration of insects and diseases in the planning process is critical

to restoring and maintaining forest health.

Some of the most important insect and disease issues are briefly described below. In many cases, insect or disease management objectives can be met by modifying the fuel treatment design or timing. Insect and disease treatment needs vary by location, tree species, and management objectives—one treatment does not fit all. Your local Forest Health Protection specialist can provide more detailed and site-specific information.

## Bark Beetles

Bark beetles are one of the most significant agents causing conifer mortality in California's forests. At endemic levels, bark beetles typically attack and kill trees weakened by disease, old age, fire-injury, competition, lightning or other causes. However, drought conditions and overstocked forests can facilitate outbreaks where large groups of apparently healthy trees are killed, sometimes affecting entire landscapes. This can negatively impact critical wildlife habitat and recreation opportunities as well as increase the risk to stand replacing wildfire.

Bark beetles can become an issue in the following situations:

1. **Leaving stands overly dense (stem numbers and/or crown closure) after fuels reduction treatments**

Thinning can reduce susceptibility to bark beetles; however, it may be necessary to thin stands to a lower density than might be adequate for fuel reduction purposes alone. Drier pine sites, especially on ridgetops and south facing slopes do not support high stand densities and are more susceptible to high levels of bark beetle caused tree mortality during drought. White fir growing on drier sites are also more likely to succumb to fir engraver beetles regardless of stand density.

**Mitigation:** Seek out District/Forest Silviculturist or Forest Health Protection entomologists for suggested residual stocking levels that reduce susceptibility to bark beetles.

2. **Thinning too few acres in an overstocked landscape**

Thinning small areas within a larger landscape of overstocked forest may not achieve a long-term reduction in susceptibility to bark beetles. While the health and vigor of individual trees within the treated stand will likely increase, bark beetle outbreaks can still develop over the larger area during drought, causing high mortality even within treated stands.

**Mitigation:** Thin larger units or increase the number of smaller thinning units to reduce susceptibility over larger areas such as the watershed scale. This is especially important in pine dominated forest types. Consult with your Forest Health Protection entomologist during project planning to help determine the size and extent of treatment areas that will reduce susceptibility to bark beetles over a larger area.

### 3. Not thinning to density levels that provide long-term resilience

Most California forests are extremely productive and will respond quickly to reduced inter-tree competition with increased growth. Thinning treatments that fail to reduce stand densities to levels that provide long-term resilience will require more frequent entries to maintain tree health and reduced susceptibility to bark beetles. More frequent entries may increase the potential for root disease infection and spread of invasive weeds.

**Mitigation:** In most cases, thinning to a relative density of 25 - 40% (relative to the maximum Stand Density Index, or SDI) for a specific conifer species or for a weighted composition of conifer species will effectively reduce competition for limited water and nutrients and reduce the susceptibility to future bark beetle-caused tree mortality for many years. Consult with District/Forest Silviculturist to determine appropriate residual stocking levels.

### 4. Creating fresh pine slash

Pine engraver beetles are attracted to and breed in fresh pine slash. Occasionally, especially during droughts, these insects can move from slash and attack residual trees or trees in adjacent unthinned areas. During outbreaks, thousands of desired residual trees may be killed adjacent to and within project areas.

**Mitigation:** Pine engraver beetle attacks in living trees can be reduced through greater wood utilization, slash treatment (chipping, burning), consolidating slash at landings, and/or by avoiding slash creation during high hazard months (typically January through June). Utilize C clauses to ensure that mitigation work is accomplished.

### 5. Injuring trees during prescribed fires

Interactions between bark beetles and fire are complex. Over time, reintroducing fire to fire-adapted forest ecosystems will favor species and plant communities that are better adapted and more resilient to disturbance. However, fire can injure residual trees to the extent that they become more susceptible to bark beetle attacks and in some cases can lead to increased bark beetle activity for one to two seasons following the fire. Tree mortality resulting from these attacks could negate much of the fuels reduction gained from the underburn. Excessive crown scorch on trees of all species and high levels of cambium kill around the base of large trees are the most common injuries leading to post-fire mortality.

**Mitigation:** Develop burn prescriptions to minimize injury to desired residual trees. In general, keeping crown scorch below 50% of existing live crown and preventing excessive cambial injury at the base of trees will reduce the likelihood of post-fire beetle activity. Pre-treatment of fuels may be required such as mastication of ladder fuels and raking duff and litter away from the base of large pines. Prescribed fire can be used as the primary tool to meet desired conditions if existing or pre-treated stand conditions will likely only result in mortality of individual or small groups of smaller diameter trees and minimize impacts to desired residual trees.

6. **Implementing fuels treatments during severe drought conditions**

Drought conditions cause moisture stress in trees and reduce their ability to produce resin, or pitch - their primary defense against bark beetles. In addition, bark beetle activity is also generally elevated during drought. Implementing fuels and vegetation treatments during severe drought can cause additional stress on trees through wounding of tree boles or compacting and disturbing roots. Prescribed fire can cause addition stress through crown scorching and bole and root injury. Volatiles released by cut and/or chipped trees can also attract bark beetles such as pine engravers to the treatment area.

**Mitigation:** Whenever possible, conduct fuels and vegetation treatments during non-drought periods when bark beetle activity is at a low level and trees are not experiencing additive stresses. If implementing treatments during drought, take extra care to minimize tree injury and disturbances to the root zone. It is also critical to treat or remove pine slash during high pine engraver hazard months (January-June).

## Root Diseases and Stem Decays

Root diseases and stem decays are caused by various fungal pathogens that kill or decay roots or the stem of their primary hosts, often leading to tree death. Thinning or prescribed fire can increase disease-caused tree mortality or cause extensive stem decay, the extent of which may not be realized for many years. Once root disease becomes established in a stand, tree mortality may become a long-term problem. Infected trees may also become hazardous, especially if located near roads or within recreation or other high use areas.

Root diseases and stem decays can become an issue in the following situations:

1. **Creating fresh stumps that can be infected with root disease fungi**

Heterobasidion root disease becomes established by invading conifer stumps following cutting, then persists and kills trees for decades. Larger diameter stumps greater than 14” are most likely to be infected and create new root disease pockets. Infections in pine typically result in mortality while infections in true fir cause excessive root and bole decay, leading to tree failure or increased susceptibility to fir engraver attacks during drought.

**Mitigation:** Infection can be prevented by treating freshly cut stumps with a registered borate product. Stump treatment should occur as soon as possible but no later than 24 hours after cutting. Recreation and administrative sites should have all cut stumps >3” in diameter treated.

2. **Thinning in a blackstain root disease infected stand at the wrong time of year**

Thinning in pine stands infected with blackstain root disease when soils are wet or easily compacted

and/or when beetle vectors are active can lead to new infection centers and increased mortality over time. Leaving too many trees can facilitate root disease spread due to increased inter-tree competition and greater root to root contact.

**Mitigation:** Consult with your Forest Health Protection specialist to confirm suspected blackstain infected stands. Thin aggressively to lower stocking levels and wider spacing to increase the health and vigor of residual trees and minimize root to root contact. Follow-up prescribed burning can enhance thinning treatments by reducing brush and conifer ingrowth.

3. **Creating wounds in live trees that can serve as entry courts for decay fungi**

Wood decay fungi can rot the wood of living trees following fire scaring, logging injury or other means. Infected trees can become hazardous if located near roads or within recreation or other high use areas.

**Mitigation:** Damage can be prevented or reduced by avoiding bole injuries to residual trees when thinning or burning, favoring decay-resistant species, or removing decayed or damaged trees in subsequent thinning.

## Dwarf Mistletoes

Dwarf mistletoes are parasitic plants that infect the branches and stems of many conifers. Heavy infections take water away from the tree, reducing growth and leading to premature death. In addition, the brooms formed by infected trees are highly flammable. Dwarf mistletoes are difficult to eliminate from stands and complete removal may not be desirable due to the wildlife values associated with brooms.

Dwarf mistletoes can become an issue in the following situations:

1. **Leaving too many trees heavily infected with dwarf mistletoe**

In addition to the immediate effects of dwarf mistletoe brooms potentially increasing the probability of crown fire, leaving heavily infected trees within the stand will continue to provide an abundance of dwarf mistletoe seed that will facilitate spread to adjacent trees and intensify infections within trees. Heavily infected trees on poor sites will have high rates of mortality during droughts as they succumb to extreme moisture stress and attacks by bark and woodboring beetles.

**Mitigation:** Dwarf mistletoe can be reduced during thinning by favoring non-hosts or lightly infected trees. The probability of crown fire can be reduced by removing smaller infected trees and by pruning brooms from the lower crowns of larger trees. Pruning of large brooms and heavily infected branches can also lengthen the life of individual trees.

## Tools for accomplishing fuels and vegetation treatments

1. **3,000 acre categorical exclusion for treatments within Farm Bill Insect and Disease designated watersheds.**

Designated watersheds are experiencing declining forest health based on annual surveys; are at risk of substantially increased tree mortality over the next 15 years due to insect or disease infestation, based on the National Insect and Disease Risk Map; and/or contain hazard trees that pose an imminent risk to public infrastructure, health and safety.

These designations, and the associated categorical exclusion, bolster the agency's ability to accomplish restoration projects that not only combat insect and disease threats, but reduce the risks of catastrophic wildfire and impacts from invasive species. The Forest Service will work with States, Tribes, partners, and stakeholders to develop and implement projects in the designated areas. Forest Health Protection staff can assist with support and justification for fuels and vegetation treatments in designated areas and respond to comments received regarding the impacts of treatments on forest health and resiliency.

2. **Good Neighbor Authority**

Good Neighbor Authority (GNA) allows state partners to act on the Forest Service's behalf for forest restoration work. States may perform or supervise work on the NFS lands including contracting or sub-awarding work on behalf of the Forest Service. Forest Service maintains its land stewardship responsibilities and projects must comply with all applicable laws and regulations. This authority can facilitate cross boundary opportunities for larger scale treatments. The 2018 Farm Bill extended GNA to tribes and counties and allows states to retain GNA revenue for future restoration projects on NFS lands.

3. **Stewardship Agreements**

Stewardship agreements are tools that can be used to accomplish landscape restoration objectives. These may include removal of vegetation or other activities to promote healthy forest stands, fire hazard reduction, and other land management objectives (Goods for Services). Stewardship agreements are used when both parties contribute resources to the accomplishment of mutually beneficial projects when mutual interest exists.

4. **Region 5 Forest Health Treatment Priority map**

Forest Health Protection has developed a treatment priority map for Region 5. This map highlights overly dense forested areas that are at an elevated risk for bark beetle-caused mortality, have a history of tree mortality during drought and are likely to experience high severity wildfire due to high stand densities and heavy fuels loads. An ArcGIS online webmap version is available. Please contact your local Forest Health Protection staff to be added to the priority treatment area map user group in the US Forest Service ArcGIS Online organization.

### 5. Designation by Prescription (D x P)

Designation by Prescription is a method used to designate trees for removal without painting individual trees and its use is encouraged to increase efficiencies and reduce costs. It is based on what forest cover for the designated areas should look like after timber harvest. D x P allows the marking of select cut trees to ensure the removal of undesired species, tree characteristics or trees affected by insects or disease. Pre-harvest marking is also a means of verifying compliance with the prescription prior to harvesting.

- D x P is best applied when prescriptions are not complex, such as having no more than 3 main prescription criteria.
- Written designation guides are included in the prescriptive language in the contract as an aid for the timber sale purchaser or stewardship contractor in selecting trees to cut or leave.
- Complex prescriptions aimed at increasing heterogeneity through variable density retention, the creation of openings and leaving clumps or that are designed to control or manage insects or disease may not be appropriate for the D x P method.
- Diseased or bark beetle infested trees may be difficult to identify and remove with D x P. Pre-harvest marking can be utilized to mitigate potential problems.

D x P increases contract administration workload over other forms of timber designation and may require skills beyond those normally possessed by certified sale administrators. Forest Health Protection staff can help with written guideline development and training for timber sale purchasers, contractors and sale administrators when prescriptions are dealing with insect and disease issues. Examples include the removal of white pine blister rust infected sugar pine, dwarf mistletoe infected conifers, bark beetle infested trees and identification of root disease pockets.

### 6. Forest Health Protection western bark beetle funding program

Forest Health Protection can provide funding for thinning treatments that reduce the susceptibility of stands to bark beetles and increase forest resiliency. Funds are available on a competitive basis through the Regional performance contribution request and are targeted primarily for project implementation but can also be used for NEPA-related surveys, project layout and timber marking in some situations. Contact your local Forest Health Protection staff to request a project site visit and assistance with developing a proposal.

### 7. California Climate Investment (CCI) Forest Health Program Grants

These CA State Forest Health Program funds can support the following activities: reforestation, fuel reduction, pest management, conservation, and biomass utilization which are intended to increase forest health, restore watershed health and function, support biodiversity and wildlife adaptation to climate change, increase carbon storage in forests, reduce wildfire emissions and protect upper watersheds, where much of the State’s water supply originates. Projects that implement a mix of these activities, with multiple partners have priority. Projects should focus on large landscapes that include State

Responsibility Areas (SRA). Non-SRA lands may be included within project boundaries but project activities must provide a benefit to State Responsibility Areas. Large landscapes will usually mean subwatersheds, firesheds, or larger logical management units. More information is available at: http://fire.ca.gov/grants/grants

# Additional Information and Assistance

The Forest Health Protection (FHP- State and Private Forestry) staff, can provide additional information on forest insects, diseases and tree health. We provide training and technical support for forest silviculturists, foresters, fuels officers, wildlife biologists and other resource specialists. This includes NEPA document review, response to comments, marking guidelines and site specific biological evaluations for your project.

**Northern CA (National Forests: Klamath, Mendocino, Shasta-Trinity, Six Rivers)**

Plant Pathologist: VACANT

Entomologist: Cynthia Snyder
(530) 226-2437
e-mail : cynthia.snyder@usda.gov

**Northeastern CA (National Forests: Lassen, Modoc, Plumas, Tahoe, LTBMU)**

Plant Pathologist: Bill Woodruff
(530) 252-6680
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Entomologist: Danny Cluck
530-252-6431
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**South Sierra (National Forests: Eldorado, Inyo, Sequoia, Sierra, Stanislaus)**

Plant Pathologist: Martin MacKenzie
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Entomologist: Beverly M. Bulaon
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**Southern CA (National Forests: Angeles, Cleveland, Los Padres, San Bernardino)**

Plant Pathologist: VACANT

Entomologists: Andrea Hefty
(909) 382-2871
e-mail: andrea.hefty@usda.gov

Stacy Hishinuma
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Useful websites:

- Region 5 Forest Health Protection:

  https://www.fs.usda.gov/main/r5/forest-grasslandhealth

- Region 5 Insect and Disease Sharepoint site (includes Farm Bill designations, categorical exclusion and Good Neighbor Authority information):

  https://usdagcc.sharepoint.com/sites/fs-r05-epnepa/_layouts/15/start.aspx#/Other%20Resources%20Library/Forms/AllItems.aspx?RootFolder=%2Fsites%2Ffs%2Dr05%2Depnepa%2FOther%20Resources%20Library%2FInsect%20and%20Disease%20Mortality%20toolbox&FolderCTID=0x0120005BD718AA04F9B8439C4C258BE2252833&View=%7BC138B64F%2D02CA%2D4495%2D883F%2D2E1647C35825%7D

  Use your FS email address for access.

- Examples of recent Farm Bill CE projects in Region 5
  - Sunny South, Tahoe National Forest https://www.fs.usda.gov/project/?project=48304
  - Joseph 17, Modoc National Forest https://www.fs.usda.gov/project/?project=47815
  - Black Fox, Shasta-Trinity National Forest https://www.fs.usda.gov/project/?project=50331
  - Cradle Valley, Plumas National Forest https://www.fs.usda.gov/project/?project=48318

# Fuels and Vegetation Management Project Checklist

Bark beetles

- ☐ Stand density reduced to levels that reduce susceptibility to bark beetles
- ☐ Thinning is occurring over a large area or contributing to landscape scale treatments
- ☐ Thinning prescriptions designed to provide long-term resilience
- ☐ Green pine slash is treated, removed or otherwise mitigated to minimize risk of pine engraver beetle infestation
- ☐ Prescribed fire prescriptions and/or pre-treatment of fuels aim to minimize tree injury
- ☐ Treatment implementation is accounting for drought-stressed trees and elevated bark beetle activity

Root diseases and stem decays

- ☐ Stumps treated with borate compound to prevent Heterobasidion root disease
- ☐ Timing of thinning and residual stocking account for the presence of black stain root disease
- ☐ Prescribed fire and/or thinning treatments aim to minimize basal injury to trees

Dwarf mistletoes

- ☐ Treatments remove heavily infected trees and retain non-hosts to reduce infection levels within the stand

Other considerations

- ☐ Forest Health Protection staff involved in project planning to evaluate insect and disease issues
- ☐ Recreation or administrative sites included in NEPA analysis
- ☐ Invasive insect, disease or plant issues identified and mitigated