

# **WESTERN BARK BEETLE ASSESSMENT:** *A Framework for Cooperative Forest Stewardship*

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***Prepared by:***



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# WESTERN BARK BEETLE ASSESSMENT: *A Framework for Cooperative Forest Stewardship*

## ***Executive Summary***

Although bark beetles are native to forests of the western U.S., recent high levels of bark beetle-caused tree mortality have alarmed natural resource professionals and the public alike. Over the past decade severe drought periods in combination with unhealthy forest conditions have resulted in unprecedented levels of bark beetle-caused tree mortality across the West. Fortunately, we are positioned to address the unhealthy forest conditions contributing to bark beetle outbreaks by actively managing forests of the West. Active forest management consists of manipulating forests through various means including mechanical thinning, prescribed burning, planting, and other techniques at varying scales. Given the current expanse of western forests susceptible to beetle attack, together with compounding factors such as drought, we cannot stop large outbreaks. However, with additional resources we can minimize the impacts of ongoing and future outbreaks on the highest priority acres in the West. Without increased active forest management we can expect more bark beetle outbreaks, severe wildfire, and negative impacts on public benefits from forests. Now is the window of opportunity for action.

***The Problem: Unhealthy Forests and Bark Beetle Outbreaks.*** The current condition of western forests is a result of many influences, not the least of which is the past actions of humans on the landscape. Although human activity has contributed to unhealthy conditions of many western forests, current climatic conditions are combining with these forest conditions to trigger widespread bark beetle-caused tree mortality. Many of today's western forests are denser, have different species composition and stand structure, and lack age diversity compared with forests prior to European settlement. In the wetter, high elevation forests of the West, stand density is naturally high but the majority of stands have reached an age where bark beetle susceptibility is peaking. For these reasons, bark beetles are flourishing in many western forests, negatively impacting communities, and placing important public values at risk.

***The Consequences: Public Benefits at Risk.*** Healthy forests provide clean air and water, wildlife habitat, recreational opportunities, and serve as renewable sources of forest products. The nation depends upon these public benefits derived from healthy forests for their economic, social, and ecological well-being. These public benefits are being negatively impacted by bark beetle outbreaks, and are at risk of being negatively impacted for many generations to come. Native bark beetles are important components of western forest ecosystems and some level of bark beetle-caused tree mortality is desired for proper ecosystem function. However high levels of tree mortality negatively impact public benefits from forests. From 2002 to 2003, the number of forested acres in the West detected with bark beetle-caused tree mortality saw the largest increase ever recorded, more than doubling from 4 million to 10 million acres.

***A Part of the Solution: Western Bark Beetle Assessment.*** This assessment consolidates the most up-to-date information on bark beetle outbreaks in the western U.S. and outlines a framework for prioritized action. This framework includes: a map of high priority acres to be considered for active forest management at the local level, a toolbox of scientifically-sound active management techniques to mitigate negative impacts from bark beetles, and the identification of cooperative groups that can leverage resources and manage bark beetle outbreaks across all boundaries. This framework will serve to efficiently and effectively address this growing problem on the highest priority acres in the West. Even with additional resources and a highly concerted effort, there will be no quick fix; this problem requires a commitment to long-term forest stewardship which can shift the balance back toward healthy, vigorous forests that are resilient to drought and bark beetle attacks. This stewardship strategy can help ensure that forests continue to provide the numerous public benefits that Americans value for generations to come.

The *Western Bark Beetle Assessment* is:

**1. Strategic, Not Tactical:** The *Western Bark Beetle Assessment* includes both a comprehensive assessment of the problem and consequences of bark beetle outbreaks as well as a strategic framework for prioritized action. This strategic level assessment and framework for action includes an accurate estimate of west-wide resource needs to actively manage the highest priority forested acres affected by bark beetle outbreaks. This assessment is coarse scale. Though it identifies high priority acres to estimate resource needs, it is not intended to set specific priorities for local planning, decision making, and implementation. Rather, we encourage new and rely upon existing collaborative efforts at the local level to identify fine-scale tactical areas for active management, coordinate partners working cooperatively across boundaries, and leverage limited resources.

**2. Based on the Best Available Science:** A comprehensive, peer-reviewed synthesis of scientific studies investigating active forest management to mitigate bark beetle outbreaks has been completed by an expert team of agency and university researchers. This research synthesizes almost 500 publications on the subject. Conclusions from this synthesis generally support the hypothesis that active forest management techniques can reduce the impacts of bark beetle activity and increase resiliency to future attacks. We rely on this scientific analysis and recent work by the U.S. Forest Service Research and Development's Western Bark Beetle Research Group for broad guidance on management actions and to identify knowledge gaps for further research.

**3. A Common Framework for Cross-Boundary Collaboration and Partnerships:** This assessment dovetails with the goals and efforts of the *National Fire Plan, 10 Year Strategy Implementation Plan, Healthy Forest Initiative, and Healthy Forest Restoration Act*. Using collaborative frameworks, this assessment lays out a plan for actively managing the unhealthy forest conditions that contribute to both bark beetle outbreaks and severe wildfires on the highest priority acres in the West. Bark beetles and wildfire do not recognize administrative boundaries. Therefore partnerships within and among agencies and communities have been recognized as critical to effectively managing forests. As such, cooperative groups with shared goals have coalesced in many areas. They have identified ways to leverage resources, work across boundaries, and actively manage the western forests upon which they depend for their economic, social, and ecological well-being.



Bark beetle outbreaks threaten both private and public values alike; local partnerships like this one made up of agencies and communities have coalesced in response. These cooperative groups are poised to leverage resources and actively manage forests across all boundaries.

## ***The Problem: Unhealthy Forests, Bark Beetles Outbreaks, and Public Values at Risk***

**Why are many western forests unhealthy?** Many factors have influenced the western forests we see today, not the least of which have been a number of human influences. Over the past century fire exclusion, grazing, logging, and other activities have all influenced structural changes in western forests. In recent decades, a *lack* of active forest management has had an equally important effect on the current state of western forests. Active forest management consists of manipulating forests through various means including mechanical thinning, prescribed burning, planting, and other techniques at varying scales. The net results of these influences are the forests we see today. These forests exhibit high tree densities and hazardous fuel buildup—key factors contributing to the unhealthy state of many western forests. In addition, recent climatic conditions are combining with and intensifying these unhealthy forest conditions in many areas of the West. This “perfect storm” has resulted in a significant proportion of western forests that are highly susceptible to bark beetle outbreaks and severe wildfires.

**What factors are causing bark beetle outbreaks?** Forest structure—the age, size, and distribution of trees across the landscape—can limit or exacerbate the effects of weather and climate on forests. Currently, the structure of many western forests includes more trees than were present earlier in the century (Figures 1 and 2). Overly-dense forest structure increases stress on individual trees as competition for limited nutrients and water increases. In addition, an extreme alteration of species composition has occurred in some areas. Many drought tolerant species such as pine have been replaced by other species that are more stressed by drought. Increased stress weakens trees, making them highly susceptible to bark beetle outbreaks. On a larger spatial scale, many historic forests of the West were made up of different age and size patches, similar to a jigsaw puzzle. This pattern tended to interrupt beetle migration. Much of the western forested landscape now lacks the structural, species, and spatial diversity necessary to resist and slow bark beetle attack. Fortunately, we have tools available to manage forests to increase their diversity, thus making them more resistant and resilient to bark beetle attacks.



Figure 1. Photograph taken in August 1925 of western U.S. pine dominated forest stand exhibiting open, low density forest structure. Photo by A.E. Weislander.



Figure 2. Photograph taken in July 1993 of the same western U.S. pine dominated forest stand, exhibiting a significantly higher number of trees. Photo by A. H. Taylor.

**What values are at risk?** Values at risk from bark beetle outbreaks are numerous. Healthy forests are aesthetically pleasing for sightseeing and recreation, they provide habitat for fish and wildlife, and a renewable source of forest products. Healthy forests also provide “ecosystem services” such as clean air and water, and serve as a sink for greenhouse gases such as carbon dioxide. Healthy forests enhance private property values (Figure 3), provide places for quiet relaxation and contemplation, and provide habitat for many species of plants and animals. Forests impacted by severe bark beetle outbreaks are often compromised and thus struggle to provide these essential services and public values that contribute to the ecological, social, and economic well-being of the nation.



Figure 3. Bark beetle-killed trees can negatively impact values in forested residential areas. They also present a significant hazard as they decay and fall to the ground.

## ***The Consequences: Bark Beetle Outbreaks and Negative Impacts on Public Values***

**What is the current status of bark beetle outbreaks?** In recent years, bark beetle outbreaks have reached epidemic proportions. Between the years of 2002 to 2003, the number of acres of western forest with bark beetle-caused tree mortality saw the largest jump in recorded history, more than doubling from 4 million to 10 million acres; the largest annual increase in recorded history (Figure 4).

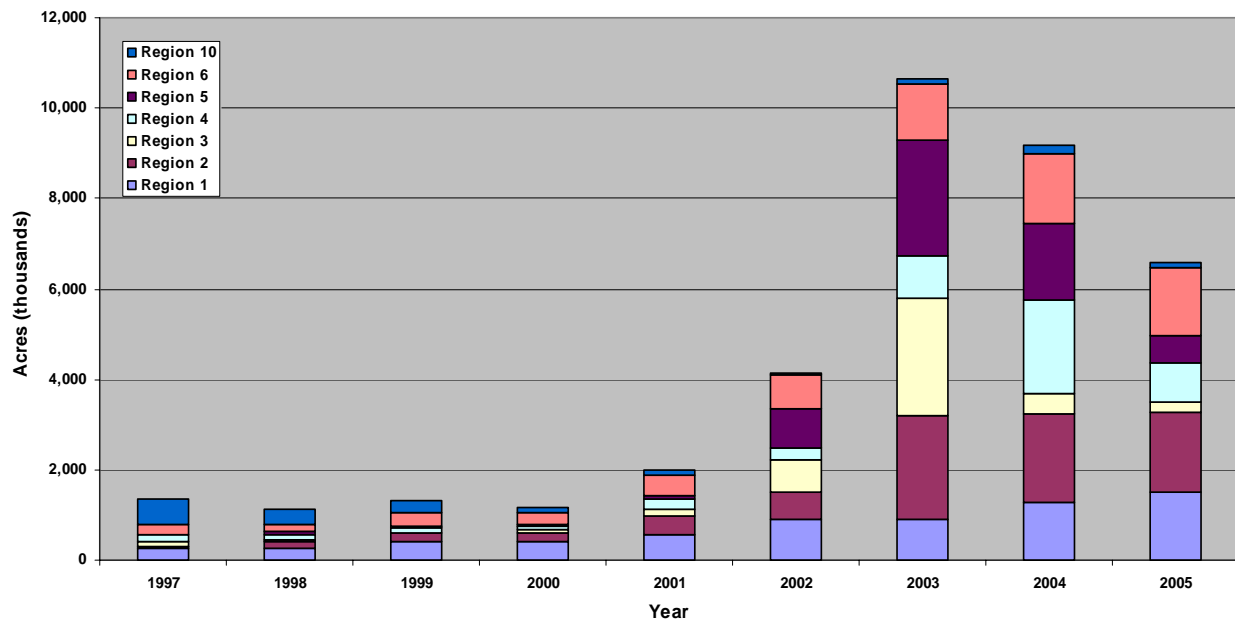


Figure 4. Number of acres with bark beetle-caused tree mortality in the western U.S. by western U.S. Forest Service regions 1997-2005.

**What is the scientific basis for active forest management to mitigate bark beetles?** A panel of experts that includes U.S. Forest Service Research scientists, university researchers, and U.S. Forest Service Forest Health Protection specialists has recently concluded a review of approximately 500 scientific studies that analyze the effects of vegetation management to control and mitigate the effects of bark beetle outbreaks<sup>1</sup>. During the course of their investigation they were able to gather extensive amounts of literature on the effects of forest thinning and other vegetation management practices on forest susceptibility to insect infestation. Some of their general conclusions are as follows:

- Native tree-killing bark beetles are a natural component of forest ecosystems. Eradication is neither possible nor desirable and periodic bark beetle outbreaks will occur as long as susceptible forests and favorable climatic conditions exist.
- A variety of vegetation management practices can help reduce the impact of bark beetles where desired. These include thinning forest stands, prescribed burning, and selective cutting of insect infested trees, and others.

<sup>1</sup> C.J. Fettig, et al. *The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States*. *Forest Ecology and Management* 238 (2007) 24–53.

- Management to reduce stand or landscape-level susceptibility to bark beetles must address factors related to tree density.
- The scientific literature generally supports the effectiveness of thinning in preventing and/or reducing tree mortality caused by bark beetles in the western U.S.

**What is the relationship between bark beetle outbreaks and wildland fire?** Bark beetle-caused tree mortality can alter wildfire severity and intensity. How fire behavior is modified in a stand of trees killed by bark beetles is dependent on many factors. One significant factor is surface fuel. As bark beetle-killed trees fall, heavy surface fuel loads are created on the ground (Figure 5). When burned, these fuels can carry a surface fire into tree crowns. Heavy surface fuel loads also increase heat intensity and duration of the fire on the forest floor which can severely impact soil, water, and other public values. Changes in hazardous fuel loads resulting from bark beetle-caused tree mortality do not change the “fire risk” (probability of a fire occurring) but do change the fire hazard (potential for high severity fire).

Bark beetle-caused tree mortality may not only lead to increased wildfire hazard, but the susceptibility of trees to bark beetle attack can also be increased by wildfire effects. It is well established in the scientific literature that fire-weakened trees are more susceptible to successful attack by bark beetles, thus increases in bark beetle populations associated with wildfire could occur and move into unburned areas. This varies by tree species and bark beetle. For example, the Douglas-fir beetle has the ability to increase in population size following fire and then move into adjacent live host material outside the burned area.

As dead trees decay and fall to the ground, they often pose an additional risk to the public and private property. Mature, beetle killed trees can be large and very heavy, increasing the likelihood that they will create significant damage if they land in an area where people, structures, communication sites, or other values are present. Often times the hazard of falling dead trees is innocuous to the untrained observer.



Figure 5. As these bark-beetle killed trees decay they fall to the ground and add to the total fuel load that contributes to wildland fire hazard.

**How is this assessment related to the goals of other initiatives addressing wildland fire?** The *Western Bark Beetle Assessment* has similar goals and thus dovetails with the *National Fire Plan*, *10-Year Strategy Implementation Plan*, *Healthy Forest Initiative*, and *Healthy Forest Restoration Act*. The basis for an increase in both the number of acres burned by wildfires and impacted by bark beetle-caused tree mortality is unhealthy forest conditions. This assessment also recognizes the serious risk of additional mortality due to bark beetle outbreaks across the West, and the influence this could have on increasing fuels and wildfire hazard in the future. Active forest management techniques that alter forest structure and species composition are effective tools to reduce susceptibility to bark beetles and wildfire.

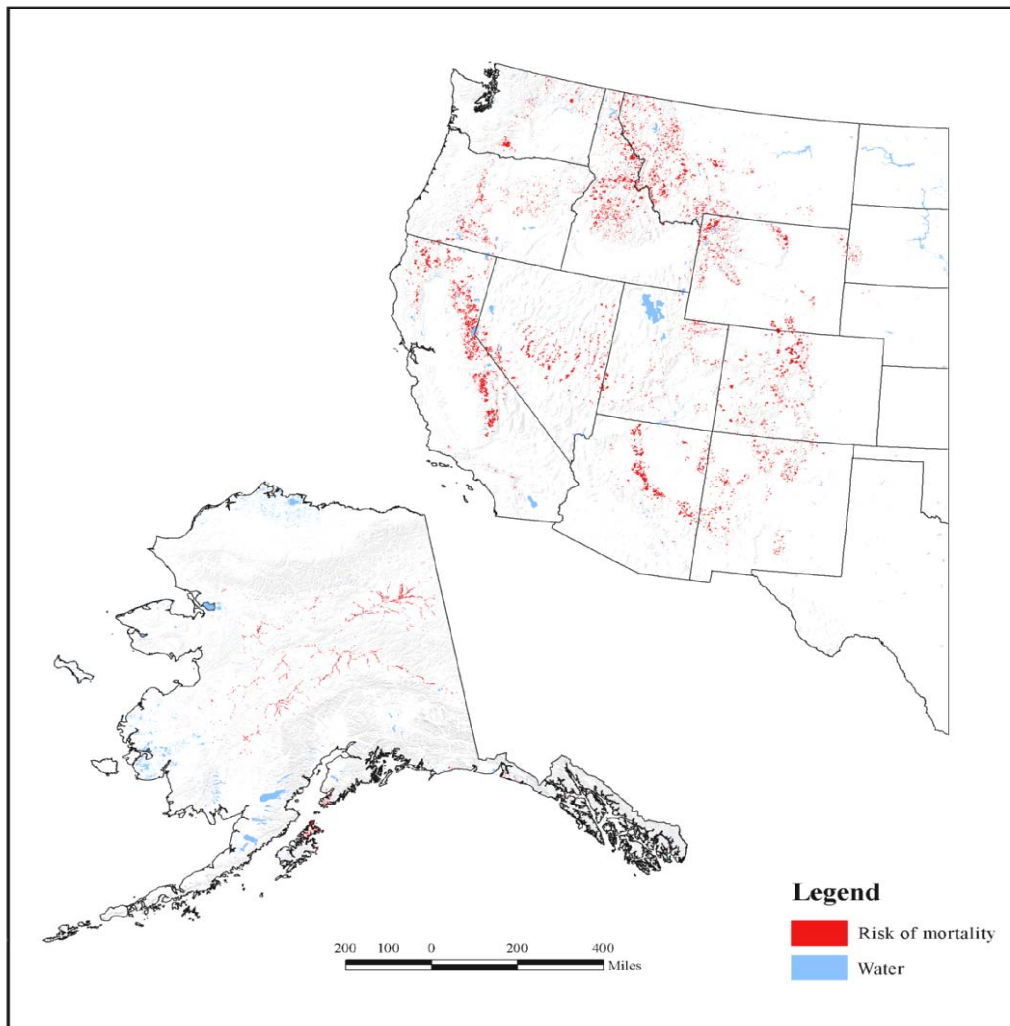
## Assessing and Addressing Bark Beetle Risks

**What is the future risk of additional bark beetle outbreaks?** The USDA Forest Service estimates that over the next 15 years, approximately 22 million additional acres of western forests, on both federal and non-federal lands, could experience significant tree mortality from bark beetles (Figure 6). These acres are at risk because much of the western forested landscape now lacks the structural, species, and spatial diversity necessary to resist and slow bark beetle attack.

### NATIONAL INSECT and DISEASE RISK MAP

#### Bark Beetle Risk\*

Acres at risk: Approximately 22 million



\* The expectation that 25% or more of the standing live volume of trees greater than 1" in diameter will die over the next 15 years.

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Figure 6. Forested acres in the western U.S. at significant risk of bark beetle-caused tree mortality over the next 15 years (in red).



## ***Risk Mitigation Strategy: Prioritizing Acres for Treatment***

**How do we prioritize acres to actively manage?** Over 22 million acres are at risk of significant bark beetle caused tree mortality across the West in the next 15 years (Figure 6). Actively managing all 22 million acres at once is beyond our current ability. Because of this fact, a strategic approach is necessary to prioritize areas for treatment. As stated earlier in the document, this assessment is not intended to replace tactical decisions for management at the regional or local level. Rather, it assesses the size and extent of bark beetle outbreaks to estimate resource needs on a west-wide basis. As such, the prioritization of acres to be actively managed identified in this document is done on a coarse scale and is not intended to be used for regional or local allocation or reporting purposes. However a coarse scale prioritization of acres is necessary to accurately estimate resource needs on a west-wide basis.

**Taking Into Consideration Ecological, Social, and Economic Factors:** Because forests are embodiments of not only ecological systems, but social and economic ones as well, all three of these factors must be considered when prioritizing acres for treatment. This framework is used to illustrate the multitude of factors that local cooperators may use to prioritize acres to be actively managed at the local scale. The table below (Figure 7) is intended to provide examples of factors that may be taken into consideration at the local scale:

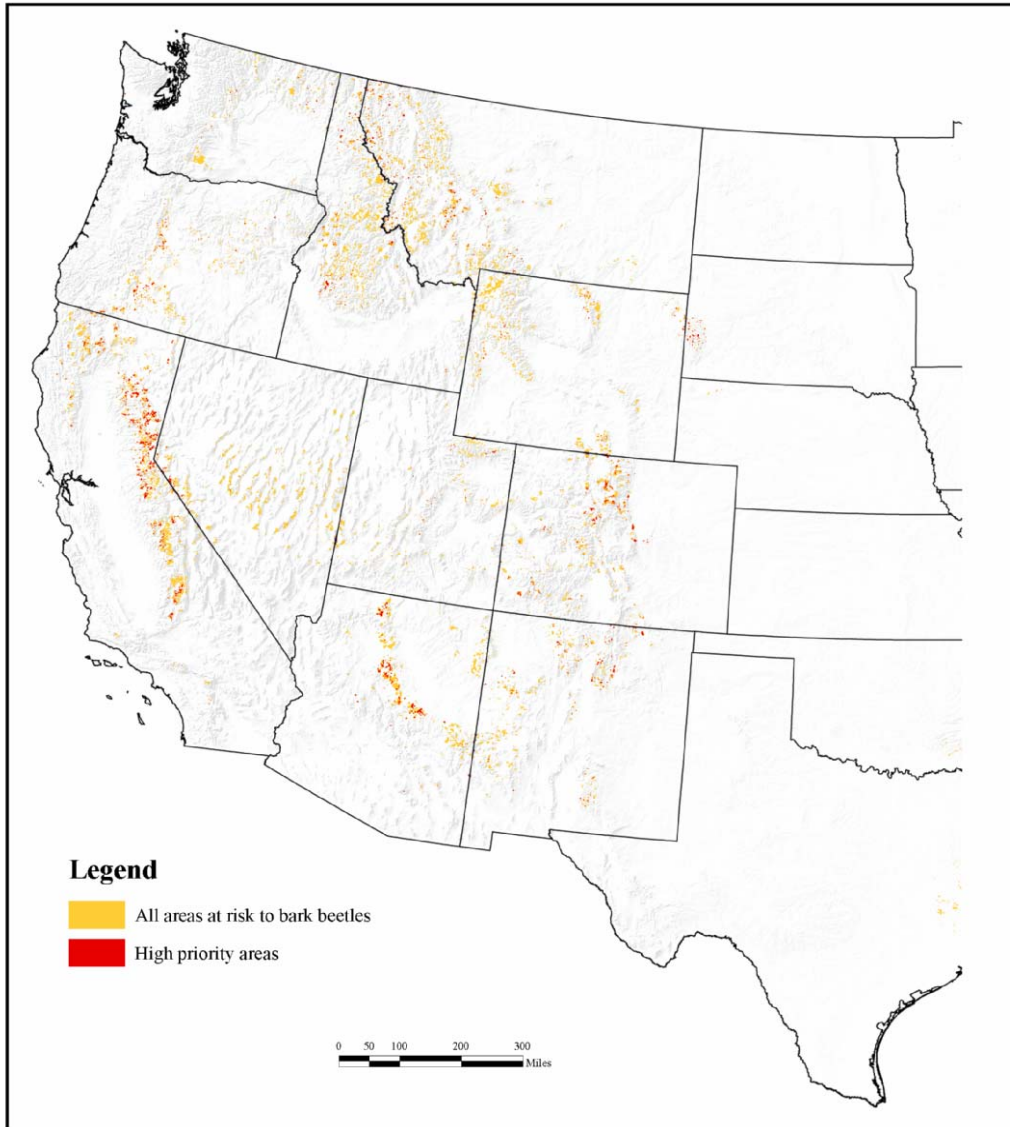
<b><i>Ecological</i></b>	<b><i>Social</i></b>	<b><i>Economic</i></b>
Forest Type (Lodgepole Pine, Douglas-Fir, Ponderosa Pine, etc.)	Suitable Uses for Land (Wilderness, High-Use Recreation, etc.)	Distance to Wood and/or Biomass Processing Facilities
Anticipated Mortality Level (10%, 50%, 90%, etc.)	Visual and Aesthetic Values	Impact on Recreation-Based Economies
Threatened and Endangered Species Habitat	Public Safety	Wildland Urban Interface
Wildfire Risk	Wildland Urban Interface (WUI)	Likelihood of Recovering Economic Value of Wood Products

Figure 7. Factors influencing prioritization of areas on which to actively manage bark beetle outbreaks at the local scale.

**Coarse-scale mapping of priority acres based on coincidence with WUI:** The first steps in a long-term stewardship approach using active management is to prioritize the acres that can be realistically managed in the short-term and which present the greatest risk to public values such as private property, recreation areas, communication sites, and others associated with the WUI. As such, we have created a map below (Figure 8) that overlays risk of bark beetle caused tree mortality based on the *National Insects and Disease Risk Map* layer and the occurrence of wildland urban interface based on the *Wildland Fire Risk to Flammable Structures* layer (<http://www.fs.fed.us/fire/fuelman/hrisk.htm>). Additionally, we have purposefully left out areas with less than 35 percent or greater than 65 percent risk of future bark beetle-cause tree mortality from the *National Insects and Disease Risk Map* layer. This was done because we believe that actively managing areas that fall within the 35-65% mortality range has the greatest likelihood of success. When these two layers are overlaid, 2.4 million acres out of the 22 million acres west-wide meet this priority rating system. Although the data is coarse scale, we believe that Figure 8 represents an accurate estimate of the highest priority acres across the West for consideration at the local

level. Local managers, working within cooperative groups, may apply other ecological, social, and economic factors as they plan projects to actively manage bark beetle outbreaks.

### Western Bark Beetle Risk\*



\* The expectation that 25% or more of the standing live volume of trees greater than 1" in diameter will die over the next 15 years, including background mortality.

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Figure 8. Forested acres in the western US where bark beetle risk is coincident with where fire prone properties indicate a wildland urban interface. This map represents a west-wide, coarse-scale analysis of priority acres on which to actively manage forests susceptible to bark beetles.

### **Long-Term Commitment to Active Management: Stewardship**

It has taken decades to arrive at the current state of unhealthy forest conditions and bark beetle-caused tree mortality across the West. It will take a long-term commitment to active management of the forests of the West to increase their vigor and resistance to/resiliency after bark beetle outbreaks. There is no silver bullet to immediately fix the problem. However, if resources are made available that enable active forest management efforts to match the extent and severity of the problem, major progress can be made over time towards mitigating the negative ecological, social, and economic effects of bark beetles. Important to note is that the first step in a long-term stewardship approach using active management is to prioritize acres which present the greatest risk to public values such as private property, recreation areas, communication sites, and others associated with the WUI.

### **Bark Beetles Cross Administrative Boundaries: Collaboration and Partnerships**

Because bark beetles do not recognize administrative boundaries, cooperative groups and partnerships among agencies and communities are critical to actively manage beetle outbreaks and hazardous fuels. These groups are already in place in many areas across the West. They are prepared to leverage resources to implement scientifically-sound active management that will protect and restore western forests upon which Americans depend for their quality of life. Examples of areas experiencing high levels of bark beetle-caused tree mortality and hazardous fuels and who are working in collaborative partnerships include: the Kenai Peninsula's *All Lands/All Hands Program* in Alaska; the *Mountain Area Safety Task Force (MAST)* in Southern California; and the *Northern Colorado Bark Beetle Cooperative* in Northern Colorado. Many other collaborative groups exist across the West. They have formed in response to the severe bark beetle outbreaks in their areas and are poised to actively manage forests across jurisdictional boundaries. Because so many different authorities, agencies, and programs can be utilized, close coordination and sharing of resources and information is critical to successful implementation of projects.

## ***Management Strategies: Prevention, Suppression, Restoration, Research and Outreach***

Actively managing the forests of the West to reduce susceptibility to bark beetles can provide long-term benefits ecologically, socially, and economically. This report focuses on four commonly accepted strategies: *Prevention, Suppression, Restoration, and Research and Outreach*. Although all components are necessary to effectively manage the current proliferation of bark beetles, prevention, along with education, may be the most effective long-term strategy. Preventive thinning can effectively increase forest resistance to both bark beetle outbreaks and catastrophic wildfire. It is likely more cost-effective and feasible to prevent large-scale bark beetle outbreaks than to attempt to suppress an active outbreak or restore a forest that has experienced significant mortality from beetle outbreak, wildfire, or both.

**Prevention:** Prevention is a proactive approach designed to reduce forest susceptibility to bark beetle outbreaks by changing forest conditions. Prevention presents the greatest opportunity for long-term improvement and maintenance of forest health in the West and is mainly accomplished by thinning forest stands. Through variable thinning across landscapes and/or among size/age classes and species of trees, prevention treatments reduce the risk of outbreaks on the landscape by creating a mosaic of species-mix and age distribution – hence reducing the homogenous, overcrowded forests over extensive areas that have proved conducive to bark beetle expansion. These treatments will ultimately result in lower fuel accumulation and ladder fuels, will lower risk of stand-replacing wildfires, and will help facilitate the re-introduction of safer, prescribed fires. Such forests are less susceptible to bark beetle outbreaks and destructive fires. Hence, the long-term benefits will help reduce suppression costs and restoration efforts.

Prevention thinning is not a “cookie cutter” or one-size-fits-all approach. Not all forests are equally susceptible to bark beetle outbreaks. Less-susceptible forest types would not necessarily be a priority for treatment under this assessment; however other social or economic factors may contribute to a decision to treat those forest types. These factors may include proximity to the WUI. By actively managing susceptible stands, the risk of significant bark beetle caused tree mortality can be lowered. Increasing both the amount and scale of prevention treatments will result in a decrease in the number of acres at high risk of mortality as identified by the *National Insects and Diseases Risk Map (Figure 5)*.

To obtain the greatest benefits over large areas, prevention treatments must be encouraged and supported across all ownerships and boundaries. Technical and financial assistance must be provided to non-industrial, private forest landowners to assist with treatment costs. This initiative complements and builds upon ongoing U.S. Forest Service State and Private Forestry programs that emphasize partnerships and cost-sharing of investments, and multi-ownership, watershed-level improvement projects. There is also a need for increasing scientifically-credible information on where, when, and how to accomplish prevention treatments. This should include development of science-based decision support systems for strategic timing and placement of treatments from stand to landscape to regional scales. Long-term monitoring of treatment effectiveness is critical to improve practices in the future.

**Suppression:** Current forest conditions and ongoing bark beetle outbreaks in the West require continued suppression efforts. Unlike long-term prevention treatments that reduce future mortality by altering stand conditions, short-term suppression strategies call for expedited treatments sometimes necessary to limit the negative impacts of ongoing outbreaks in high-value areas such as threatened and endangered species habitat, recreation sites, the WUI, and municipal watersheds. Depending on the type of bark beetle, successful short-term suppression actions can include removal of potential and infested host material, such as wind-thrown trees; the use of pheromone-baited funnel traps and trap trees to capture beetles; and the use of pesticides and anti-aggregation compounds to protect high-value trees during an outbreak. These short-term suppression strategies are effective and provide resource managers with valuable time to design and implement prevention treatments that will reduce bark beetle susceptibility risk and restore forest resiliency. Over time, a large-scale prevention program will decrease the need for suppression treatments. This assessment recognizes the increasing need for new and improved, cost-effective suppression treatments in light of the increase of bark beetle infestations on all lands, and hence the need for research, development and technology transfer on suppression techniques.

**Restoration:** Bark beetle outbreaks have severely impacted high-value areas, such as developed sites, threatened and endangered species habitat, private lands and Federal ownership adjacent to them, and visual corridors. Restoration activities are essential to reduce the negative impacts associated with the change from live forests to dead ones. While some areas of dead trees are normal and necessary, the current massive proliferation of bark beetles is producing increasingly vast areas of dead forests, some of which are in need of active restoration.

Restoration efforts have the overarching goal of accelerating and directing the regeneration of healthy forest ecosystems in beetle-killed areas, at rates and along trajectories faster, more predictable, and more consistent with societal expectations than those associated with natural recovery alone. Restoration treatments include reducing potential or actual ground fuel loading, ladder fuels, and hazard trees, planting proper species mix, and restoring and protecting early successional habitat (accomplished through natural regeneration, artificial seeding, and/or planting). Specific restoration treatments will be implemented on a priority basis dependent upon needs determined at the local level.

**Research and Outreach:** Much of what we know about bark beetle outbreaks has been learned through research. Although a great deal of knowledge and multiple tools are available to address the bark beetle problem, we will continually strive to know more and develop better tools to be successful over the long term. The U.S. Forest Service has recently organized a research group to specifically address research needs regarding bark beetle outbreaks across the West. Through the formation of the Western Bark Beetle Research Group (WBBRG), the directors of the three western Forest Service Research Stations<sup>2</sup> have committed to improving the effectiveness of their programs through enhanced communication and coordination, and have identified bark beetle research and development as a priority area for increased inter-station collaboration. To strengthen working relationships and maximize effectiveness in addressing bark beetles outbreaks, the three western Research Stations recently met with regional partners in Forest Health Protection, State & Private Forestry. The mission of the WBBRG is to enhance responsiveness, delivery, and impact of bark beetle research in the western U.S.

Additionally, outreach and technology transfer must occur between research and development and managers. For outputs of R&D and monitoring activities to be useful, they must prove relevant, practical *and be ultimately adopted* by the management community. Hence, open communication between the science and management communities will be an essential component of this framework to promote mutual understanding on bark beetle management needs, as will effective transfer of science-derived information, tools, and technologies from R&D to land managers. The WBBRG provides a vehicle for this communication and technology transfer to occur.

Outreach to the public, private landowners, and others as to the importance of active management and stewardship to maintain western forest health over the long-term is essential to success. Outreach is a critical component of any forest health strategy. Informing people of the impacts of tree mortality, the underlying causes of the mortality, and ways to limit the amount of mortality will gain a greater understanding and acceptance of the need for action. Identifying the effects of no action is a key piece of the outreach message.

## ***Measuring Progress: What Does Success Look Like?***

**High Priority Acres Treated:** Successful prevention, suppression, and restoration treatments can be measured in myriad ways. The number of acres treated through these key components will provide a quantitative measure of success. A reduction in large scale bark beetle outbreaks and catastrophic stand-replacing fires in areas that have been thinned will provide a more long-term measure of forest health improvement.

The local identification of high priority acres is being accomplished through cooperative partnerships at both regional and local community levels. Specifically, cooperative task forces have identified specific acres for treatment on maps and have put into place the agreements necessary to actively manage these acres. This local prioritization also takes place during the development of Community Wildfire Protection Plans (CWPPs) as directed by the *Healthy Forests Restoration Act*. CWPPs specifically identify community values at risk, and provide a general plan of attack for decreasing wildfire risk. Because these same values are at risk to both bark beetle outbreaks and wildfire, many cooperative partner groups have utilized the same type of risk assessment for prioritizing acres to actively manage forests to mitigate impacts from bark beetles and wildfire. Because of the close relationship between bark beetle-caused tree mortality and wildfire hazard, this dovetailed approach makes logical sense.

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<sup>2</sup> The three western U.S. Forest Service Research Stations are: Pacific Southwest Research Station (PSW); Pacific Northwest Research Station (PNW); Rocky Mountain Research Station (RMRS).

**Research and Development Tools Created:** Critical to the continuing development of this framework is the evaluation of existing science-based tools that address the ongoing proliferation of bark beetle infestations. Without increasing our knowledge of what management techniques and tools are working, we risk using critical and limited resources in ways that may not be providing the greatest return on our investment. Scientific monitoring and evaluation of existing management techniques is one avenue to accomplishing this goal. However, development of new, more cost-effective tools, practices, strategies and decision support systems is also necessary to address remaining questions and improve the future effectiveness of prevention, suppression, and restoration programs. Much of this work is currently being addressed by the Western Bark Beetle Research Group.

**Increased Public Understanding and Participation in Active Management:** Increasing public understanding of the risks posed to highly public benefits that forests of the West provide is critical to the long-term stewardship proposed under this assessment. Measuring success on this front is difficult at best, however. One specific measure of public understanding and acceptance of actively managing forests to prevent bark beetle outbreaks is the participation by local communities in the management of their forests. Particularly important here is the level of responsibility that local communities take in the process of mitigating the risk to their communities and the public benefits from forests that they value.

## **Conclusion: A Comprehensive Assessment and Framework to Manage and Protect Western Forests and Public Values**

The *Western Bark Beetle Assessment* lays out a strategic approach to reduce the undesirable bark beetle-caused tree mortality in the forests of the West and increase forest resiliency to drought and bark beetle outbreaks. The assessment centralizes information on the current proliferation of bark beetles throughout the West, future risk, management strategies, and tools to accomplish the long-term goal of protecting and restoring western forests to a state of improved health and sustainability. This assessment provides the large scale direction that local areas can draw upon for coordinated action to address the problem. If financial and human resources to implement this framework are made available, we can begin to strategically mitigate the impacts of bark beetle outbreaks now on the highest priority acres in the West—the first step in a long-term commitment to stewardship. Without this commitment we all risk the further compromise and potential loss of public benefits that forests provide for generations to come.