RESOURCES

NATURAL

Recommendations of the Forest Health Technical Advisory Committee to the Commissioner of Public Lands

July 2, 2012

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

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Natural Resources

PETER GOLDMARK
Commissioner of Public Lands

July 2, 2012

Dr. Peter Goldmark
Commissioner of Public Lands
Washington State Department of Natural Resources
1111 Washington St. SE
Olympia, WA 98504

Dear Commissioner Goldmark:

This letter transmits the consensus recommendations of the Forest Health Technical Advisory Committee (TAC) regarding actions warranted under Chapter 76.06 RCW, the Washington State forest health law. As you know, the TAC began its work with your appointment of its membership in January, 2012. Since then, we have conducted five public meetings in which forest health hazards, the potential for timely and effective action, and the statutory criteria for a forest health warning were evaluated in considerable detail.

I know that you share my deep appreciation for the TAC members who have devoted their time and wealth of expertise to this important work:

Doug Daoust, Asst. Director, State & Private Forestry, US Forest Service, PNW Region
Bill Gaines, Wildlife Ecologist, Washington Conservation Science Institute
Robert Gara, Professor Emeritus, Forest Entomology, University of Washington
Scott Ketchum, Northern Inland Region Manager, Forest Capital Partners
Reese Lolley, Eastern Washington Forest Program Director, The Nature Conservancy
Connie Mehmel, Forest Entomologist, US Forest Service, Wenatchee Service Center
Greg Morris, Fisheries Habitat Biologist, Yakama Nation
Dave Peterson, Fire Applications Team Lead, US Forest Service, PNW Research Station

The TAC wishes to make special recognition of Chuck Hersey and Karen Ripley in the Department of Natural Resources' Forest Health Program for their lead roles in the significant analytical and support work that was required throughout the committee's proceedings.

Sincerely,

Aaron Everett
Washington State Forester
Chair, Forest Health Technical Advisory Committee

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Forest Health
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Committee Technical Support and Engagement

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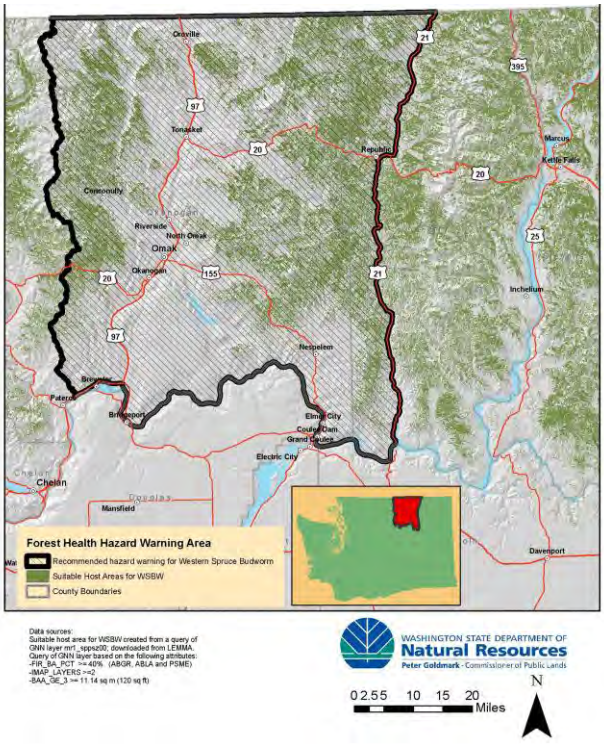
Executive Summary

Concerned about the health of Washington State's forests the Commissioner of Public Lands initiated the state's forest health warning process in November 2011 and convened a Forest Health Technical Advisory Committee in January 2012. Following state statute, the role of the committee is to provide the Commissioner with a report on the nature and extent of forest health threats, and recommend areas for further action under the forest health law. There are concerns throughout eastern Washington, but the committee focused its efforts on those with both high hazards, and high potential for effective actions to address those hazards.

The committee deliberated over the course of five public meetings and recommends:

- A forest health hazard warning is warranted for western spruce budworm in eastern Okanogan County and western Ferry County.
- The following are identified as areas of concern, although the statutory criteria for a warning are not entirely met:
    - Western spruce budworm in eastern Ferry County
    - Mountain pine beetle in lodge pole pine in central Okanogan County
    - Ponderosa pine bark beetles in Okanogan, Ferry, Klickitat and Yakima counties



The committee makes specific action recommendations at the landscape scale. These are designed to gauge success and progress toward abating budworm-susceptible forest conditions that underlie the proposed warning designation. Landscape recommendations are based on a comparison of current forest conditions with an estimated historical range of variability. Managing toward 360,000 acres of mature, open forest structure in susceptible forest types would significantly reduce the hazard. Current forest conditions contain only 43,000 acres. Similar recommendations are made for the identified areas of concern.

The committee also makes action recommendations at the finer scale of forest stands. These include a wide array of strategies for silvicultural action that landowners and managers should take on the ground depending on their management objectives. For western spruce budworm in the recommended warning area, these recommendations include reducing the encroachment of true fir and Douglas-fir trees, retaining and encouraging the growth of budworm-resistant species such as ponderosa pine and western larch, thinning small trees from the forest understory, and increasing the spacing between the residual larger trees. Similar recommendations are made for the identified areas of concern.

Recommendations of the Forest Health Technical Advisory Committee to the Commissioner of Public Lands

July 2, 2012

A. Introduction

The Forest Health Technical Advisory Committee (TAC) was convened by Commissioner of Public Lands Peter Goldmark in January 2012 to respond to concerns over forest health conditions in eastern Washington. The TAC deliberated over the course of five in-person meetings to evaluate threats to forest health, determine areas where a forest health hazard warning may be warranted under state law, and develop specific recommendations to address the threat. This document describes the TAC recommendations to the Commissioner. Detailed documentation of the TAC proceedings, methodologies, and deliberations is contained in a separate Staff Report to the Commissioner prepared by Department of Natural Resources personnel.

To effectively address Forest Health issues discussed and identified by the TAC, land managers from federal, state, and private entities will be required to act expeditiously and in a coordinated fashion. This will require an all-lands approach and a high level of collaboration so that limited resources are used to restore forest conditions in priority areas.

Forest health concerns exist throughout eastern Washington, many of them severe. The TAC undertook a process of evaluating recent, current, and projected future hazards to prioritize top prospects for landscapes warranting further action under state law. This process also included a strong focus on efficacy potential to quickly implement treatments; meaning that among two landscapes with comparable hazard levels, the one with better potential for actual on-the-ground action would be prioritized higher than one with low potential (such as extensive reserve areas on federal land).

These recommendations contain two categories of action:

- Forest Health Hazard Warning: The committee recommends that the Commissioner of Public Lands declare a forest health hazard warning under state law (RCW

76.06.170, 180), including a specific area and specific insect or disease that represents the threat. These areas have met the following statutory criteria:

- An "uncharacteristic insect or disease outbreak" has occurred or is likely to occur [RCW 76.06.180(2)(a)]; and
- Forest conditions in the area lend themselves to further spread and intensity [RCW 76.06.180(2)]; and
- The outbreak "has or is likely to (i) spread to multiple ownerships and cause extensive damage to forests; or (ii) significantly increase forest fuel that is likely to further the spread of uncharacteristic fire" [RCW 76.06.180(2)(a)].

- Area of Concern: The committee finds that after evaluating a specific area and specific insect or disease threat, one or more of the forest health hazard warning criteria are not met. For example, forest conditions may lend themselves to an outbreak but the recent trend in actual damage is downward, or the outbreak has the potential to affect only one landowner. These areas could be included in a forest health hazard warning at the Commissioner's discretion, could continue to be monitored, or the current rate of land management activities may contain the extent of damage. The TAC makes recommendations as to which action is appropriate.

Management recommendations are provided for both categories of action. A more exhaustive discussion of specific areas, threats, and the evaluation of statutory criteria is contained in the Staff Report.

B. Recommended Forest Health Hazard Warning Area

Based on an evaluation of forest health threats in eastern Washington, the Forest Health Technical Advisory Committee finds that issuance of a forest health hazard warning by the Commissioner of Public Lands is warranted for the area and damage agent described below. As previously noted, forest health threats are pervasive, many of which may meet the technical criteria for a forest health hazard warning under state law. The TAC process was designed to prioritize potential actions under Chapter 76.06 RCW and make recommendations at the confluence of the greatest and most immediate threats, and greatest efficacy potential.

Hazard Warning Area	East Okanogan/West Ferry
Warning Area Boundary	Warning is applicable to host tree species, highest priority forest types and suitable conditions in the area bounded by the Columbia River to the south, the Canadian border to the north, the Okanogan River Watershed boundary to the west and Highway 21 to the east. See Figure 1.
Damage Agent	Western spruce budworm
Host Tree Species	Douglas-fir, grand fir, subalpine fir, Engelmann spruce and western larch
Highest Priority Forest Types	Dry, fire-prone mixed conifer forest biophysical settings as specified in Landscape Recommendations (Section D.1.2.)
Suitable Host Forest Conditions	Forest stands characterized by a composition of 30 percent or greater in host tree species, 80 percent or greater total crown closure, with two or more canopy layers, aged greater than 90 years.
Nature of Threat	Extensive recent defoliation and high trap counts predict significant defoliation in 2012. Area has experienced light defoliation in the last decade, and appears to be cycling upward. Area is anticipated to experience heightened levels of budworm defoliation for at least the next two to three years. The potential for an uncharacteristic outbreak exists based on current forest conditions. Mortality resulting directly from defoliation can be as little as 5 percent or as much as 48 percent depending on the outbreak duration. Secondary/subsequent mortality of weakened trees from bark beetles and other damage agents is common and can be severe.

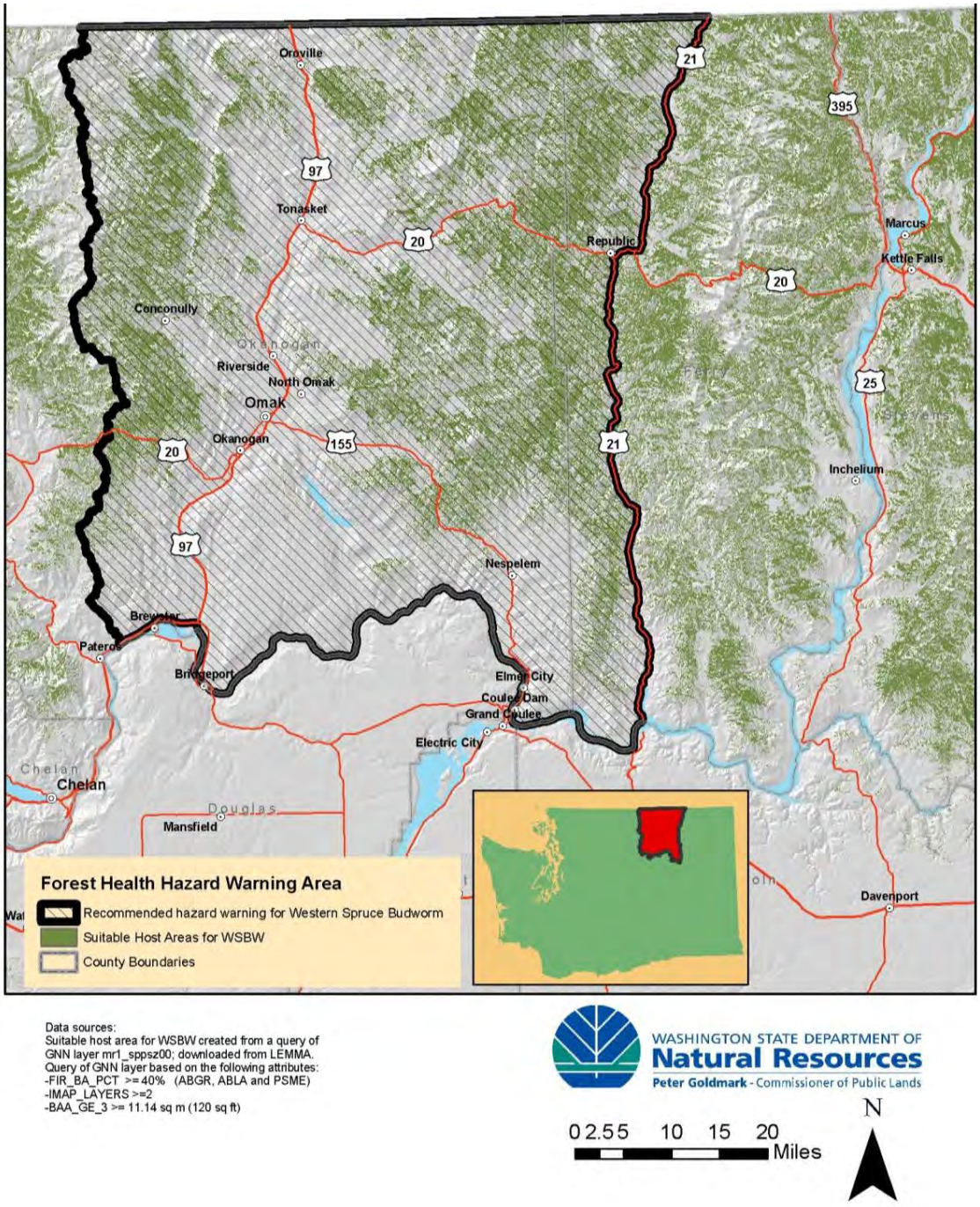


Figure 1. East Okanogan/West Ferry County recommended forest health hazard warning for western spruce budworm.

The TAC finds that all the statutory criteria for recommending a forest health hazard warning are satisfied in the East Okanogan/West Ferry County area for western spruce budworm. Detailed information on criteria, data and determinations is presented in the Staff Report. The Committee wishes to emphasize that many forest health concerns are intermingled in the suitable host area for western spruce budworm. These concerns, such as mountain pine beetle, western pine beetle, Douglas-fir beetle, fir engraver, dwarf mistletoe, and root disease,

do not individually constitute grounds for a warning. Western spruce budworm susceptibility can be considered an indicator of underlying forest conditions that are problematic for multiple insects and diseases. Therefore, most actions designed to reduce budworm hazard should serve an integrated purpose of decreasing other hazards. The Committee describes these specific actions in Section D, Management Recommendations.

C. Areas of Concern

The committee also identified several areas of concern in Okanogan, Ferry, Klickitat and Yakima counties. Conditions do not technically meet the statutory criteria for the TAC to recommend a forest health hazard warning at the present time. However, as noted in the brief area descriptions below, the TAC believes that conditions for some agents may warrant a forest health hazard warning in the near future. The committee recommends that the Commissioner of Public Lands consider authority under RCW 76.06.180(2) to determine whether "action is necessary to manage the development of a threat to forest health." The brief descriptions below characterize the TAC's conclusions following an evaluation of these specific areas and threats. Further information on area-by-area determinations is presented in the Staff Report.

Area of Concern	**East Ferry County**
Area of Concern Boundary	Area of concern is applicable to host tree species, highest priority forest types and suitable conditions in the area bounded by the Ferry County boundary to the south and east, the Canadian border to the north and Highway 21 to the west. See Figure 2.
Damage Agent	Western spruce budworm
Host Tree Species	Douglas-fir, grand fir, subalpine fir, Engelmann spruce and western larch
Highest Priority Forest Types	Dry, fire-prone mixed conifer forest biophysical settings as specified in Landscape Recommendations (Section D.1.3.1.)
Suitable Host Forest Conditions	Forest stands characterized by a composition of 30 percent or greater in suitable host tree species, 80 percent or greater total crown closure, with two or more canopy layers, aged greater than 90 years.
Nature of Threat	Area has too little recent defoliation to meet the statutory criteria for the "presence of an uncharacteristic outbreak" (emphasis added). However, high trap counts east of Hwy 21 predict significant defoliation in the western portions of the area in 2012. Multiple forest ownerships are already affected, but the area is not yet extensive. Area is anticipated to experience heightened levels of budworm defoliation for at least the next two to three years. Potential for uncharacteristic outbreak exists based on current forest conditions. Committee recommends consideration of further action by the Commissioner pursuant to RCW 76.06.180(2).

Area of Concern	**Central Okanogan County**
Area of Concern Boundary	Area of concern is applicable to host tree species, highest priority forest types and suitable conditions in the area bounded by the Columbia River to the south, Hwy 97 to the east, the Canadian border to the north and the Okanogan River Watershed boundary to the west. See Figure 2.
Damage Agent	Mountain pine beetle
Host Tree Species	Lodgepole pine

Highest Priority Forest Types	Lodgepole pine
Suitable Host Forest Conditions	Forest stands characterized by basal area greater than 80 ft² per acre, quadratic mean diameter greater than 8 inches, aged greater than 80 years are susceptible to mortality.
Nature of Threat	Extensive recent and historical lodgepole pine mortality has been recorded in the area and is predicted to continue. Damage from 2006-2010 was moderately extensive with moderate to high intensity of trees killed per-acre that suggests precursors to irruptive population behavior. However, a reduction in extent and severity is observed in the 2011 recorded damage level. Persistent moisture stress over one or more growing seasons is likely to accelerate the outbreak again. Host species is primarily confined to DNR and US Forest Service-managed lands, meaning that the criteria under state law regarding likelihood of spread to other ownerships is not met. The efficacy potential for action on US Forest Service-managed lands is low due to reserve areas, poor road access, and a management priority for lower-elevation forests. Both agencies are limited in efficacy potential for action due to existing habitat commitments for Canada lynx. The potential for a significant outbreak nevertheless exists based on current forest conditions. The Committee recommends consideration of further action by the Commissioner pursuant to RCW 76.06.180(2).

Area of Concern	**East Okanogan/All Ferry County**
Area of Concern Boundary	The area of concern is applicable to host tree species, highest priority forest types and suitable conditions in the area bounded by the Columbia River to the south, the Canadian border to the north, the Okanogan River Watershed boundary to the west and the eastern Ferry County boundary.
Damage Agent	Western pine beetle, mountain pine beetle
Host Tree Species	Ponderosa pine
Highest Priority Forest Types	Dry ponderosa pine forest biophysical setting as specified in Landscape Recommendations (Section D.1.3.2.)
Suitable Host Forest Conditions	Ponderosa pine and mixed conifer forest with a 50 percent or greater pine component, greater than 120 square feet per acre of basal area, and a quadratic mean diameter greater than 10 inches.
Nature of Threat	Ponderosa pine damage from bark beetles in recent years has been relatively light. However, a significant overabundance of closed-canopy, high density multistory forest conditions in pure ponderosa pine stands and similar conditions in mixed conifer stands represents a considerable mortality hazard. Outbreak behavior differs significantly from the irruptive or epidemic mortality observed in lodgepole pine. However, widespread mortality is possible under moisture stressed conditions. In mixed conifer stands ponderosa pine represents an important component of resiliency to other forest health damage agents, but is potentially jeopardized by the ingrowth of Douglas-fir and other shade tolerant species that are causing excessive tree crowding.

Area of Concern	Klickitat and Yakima Counties
Area of Concern Boundary	Area of concern is applicable to host tree species, highest priority forest types and suitable conditions delineated in Figure 3 in Klickitat and Yakima Counties.
Damage Agent	Western pine beetle, mountain pine beetle
Host Tree Species	Ponderosa pine
Highest Priority Forest Types	Dry ponderosa pine and mixed conifer forest biophysical settings as specified in Landscape Recommendations (Section D.1.3.2.)
Suitable Host Forest Conditions	Ponderosa pine and mixed conifer forest with a 50 percent or greater pine component, greater than 120 square feet per acre of basal area, and a quadratic mean diameter greater than 10 inches.
Nature of Threat	Ponderosa pine damage from bark beetles in recent years has been relatively light. Based on the downward damage trend, the "presence of an uncharacteristic outbreak" criteria was not satisfied. However, a significant overabundance of closed-canopy, high density multistory forest conditions in pure ponderosa pine stands and similar conditions in mixed conifer stands represents a considerable mortality hazard. Outbreak behavior differs significantly from the irruptive or epidemic mortality observed in lodgepole pine. However, widespread mortality is possible under moisture stressed conditions. In mixed conifer stands ponderosa pine represents an important component of resiliency to other forest health damage agents, but is potentially jeopardized by the ingrowth of Douglas-fir and other shade tolerant species that are causing excessive tree crowding. Significant forest management treatments have recently been implemented in Yakama Nation and private industrial stands with susceptible ponderosa pine. The TAC is concerned that these efforts are sustained over the long-term, and that other forest landowners and managers are similarly active in addressing the threat.

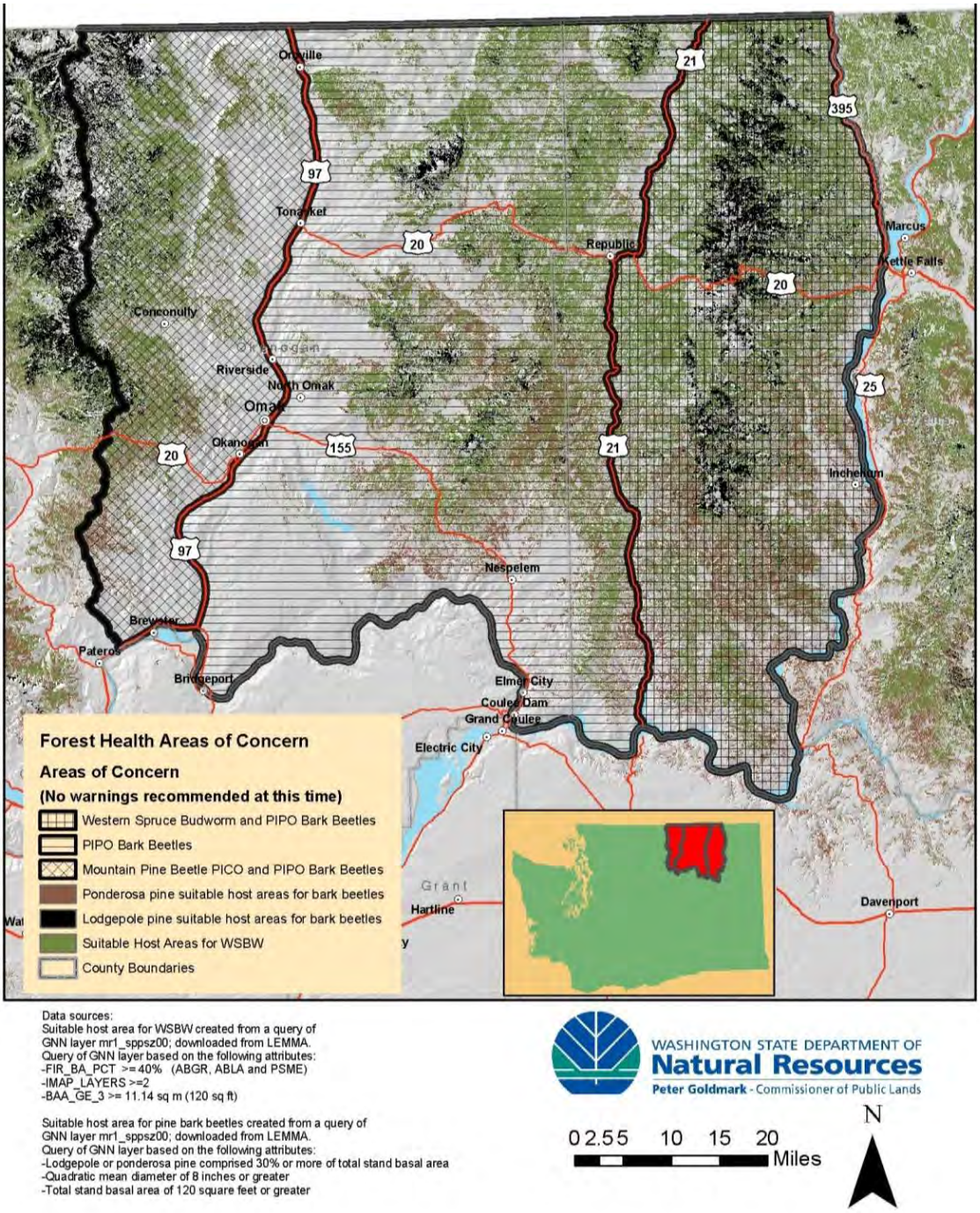


Figure 2. Areas of concern for forest health damage agents in eastern Okanogan and Ferry counties.

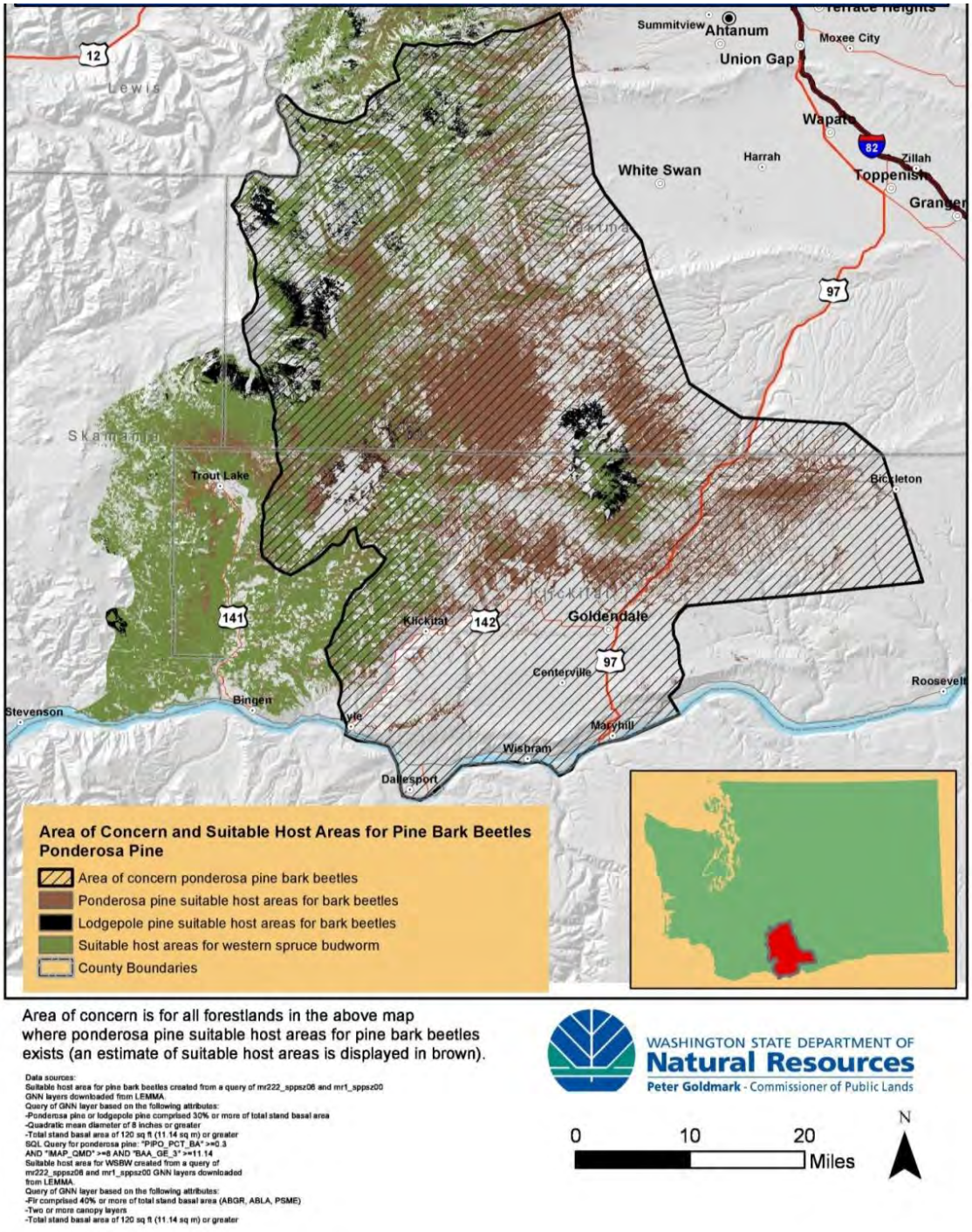


Figure 3. Area of concern for ponderosa pine bark beetles in Klickitat and Yakima counties.

D. Management Recommendations

The committee recommends the following specific actions to address and mitigate the forest health threats within the areas determined to warrant a forest health hazard warning. While warning determinations are specific to individual damage agents and host species, the state forest health law acknowledges the need for landowners and managers to "maintain their forest lands in a healthy condition in order to meet their individual ownership objectives, protect public resources… and avoid contributing to forest insect or disease outbreaks or increasing the risk of uncharacteristic fire" (RCW 76.06.040). For example, while western spruce budworm is the subject of one recommended warning area, the risk of undesirable mortality from bark beetles is ubiquitous and intermingled within the susceptible budworm host area.

In response to the need for an integrated approach to forest health, recommendations have been structured to address both landscape and stand-scale concerns. The TAC asked itself the question: How much activity, and of what kind, would make a meaningful improvement to the conditions that cause the warning to be warranted? Landscape recommendations presented in Section D.1 are therefore based upon the current range of forest conditions as compared with historical reference conditions. These serve as targets for broad landscape conditions which can benchmark the amount and type of management actions that are likely to improve forest resiliency to current and future outbreaks. In the event that a warning is issued by the Commissioner, the committee intends to fulfill its role of monitoring progress under RCW 76.06.170(2)(d) based on, among other things, progress toward the landscape-scale recommendations.

The concept of "departure" from historic reference conditions was used by the TAC as part of establishing whether a warning was warranted. The term "departure" describes differences between current vegetation conditions (species composition, structural stage and canopy closure) and modeled historical reference vegetation conditions (Interagency Fire Regime Condition Class Guidebook, 2010). These data arise from a national interagency vegetation, fire, and fuel characteristics mapping program called LANDFIRE, sponsored by the US Department of the Interior and the US Forest Service. Landscape scale recommendations by the TAC move one level of detail below the concept of departure to directly compare current and reference conditions within the highest priority forest areas for western spruce budworm and pine bark beetles. The highest priority forest areas are correlated to forest biophysical settings that comprise the LANDFIRE program.

Biophysical settings are "a grouping of ecologically similar vegetation types modeled with characteristic disturbance inputs" (Interagency Fire Regime Condition Class Guidebook, 2010). In other words, they describe tree species composition and structure that is adapted to a particular geography, considering how factors like soils, climate and wildfires shaped forests through time. "Succession classes" are used to characterize current forest conditions in a biophysical setting with respect to species composition, tree size, canopy cover and height of successional states (seral stages). Further detail on the use of LANDFIRE data to develop landscape recommendations is presented in the Staff Report. Appendix B and Table

10 of the Staff Report contains the individual biophysical setting models and succession class definitions used in the TAC process.

Stand-scale recommendations presented in Section D.2 are based upon well known, published scientific literature describing susceptibility to individual damage agents, as well as the technical expertise of the committee members. These are meant to guide site specific actions landowners and managers may take in pursuit of landscape-scale goals as well as their own management objectives. The term "stand scale" refers to a forest stand, which is a "contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit" (Society of American Foresters).

When implementing silvicultural treatments to reduce forest health hazards identified by the TAC, it is imperative that management practices consider other forest health issues present in a stand, such as dwarf mistletoe and root disease. Management actions designed to reduce susceptibility to one damage agent may inadvertently increase stand susceptibility to other damage agents. For example, where root disease is present, research has shown that thinning can increase damage from this disease (Slaughter and Rizzo 1999). Careful consideration and monitoring of all forest health issues in a stand is needed to ensure silvicultural treatments are successful (Maloney et. al 2008).

D.1. LANDSCAPE RECOMMENDATIONS

D.1.1. Overall Landscape Recommendations

The TAC's desired result of a forest health hazard warning is to catalyze an increased rate of actions that build broad-scale resiliency to uncharacteristically severe damage from the identified agents and from uncharacteristic wildfire. Treatment actions occur at the stand scale, but success toward affecting how much total damage occurs is unlikely unless forest composition and structure are modified across larger landscapes. The TAC's desired result is anticipated to achieve interrelated outcomes for damage agents that are not specifically the subject of hazard warning recommendations.

The TAC acknowledges that multiple management actions over multiple entries, using a full array of available tools (mechanical, commercial and controlled fire treatments) may be required to achieve and maintain desired conditions. In many cases a direct path from current conditions and desired conditions may not be available, but instead several intermediate steps will be necessary.

The use of reference conditions is not recommended so as to subjugate individual landowners and managers' objectives, but serves as a guide to judge progress toward broad-scale resiliency as outlined in state statute (RCW 76.06.140). For example, intensive stand-scale actions may be implemented to successfully mitigate damage and mortality while maintaining a commercially advantageous tree species and structural composition. State law recognizes a public interest in "protecting forest productivity on forests managed for commodity production." These may or may not contribute to the landscape recommendations established here. The committee focuses its recommendations, however, on resolving the

underlying forest landscape conditions that cumulatively contribute to uncharacteristic outbreaks.

Recommendation: The proposed warning area is comprised of forest land managed by DNR, US Forest Service, Bureau of Land Management, Washington State Department of Fish & Wildlife, Colville Confederated Tribes, industrial private landowners and small forest landowners (Figure 4). Coordination with local land managers is central to the forest health warning process described in state law and is of particular importance in this landscape. Based on the nature of the threat, the TAC recommends a rapid search process to identify projects that are in the late planning stages by major forest land management entities and could be accelerated. In turn, these should be used to leverage the actions of adjacent landowners for a more complete hazard reduction outcome. This process should include identifying the concurrence of project readiness with sub-areas of the warning boundary that exhibit high-hazard conditions in order to determine the location and best value of cooperative projects toward landscape scale outcomes.

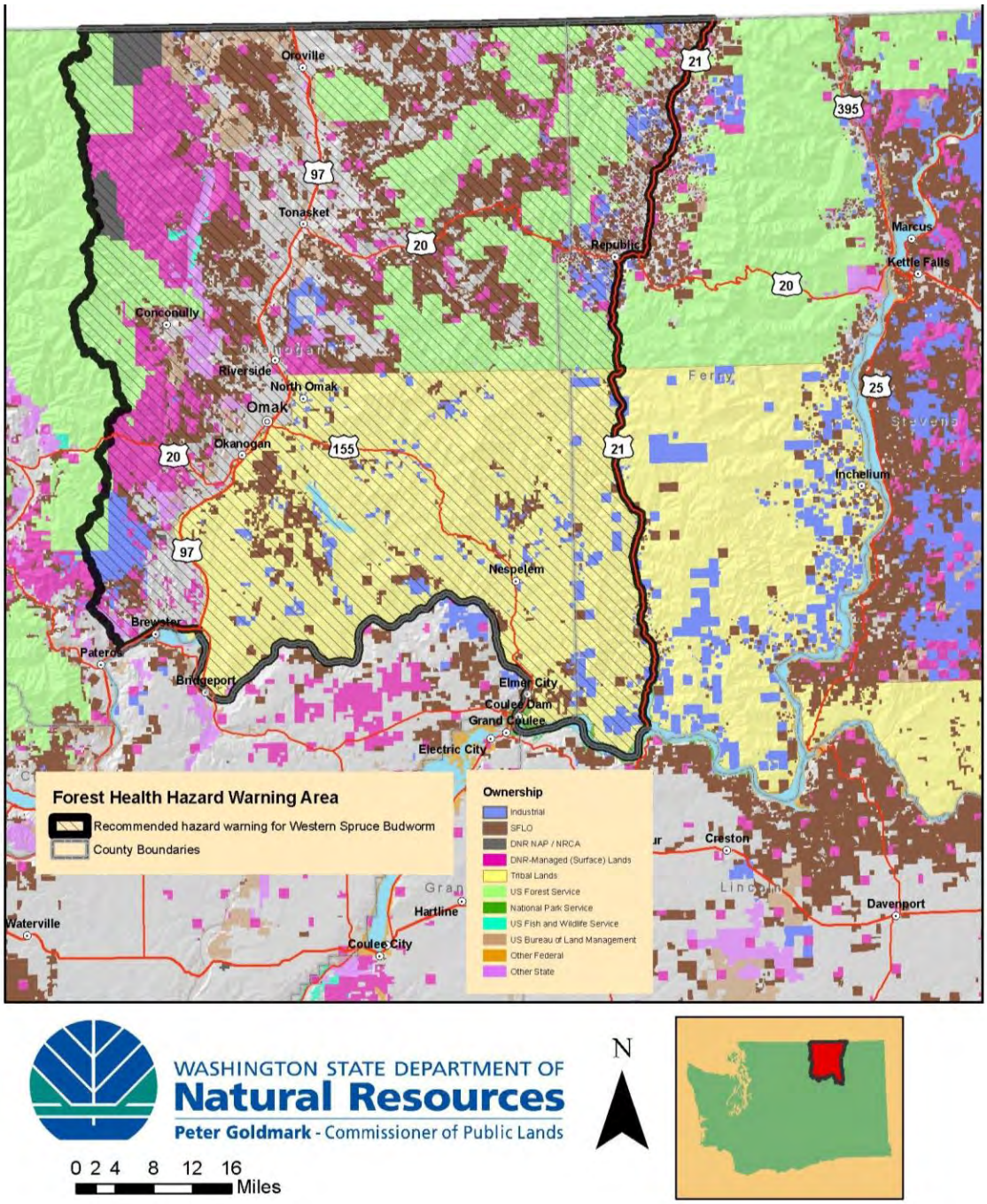


Figure 4. Forestland management and ownership within the recommended forest health hazard warning area.

D.1.2. East Okanogan/West Ferry County Proposed Warning Area – Landscape Recommendations

Table 1 illustrates the current extent of departure comparing current forest structural conditions with historical reference conditions by biophysical settings that are the highest priorities for addressing western spruce budworm hazard. Figure 5 displays the forest biophysical settings within the area and Figure 6 displays the current succession classes.

The ponderosa pine-Douglas-fir and Douglas-fir-Western larch biophysical settings are those representing the highest priority area of spruce budworm susceptible host conditions. The ponderosa pine-Douglas-fir landscape is overabundant with mid development and late development structure that is closed-canopy. There is consequently a significant deficiency of late development open structured conditions, which would have occupied approximately 265,000 acres under reference conditions but currently comprise only 16,800 acres. Management actions that move toward this reference condition can be reasonably anticipated to reduce the severity of disturbances (insects, diseases and wildfires) over time.

Table 1. Comparison of current forest condition with historical reference conditions, East Okanogan/ West Ferry Proposed Warning Area for western spruce budworm

	Forest Biophysical Setting[1]					
	Ponderosa Pine-Douglas-fir			**Western Larch-Douglas-fir**		
Succession Class[1]	**Current Acres**	**Current Percent**	**Ref. Condition Percent**	**Current Acres**	**Current Percent**	**Ref. Condition Percent**
Early Development	98,003	17%	**10%**	51,718	16%	**10%**
Mid Development Closed	165,017	28%	**5%**	28,964	9%	**15%**
Mid Development Open	185,801	32%	**30%**	175,486	55%	**25%**
Late Development Closed	122,604	21%	**10%**	34,835	11%	**20%**
Late Development Open	16,802	3%	**45%**	26,088	8%	**30%**
Total	**588,227**			**317,091**		

[1] Each biophysical setting and succession class is defined in LANDFIRE models, see Staff Report Table 10 and Appendix B for definitions.

Recommendation: Manage toward a benchmark condition of 265,000 acres in late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time.

In the Douglas-fir-Western larch biophysical setting, there is a similar deficiency of late development open structure conditions, and a large overabundance of mid development open conditions. Managing toward approximately 95,000 acres of late development open structure should be a goal of hazard reduction activities in this part of the landscape.

Recommendation: Manage toward a benchmark condition of 95,000 acres in late development open structure in the Douglas-fir-Western larch biophysical setting over time.

A legacy of previous forest management decisions that focused on recovering maximum stand value by "high grading" the large pine and larch components of these stands exists throughout these two biophysical settings. This has resulted in a reduction of large and old trees below historical reference conditions. More shade-tolerant conifers like Douglas-fir and true firs that had established in the understory prior to harvest were left to comprise the

residual stand. In other cases, stands were intentionally converted to these species in order to grow a more valuable timber commodity. These species are susceptible hosts of western spruce budworm, and now comprise a much larger percentage of dominant trees in these stands than would have occurred historically. Hazard reduction activities should have a dual focus on tree species composition as much as changing forest structure, as is recommended by the TAC in the Stand-Scale Recommendations that follow.

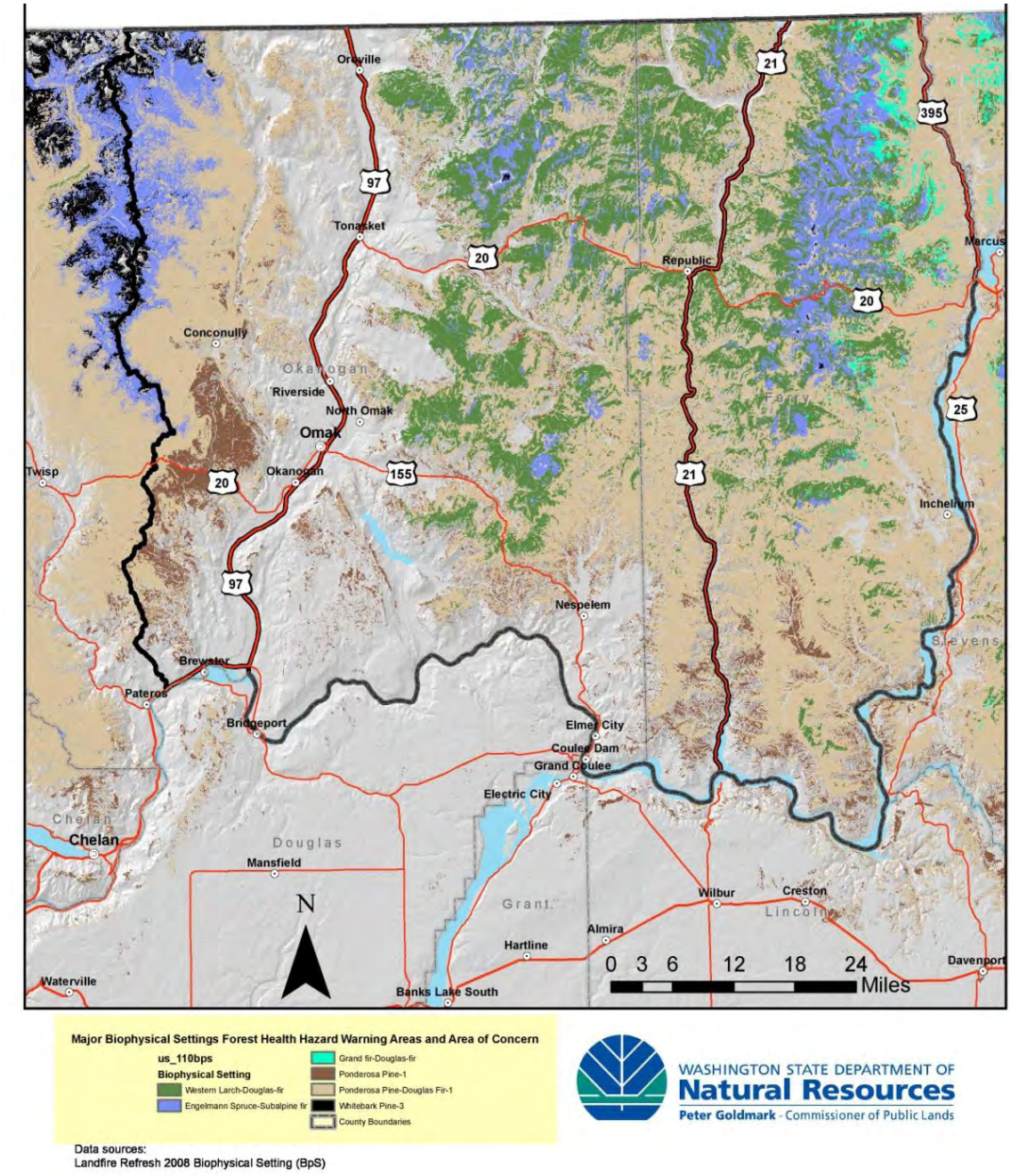


Figure 5. Forest biophysical settings within the recommended warning area and associated areas of concern.

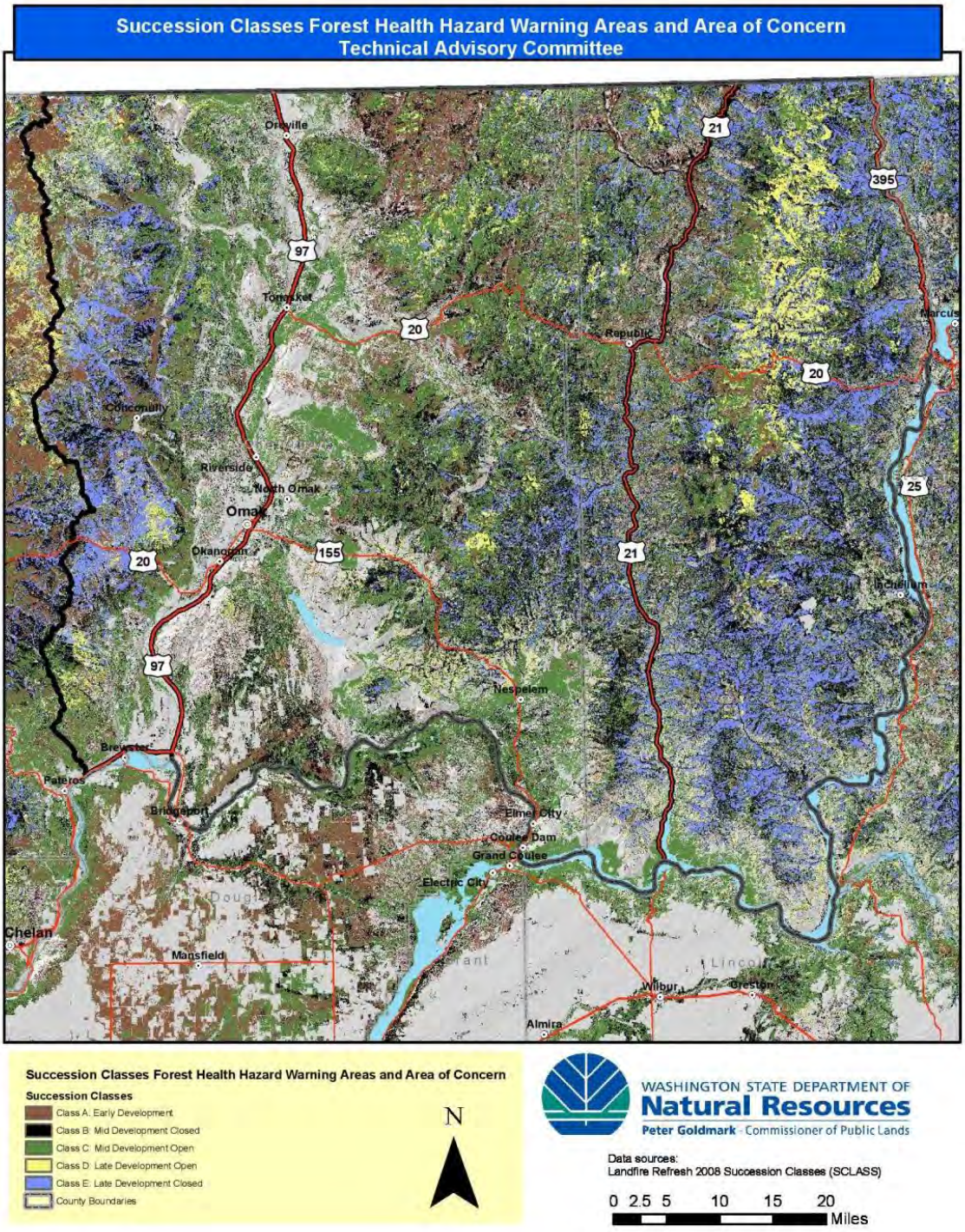


Figure 6. Current distribution of succession classes within the recommended warning area and associated areas of concern.

D.1.3. Areas of Concern – Landscape Recommendations

The TAC chose to make landscape recommendations for the identified areas of concern in addition to the recommended warning area for western spruce budworm. These recommendations are meant to apply to any additional warnings the Commissioner of Public Lands may declare in exercising the available discretion under state law. In the event a warning is not declared, they serve as a benchmark against which to evaluate ongoing voluntary management actions to resolve the identified hazards.

D.1.3.1. Western Spruce Budworm in Eastern Ferry County

The area of Ferry County east of Highway 21 is recommended for consideration of further action by the Commissioner pursuant to RCW 76.06.180(2) regarding western spruce budworm hazards (Figure 2). Table 2 illustrates the current extent of departure comparing current forest structural conditions (Figure 6) with historical reference conditions by broad succession classes (Figure 5). The ponderosa pine-Douglas-fir, and Douglas-fir-Western larch biophysical settings are those representing the highest priority area for western spruce budworm hazard. The ponderosa pine-Douglas-fir landscape is overabundant with mid development and late development structure that is closed-canopy. There is consequently a significant deficiency of late development open structured conditions, which would have occupied approximately 209,000 acres under reference conditions but currently comprise only 13,700 acres. Management actions that move toward this reference condition can be reasonably anticipated to reduce the severity of uncharacteristic disturbances (insects, diseases and wildfires) over time.

Table 2. Comparison of current forest condition with historical reference conditions, East Ferry County Area of Concern for western spruce budworm

	Forest Biophysical Setting[1]					
	Ponderosa Pine-Douglas-fir			Western Larch-Douglas-fir		
Succession Class[1]	Current Acres	Current Percent	Ref. Condition Percent	Current Acres	Current Percent	Ref. Condition Percent
Early Development	34,393	7%	10%	15,789	8%	10%
Mid Development Closed	145,400	31%	5%	35,328	19%	15%
Mid Development Open	113,912	25%	30%	73,535	39%	25%
Late Development Closed	157,543	34%	10%	49,443	26%	20%
Late Development Open	13,736	3%	45%	14,199	8%	30%
Total	**464,984**			**188,295**		

[1] Each biophysical setting and succession class is defined in LANDFIRE models, see Staff Report Table 10 and Appendix B for definitions.

Recommendation: Manage toward a benchmark condition of 209,000 acres of late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time.

The Western larch-Douglas-fir landscape is overabundant in mid development and late development closed structure. There is consequently a significant deficiency of late development open structured conditions, which would have occupied approximately 56,500 acres under reference conditions but currently comprise only 14,200 acres.

Recommendation: Manage toward a benchmark condition of 56,500 acres of late development open structure in the Western larch-Douglas-fir biophysical setting over time.

D.1.3.2. Ponderosa Pine Bark Beetles

East Okanogan County and Ferry County

Table 3 illustrates the current extent of "departure" comparing current forest structural conditions (Figure 6) with historical reference conditions by broad succession classes in the ponderosa pine biophysical setting (Figure 5) within East Okanogan and Ferry Counties. The landscape is overabundant with late development closed forest structure. There is a significant deficiency of late development open structure, which would have occupied approximately 82,000 acres under reference conditions but currently comprises only 60,226 acres. Management actions that move toward this reference condition can be reasonably anticipated to reduce the severity of disturbances (insects, diseases and wildfires) over time.

There is also a significant early development ponderosa pine component believed to be associated with recent wildfires and even-aged management practices on the Colville Reservation. As these stands mature, they can grow stagnant and become another source of pine bark beetle hazard in the long-term unless they receive intermediate treatments.

Table 3. East Okanogan County and Ferry County area of concern comparison of current forest conditions with historical reference conditions in ponderosa pine biophysical setting[1].

Succession Class[1]	Current Acres	Current Percent	Ref. Condition Percent
Early Development	34,209	23%	**5%**
Mid Development Closed	1,628	1%	**15%**
Mid Development Open	3,882	3%	**15%**
Late Development Closed	49,973	33%	**10%**
Late Development Open	60,226	40%	**55%**
Total	**149,918**		

[1] Each biophysical setting and succession class is defined in LANDFIRE models, see Staff Report Table 10 and Appendix B for definitions.

Recommendation: Manage toward a benchmark condition of 82,000 acres in late development open structure in the ponderosa pine biophysical setting over time within the East Okanogan and Ferry County area of concern.

Recommendation: Manage the transition of early development ponderosa pine to mid development stages to control stand density and avoid overabundant closed-canopy conditions contributing to future bark beetle hazard.

Klickitat and Yakima Counties

Table 4 illustrates the current extent of departure comparing current forest structural conditions (Figure 8) with historical reference conditions by broad succession classes in the

ponderosa pine and ponderosa pine-Douglas-fir biophysical settings (Figure 7) within the area of concern described for Klickitat and Yakima counties (Figure 3). The ponderosa pine biophysical setting in this landscape is overabundant with late development closed forest structure. There is a significant deficiency of late development open structure, which would have occupied approximately 89,000 acres under reference conditions but currently comprises only 65,633 acres. Management actions that move toward this reference condition can be reasonably anticipated to reduce the severity of disturbances (insects, diseases and wildfires) over time.

Table 4. Klickitat and Yakima County area of concern comparison of current forest conditions with historical reference conditions in ponderosa pine and ponderosa pine-Douglas-fir[1] biophysical settings.

	Forest Biophysical Setting[1]					
	Ponderosa Pine			Ponderosa Pine-Douglas-fir		
Succession Class[1]	Current Acres	Current Percent	Ref. Condition Percent	Current Acres	Current Percent	Ref. Condition Percent
Early Development	21,544	13%	5%	41,712	16%	10%
Mid Development Closed	6,813	4%	15%	44,106	17%	5%
Mid Development Open	5,949	4%	15%	76,596	29%	30%
Late Development Closed	61,285	38%	10%	78,535	30%	10%
Late Development Open	65,633	41%	55%	24,741	9%	45%
Total	**161,224**			**188,295**		

[1] Each biophysical setting and succession class is defined in LANDFIRE models, see Staff Report Table 10 and Appendix B for definitions.

Recommendation: Manage toward a benchmark condition of 89,000 acres in late seral open structure in the ponderosa pine biophysical setting over time within the Klickitat and Yakima area of concern.

Recommendation: Manage the transition of early development ponderosa pine to mid development stages to control stand density and avoid overabundant closed-canopy conditions contributing to future bark beetle hazard.

The ponderosa pine-Douglas-fir biophysical setting in this landscape is overabundant with mid development and late development structure that is closed-canopy. There is consequently a significant deficiency of late development open structured conditions, which would have occupied approximately 85,000 acres under reference conditions but currently comprise only 24,700 acres. Management actions that move toward this reference condition can be reasonably anticipated to reduce the severity of disturbances (insects, diseases and wildfires) over time.

***Recommendation*:** Manage toward a benchmark condition of 85,000 acres in late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time.

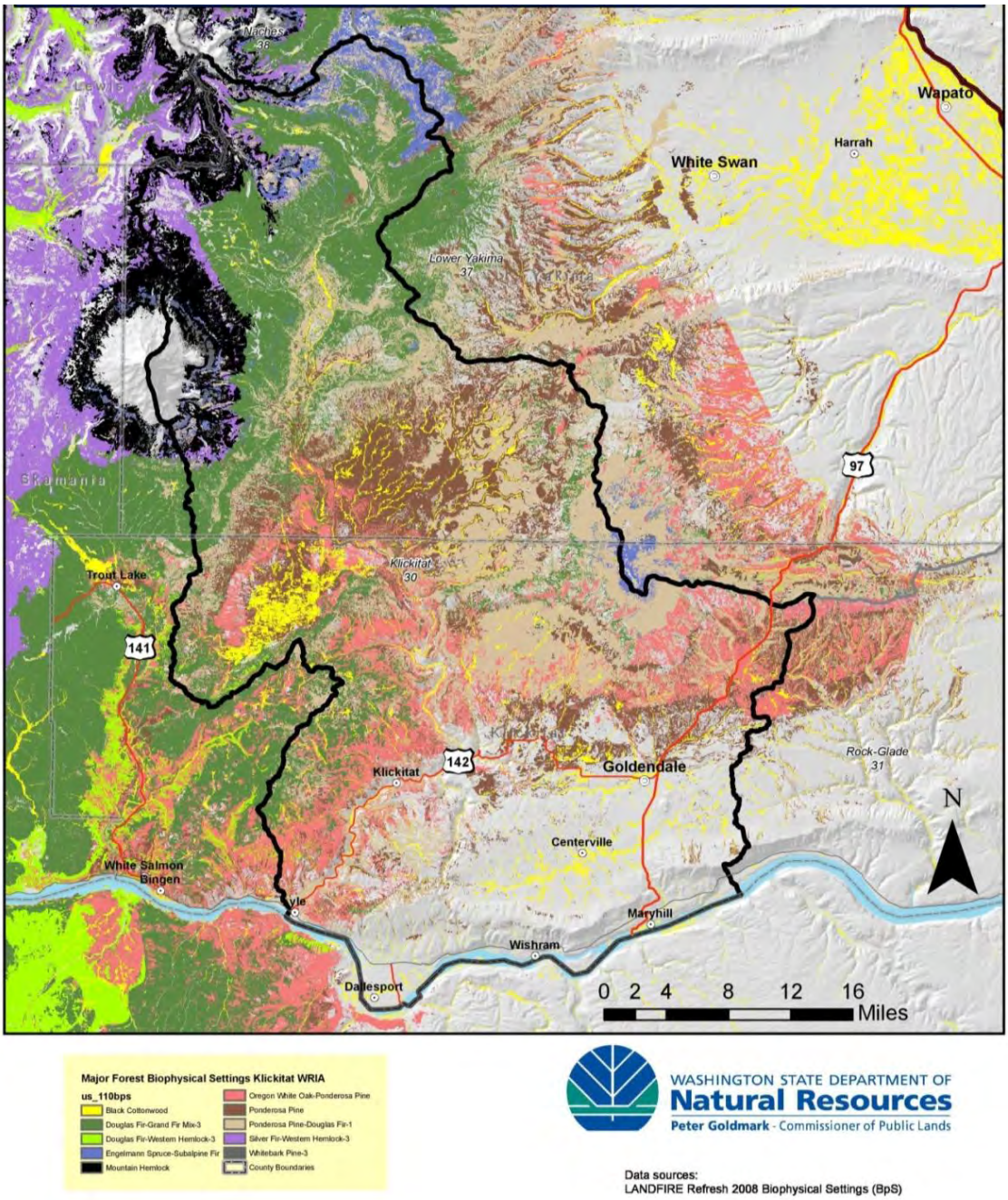


Figure 7. Forest biophysical settings within the Klickitat and Yakima County areas of concern for ponderosa pine bark beetles.

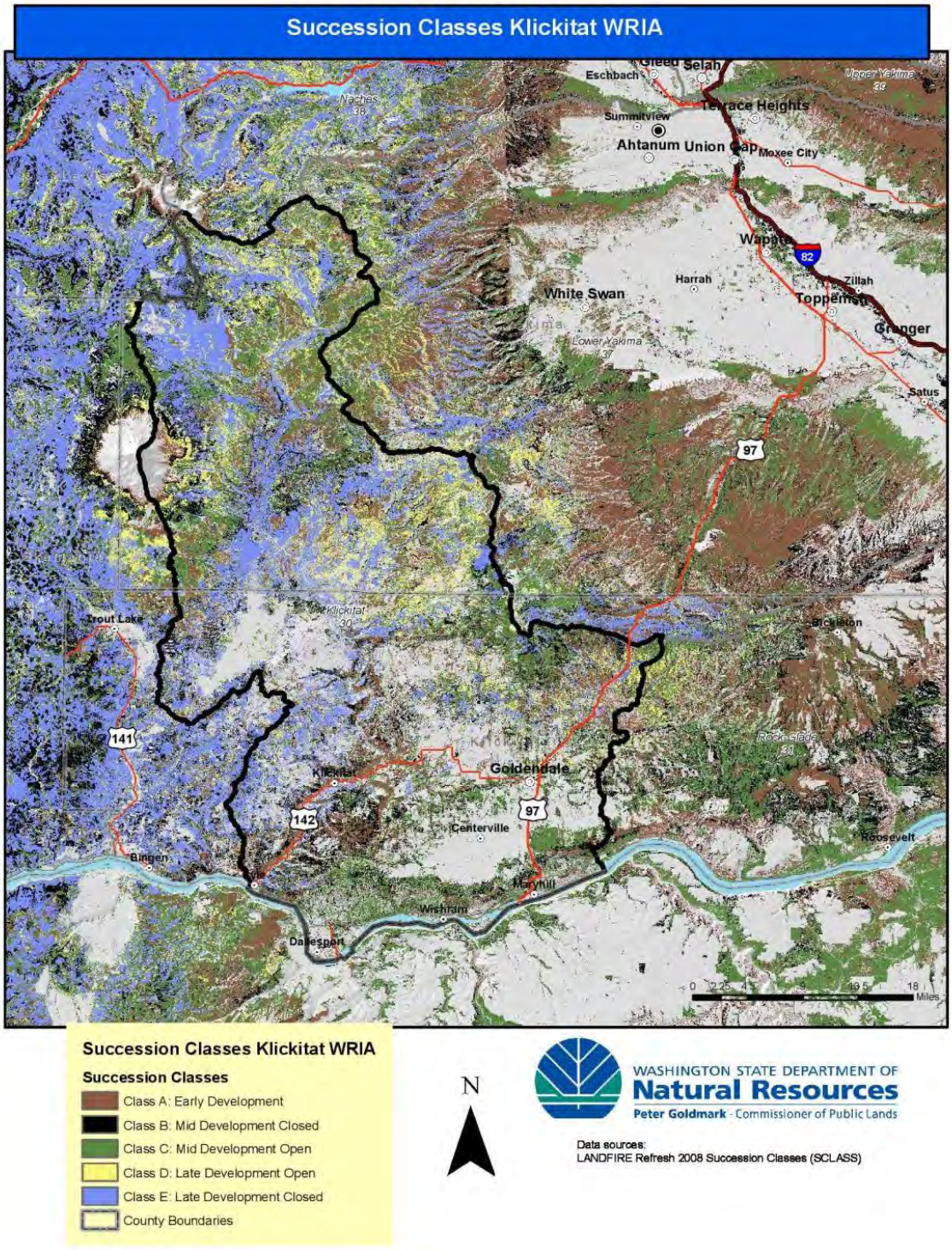


Figure 8. Current distribution of succession classes within the Klickitat & Yakima County area of concern for ponderosa pine bark beetles.

D.1.3.3. Mountain Pine Beetle in Lodgepole Pine

Central Okanogan County

The biophysical settings applicable to mountain pine beetle hazard in lodgepole pine include multiple Engelmann spruce-subalpine fir types. The TAC does not propose to establish a landscape target for lodgepole pine. The computer modeling that supports establishing reference conditions used in these recommendations is designed to work at broader scales in the spruce-fir forest types than are encompassed by the warning area or the areas of concern. Complexities in the model definitions have confounded efforts to combine data in a way that would allow for a relevant comparison of current and reference conditions. Furthermore, the orientation of reserve areas and habitat commitments in the central Okanogan area of concern for lodgepole pine serve to reduce the utility of a landscape condition recommendation.

Mountain pine beetle susceptibility in lodgepole pine is governed by the intersection of suitable host forest conditions with insect population behavior. Figure 9 provides a simple representation of some factors that affect population behavior, with the key feature being host susceptibility, in addition to site characteristics, and climatic factors such as prolonged drought that are interacting with the host conditions.

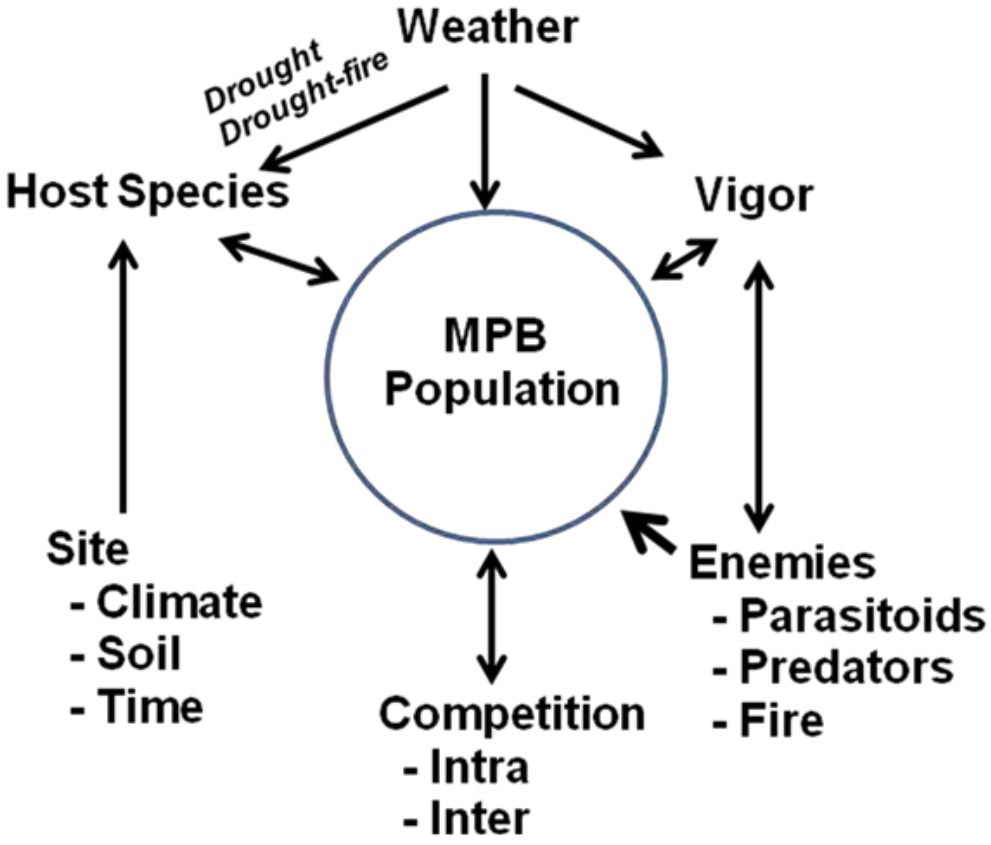


Figure 9. Simple representation of mountain pine beetle population dynamics.

Outbreak behavior can be characterized in several stages, the earliest of which involves selection of host trees for attack based on tree characteristics and stand conditions. The later, more damaging outbreak stages involve less fidelity to stand conditions. The first order recommendation is therefore to determine the condition of the host species in a specific area. From there, stand-scale actions can be developed and prioritized accordingly. Pre-outbreak strategies should concentrate on what must be done to lower host susceptibility across landscapes. These actions include host-species management, establishment of host-age-class mosaics, host density control by traditional silvicultural methods, and the use of fire.

Recommendation: Within existing land management commitments, increase or accelerate planned actions to mitigate mountain pine beetle hazards in lodgepole pine.

D.1.3.4. Summary of Landscape Scale Recommendations

Area and Agent	Action	Landscape Recommendations
Overall	All	All-owner approach is needed, and leveraging cooperative projects is an effective strategy. Conduct a rapid search process to identify projects that are in the late planning stages by major public land management entities and could be accelerated. Build multi-landowner and manager projects from these locations.
Western Spruce Budworm in East Okanogan/West Ferry County	Warning	Manage toward a benchmark condition of 265,000 acres in late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time. Current condition is 16,802 acres.
		Manage toward a benchmark condition of 95,000 acres in late development open structure in the Douglas-fir-Western larch biophysical setting over time. Current condition is 26,088 acres.
Western Spruce Budworm in Eastern Ferry County	Area of Concern	Manage toward a benchmark condition of 209,000 acres of late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time. Current condition is 13,736 acres.
		Manage toward a benchmark condition of 56,500 acres of late development open structure in the Western larch-Douglas-fir biophysical setting over time. Current condition is 14,199 acres.
Ponderosa Pine Bark Beetles in Okanogan and Ferry County	Area of Concern	Manage toward a benchmark condition of 82,000 acres in late development open structure in the ponderosa pine biophysical setting over time. Current condition is 60,226 acres.
		Manage the transition of early development ponderosa pine to mid development stages to control stand density and avoid overabundant closed-canopy conditions contributing to future bark beetle hazard.
Ponderosa Pine Bark Beetles in Klickitat and Yakima County	Area of Concern	Manage toward a benchmark condition of 89,000 acres in late seral open structure in the ponderosa pine biophysical setting over time. Current condition is 65,633 acres.
		Manage toward a benchmark condition of 85,000 acres in late development open structure in the ponderosa pine-Douglas-fir biophysical setting over time. Current condition is 24,741 acres.
		Manage the transition of early development ponderosa pine to mid development stages to control stand density and avoid overabundant closed-canopy conditions contributing to future bark beetle hazard.
Lodgepole Pine Mountain Pine Beetle in central Okanogan County	Area of Concern	Within existing land management commitments, increase or accelerate planned actions to mitigate mountain pine beetle hazards in lodgepole pine.

D.2 STAND-SCALE RECOMMENDATIONS

D.2.1. Western Spruce Budworm Stand Scale Recommendations

A wide variety of silvicultural pathways are available to reduce budworm susceptibility and improve overall forest health in the near- and long-term. These include silvicultural treatments such as selective harvest to decrease budworm host tree species, structure and density management, stand regeneration, prescribed fire, wildland fire use, and the use of pesticides as a well-timed precision tool prior to silvicultural treatments. The effect of pesticide treatment is of short-duration (Sheehan, 1996) and is not a long-term strategy to reduce forest susceptibility to damage.

The TAC recognizes the strategies and timely actions pursued by Yakama Nation tribal foresters in responding to a long-term western spruce budworm outbreak. The fundamental elements of this strategy included (Flanagan, 1999):

A. A working knowledge of the host-budworm entwined life histories and why stands become susceptible to real/potential outbreaks.
B. Development of practices that modified stand conditions to reduce incidences of budworm outbreaks.
C. Establishment of pesticide treatments if efforts at timely modification of forest conditions fail, and budworm outbreaks are building up in spite of the silvicultural approaches. The use of pesticides as a precision tool to knock down the budworm population with the understanding that renewed silvicultural attention will be given to these forests.
D. Protocols to keep track of changing landscape conditions (i.e. through flights and stand analyses) to ensure that stands and landscapes are following trajectories that are unfavorable to budworm population build ups.

Landowners and managers whose objectives are aligned with moving toward landscape-scale recommendations should map out a silvicultural pathway, recognizing that this may involve multiple activities over a period of time. Progression toward fewer canopy layers and reducing stands' component of stagnating Douglas-fir and true firs, and managing stand density are the most important long-term risk factors. For reasons previously described, susceptible hosts of western spruce budworm now occupy a much larger percentage of the landscape than would have occurred historically and are configured in a multi-layered canopy that increased damage.

As site-specific considerations allow, resilient forest conditions are enhanced by favoring the retention of large ponderosa pine and western larch, which are non-host or non-preferred species for western spruce budworm. Reducing the site occupancy of true fir and Douglas-fir below 30 percent and reducing the number of stand canopy layers will reduce the amount and continuity of suitable budworm host conditions. Extensive regeneration of shade-tolerant, late successional true firs should be strongly discouraged, such as through maintenance treatments or using low-intensity controlled fire. Early precommercial thinning that targets the removal of host species is another effective method of transitioning susceptible stands to vigorous pine and western larch dominated stands.

Hazard reduction activities in previously high-graded stands will often require the removal of low value material. The economic viability of these activities is made more difficult by the distance to forest products manufacturing infrastructure throughout much of the proposed warning area. In some cases, too little ponderosa pine or western larch will exist in the residual stand to build a future stand. Extensive dwarf mistletoe may also be present in residual overstory trees, and depending on its severity and distribution can infect the regeneration of a desirable species mix. The combination of these factors may require the harvest of the existing timber and reforesting by planting more appropriate seedling species. Each of these sets of circumstances requires site-specific conditions to be evaluated by a professional forester.

However, a useful guide to silvicultural pathways and choices is presented in US Forest Service Technical Bulletin 1695 (Brooks et al, 1985). A useful stand susceptibility rating system is proposed in the publication *Silvicultural Strategies to Reduce Stand and Forest Susceptibility to the Western Spruce Budworm* (Carlson and Wulf 1989). Relevant stand-scale factors include:

- Percent host crown cover
- Percent climax host crown cover
- Stand density
- Number of canopy layers
- Stand vigor
- Stand age/maturity
- Biophysical setting
- Regional climate
- Character of adjacent forest conditions

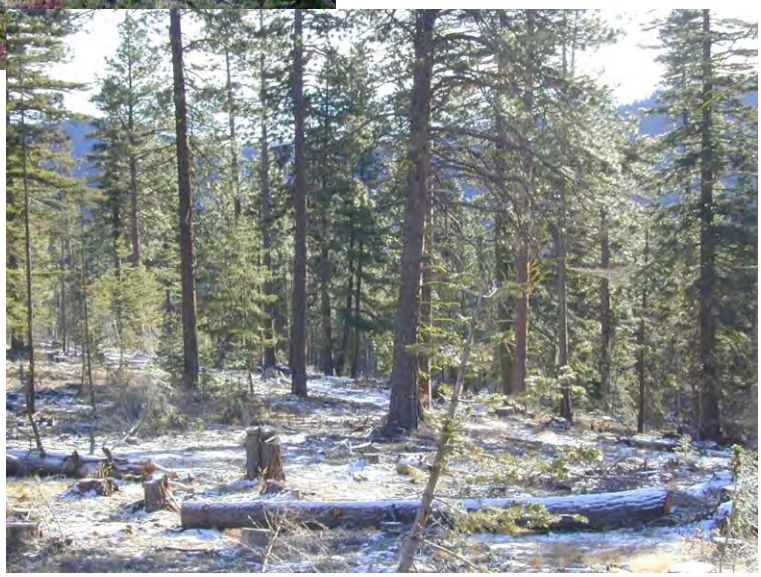
Together these factors comprise an index of susceptibility, where ratings from 0 to 20 indicate low susceptibility; 21 to 50, moderate; and more than 50, high. Actions should favor silvicultural strategies that reduce index values to low or moderate levels and contribute toward landscape-scale forest structure goals.

A specific example of well-executed western spruce budworm hazard reduction at the stand-scale is presented below using the "Nuthatch Timber Sale," which occurred on DNR-managed state trust lands in 2002. This sale was planned and harvested during a western spruce budworm outbreak. After logging, the stand changed from 72 percent Douglas-fir and grand fir to 80 percent ponderosa pine. The sample case represents the best set of circumstances for silvicultural treatment to occur while an outbreak is in progress because sufficient non-host or non-preferred species like ponderosa pine and western larch were present. Where the stand is instead comprised entirely of host species, thinning mid-outbreak effectively concentrates budworm defoliation on the residual trees thereby increasing damage severity (Wickman et al, 1992). This should be avoided. In advance of an outbreak, the best defense is to sustain and maintain a resilient stand with an appropriate density and species mix. Removal or reduction of host species can provide insurance against western spruce budworm and is the primary long-term solution to the issue.

Sample Case: Nuthatch Timber Sale – Ahtanum State Forest

The Nuthatch Timber Sale was harvested during the summer and fall of 2002. This timber sale was located in the Ahtanum State Forest in Yakima County. The primary objective of this treatment was the reduction in stocking levels of Douglas-fir and grand fir due to a western spruce budworm outbreak that had spread into the Ahtanum by 2001. This variable retention harvest removed 3,620 thousand board-feet (mbf), with Douglas-fir and grand fir totaling 90 percent of harvested volume. Today, this stand contains 46 trees per acre, an average diameter of 15.3 inches, 57 ft^2 per acre of basal area, and a relative density of 14.5. Evidence of WSBW in this area is currently very low.

Nuthatch Timber Sale (Unit 1) Pre & Post Harvest Stand Metrics						
Tree Species	**Pre-Harvest**			**Post-Harvest**		
	Avg DBH (inches)	Trees/Ac	Volume Removed (Mbf)	Avg DBH (inches)	Trees/Ac	Basal Area (ft^2/ac)
Douglas-fir	14.6	54	1,446	17.2	2	3
Grand fir	13.7	63	1,828	16.4	2	2
Ponderosa pine	13.8	40	312	13.9	37	46
Western larch	14.6	6	34	15.1	5	6
Totals		**163**	**3,620**		**46**	**57**



Left: Pre-harvest forest conditions (Photo: Eric Watrud).

Below: Post-harvest forest conditions (Photo: Chuck Wytko)

D.2.2. Lodgepole Pine/Mountain Pine Beetle Stand-Scale Recommendations

The vast majority of suitable host area for mountain pine beetle in lodgepole pine exists on lands managed by DNR and the US Forest Service. There has been substantial treatment of lodgepole pine stands on DNR-managed state trust lands during the last decade. A significant percentage of US Forest Service-managed land in the area is classified as Wilderness, inventoried roadless areas, or are areas otherwise lacking road infrastructure which greatly limits the forest management options. There has been little treatment of lodgepole pine stands on US Forest Service-managed lands in the area of concern during the last decade, however, several large, high severity fires have occurred.

A large percentage of the lodgepole pine stands on DNR and US Forest Service-managed lands have been identified as habitat for Canada lynx. Lynx is listed as a threatened species under the Endangered Species Act and recommendations for managing lodgepole pine must incorporate the habitat needs of lynx.

Table 5. Stand Scale Risk Factors for Mountain Pine Beetle in Lodgepole Pine

Factor	Value
Total stand basal area	>=80 ft²/acre
Average quadratic mean diameter	>= 8 in
Lodgepole pine percentage of total stand basal area	>=25%
Stand age	>=80 years

Due to the silvics and stand dynamics of lodgepole pine, the best means to reduce the threat of mountain pine beetle mortality is to employ regeneration harvests in stands that are susceptible (Amman et al, 1977). Mountain pine beetle requires trees with large enough diameter to provide adequate phloem (inner bark tissue) in which to feed (Cole and Amman 1980). Thinning from below will therefore have little benefit to stand susceptibility. Alternatively, removing all the large diameter trees will leave suppressed, shallow-rooted trees that are prone to blowdown.

Even-aged harvest systems are therefore recommended for lodgepole pine. Due to past land-use and extensive wildfires, much of the landscape is dominated by even-aged stands that regenerated in the early 1900s. Thus, large portions of the landscape became prime habitat for mountain pine beetle at the same time which has led to large outbreaks. These outbreaks could have been smaller or more easily contained if there was more diversity in stand ages across the landscape.

In mixed stands where there are significant components of non-host species such as western larch, Douglas-fir or subalpine fir, vigorous individuals of non-host species should be retained where feasible (Amman et al, 1977). Such an example is presented in the stand-scale case study of the “Norwegian Wood Sorts” project that occurred on DNR-managed state trust land in 2011.

Sample Case: Norwegian Wood Sorts Timber Sale – Ahtanum State Forest

The Norwegian Wood Sorts Timber Sale was harvested during the summer and fall of 2011. The primary objective of this salvage operation was to clean up lodgepole pine that had died during a prolonged mountain pine beetle outbreak that started in 2004. By 2011, nearly all the mature lodgepole pine in this area had been killed. In addition, stocking levels in the subalpine fir were reduced to help minimize the persistent problems with balsam woolly adelgid damage. This harvest removed approximately 8,217 thousand board feet in the Klickitat Meadows area, and the post-harvest stands contain a mixed-aged mosaic of mature western larch, healthy subalpine fir and Engelmann spruce, and a vigorous cohort of lodgepole pine seedlings that has naturally regenerated throughout.

Norwegian Wood Sorts TS (Units 1-7) – Pre & Post Harvest Stand Metrics						
Tree Species	**Pre-Harvest**			**Post-Harvest**		
	Avg DBH (inches)	Trees/Ac	Volume Removed (Mbf)	Avg DBH (inches)	Trees/Ac	Basal Area (ft^2/ac)
Lodgepole pine	14.2	69	5,632	N/A	0	N/A
Subalpine fir	13.5	51	1,756	15.9	12	17
Engelmann spruce	12.9	33	410	21.0	5	13
Western larch	21.3	10	55	29.4	6	18
Mountain hemlock	10.8	18	364	10.4	3	4
Totals		**181**	**8,217**		**26**	**52**

Above: Pre-harvest mountain pine beetle mortality and stand conditions (Photo: Brian Mize).

Right: Post-harvest stand conditions (Photo: Ken McNamee)

D.2.3. Ponderosa Pine/Pine Bark Beetles Stand-Scale Recommendations

Mountain pine beetle and the western pine beetle are responsible for the majority of ponderosa pine bark beetle mortality in Washington State. Decreasing ponderosa pine stand densities through well-timed and careful thinning is the primary silvicultural treatment recommended for reducing susceptibility to pine bark beetles (Amman and Logan 1998).

Table 6. Stand scale risk factors for pine bark beetles in ponderosa pine.

Factor	Value
Total stand basal area	>=120 ft²/acre
Average quadratic mean diameter	>= 10 in
Ponderosa pine percentage of total stand basal area	>=50%
Stand structure	Single story, even aged

Thin stands by removing the least vigorous trees (slowest growing, diseased, broken or wounded trees). In general, the residual stand should have a spacing of 13 to 25 feet between trees depending on the size of the trees in the stand (Braun and Gara 1990). Stands with larger diameter trees should be spaced towards the upper end of the range. Wider spacing will promote greater reductions in susceptibility to bark beetle attack, whereas closer spacing will promote greater timber quality. Residual stand basal area after thinning should be between 65 ft² and 95 ft² per acre. Table 7 provides tree spacing and density options for a range of timber quality objectives, each reducing bark beetle hazard to varying degrees. More productive sites are able to support higher tree densities than drier sites. Two examples are presented in the sample cases of the "Beetle Rock FIT" and "Vandal Timber Sale" projects that occurred on DNR-managed state trust land in 2009. Visual representations of post-harvest tree densities are also provided in the sample cases.

Table 7. Range of tree spacing and density options to reduce ponderosa pine susceptibility to pine bark beetles (Braun and Gara 1990).

Timber Quality Objective	Higher	>>>>>	Lower
Bark Beetle Hazard	Higher	>>>>>	Lower
Inter- tree spacing (feet)	13.1	19.7	26.3
Stem density (trees/acre)	133	80	67
Tree diameter (inches)	11.4	12.2	12.7
Basal area (ft²/acre)	94	66	65

"Thinning from below" will remove the suppressed and slow-growing trees providing more growing space and resources for vigorous trees that are better able to defend against bark beetle attacks. Trees with dwarf mistletoe should be removed in cases of severe infestation or where significant impacts to established regeneration would occur.

The recommendations above are presented in terms of general basal area guidelines. More precise stocking recommendations for ponderosa pine and other tree species can be found in the publication *Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington: An Implementation Guide for the Umatilla National Forest*. This publication contains recommendations on stand density index (SDI), canopy cover, basal

area and spacing based on tree species, quadratic mean diameter and plant association (Powell 1999).

Pine bark beetle hazard reduction may also be achieved by stand scale treatments that achieve a patchy or clumpy structure. The objectives for such a treatment are described in the Okanogan Wenatchee Dry Forest Restoration Strategy (USFS, 2010):

> "Historically, dry forest stands were clumped at fine scales (< ½ acre) and clumps were composed of even-aged groups of trees (Harrod et al. 1999). Stands were uneven-aged and composed of these even-aged groups. Average tree diameters were considerably larger than they are in contemporary stands. This clumpiness is consistent with the patterns of stand development described by Cooper (1960) and White (1985), in which seedlings are established in a patchy fashion due to frequent fire within occasional "hot spots" that result from accumulated fuel.
>
> Spatial patterns influence important ecological processes, such as fire spread and insect outbreaks. Historically, natural openings limited the potential for crown fire and created a diversity of habitats, promoting a diverse understory. When trees died in clumps, accumulated fuels created areas for seedling establishment following fire. On average, low-density stands maintained by fire were at or below critical thresholds for serious bark beetle outbreaks. However, beetles were present and largely confined to high-density clumps that were likely above the critical threshold for bark beetles. Disturbance processes, fire and insects, function differently in clumped stands with gaps, as compared with more evenly spaced stands. Insects cause mortality of high-density clumps allowing fires to burn dead wood and create openings for establishment of new clumps (Agee 1993, Harrod et al. 1999)."

Care must be taken to avoid soil compaction and injuring residual trees during timber harvesting. Slash from thinning operations should be lopped and scattered, or burned if thinning occurs from January to June. Untreated slash in the spring can promote high *Ips* spp. beetle populations. Conducting thinning operations from July to December mitigates much of the risk from *Ips* beetles breeding in slash. Chipping slash while bark beetles are active should be avoided (Fettig et al, 2006).

Sample Case: Beetle Rock "FIT" Project – DNR Northeast Region, Spokane County

The Beetle Rock forest improvement treatment (FIT) was conducted in 2009-2010. The primary forest health objectives were to promote ponderosa pine and reduce basal area to lower hazard from pine bark beetle caused mortality. The harvest units were located on dry, severely moisture-limited sites. Tree density is variable, exhibiting an aggregated or clumped pattern of distribution dependent on moisture availability. Pre-treatment stand basal area averaged 170 square feet per acre. Radial growth was poor, 13 rings or more per inch, due to dense stand conditions. The reduced radial increment of dominant and co-dominant trees provided further evidence of competitive stress, loss of vigor, poor resiliency and low resistance to bark beetles. Post-treatment stand basal area averaged 68 square feet per acre. In this case the residual stand density is on the low end of the ranges discussed in Table 7, Section D.2.3. of the Stand-Scale Recommendations and reflects the moisture limitations of the site.

Above: Pre-harvest stand conditions. (Photo: Mike Johnson/DNR)

Right: Post-harvest thinned stand. (Photo: Mike Johnson/DNR)

Sample Case: Vandal Timber Sale – Klickitat Unit near Glenwood, WA

The Vandal Timber Sale was harvested in 2009. The existing stand contained an older cohort (120 yrs) of ponderosa pine, a Douglas-fir cohort of 64 years old and a broad range of younger Douglas-fir and grand fir cohorts. Many of the large ponderosa pines were attacked by western pine beetle leading to thinning crowns and mortality, especially in the denser groups. The primary objectives of this silvicultural treatment were 1) to maintain a large, vigorous ponderosa pine component of the stand; and 2) manage the Douglas-fir component at a sustainable stocking level and structural diversity that provides long-term nesting/roosting/foraging habitat in support of two adjacent Northern spotted owl nest sites. Large, healthy ponderosa pines were retained during the harvest to promote species and structural diversity. Dead and damaged pines were removed as well as reducing the density of Douglas-fir and grand fir trees surrounding the remaining pine. In this case the residual stand density is on the high end of the ranges discussed in Table 7, Section D.2.3. of the Stand-Scale Recommendations and reflects the higher productivity of the site.

Vandal Timber Sale - Pre & Post Harvest Stand Metrics				
Pre-Harvest (2008)			Post-Harvest (2010)	
Trees/Ac	Basal Area (ft²/acre)	Volume Removed (Mbf/ac)	Trees/Ac	Basal Area (ft²/acre)
160	160	12	90	120

Above: Pre-harvest western pine beetle mortality and stand conditions (Photo: DNR).

Right: Post-harvest large, healthy ponderosa pine retained (Photo: DNR).

D.3 SPECIAL LANDOWNER/MANAGER RECOMMENDATIONS

The TAC is required to recommend "potential approaches to achieve the desired results for forest land ownerships of fewer than ten acres and for forests owned for scientific, study, recreational, or other uses not compatible with active management." [RCW 76.06.170(2)(b)]

Landowners under ten acres in size typically include a primary or secondary (i.e., vacation home) residential structure and therefore are less likely to include forestry in their management objectives. However, these landowners are often clientele of DNR's wildfire hazard reduction programs, which are prioritized to address homes at risk of wildfire and therefore oriented toward residential forest owners. The most effective way to accomplish forest health hazard reduction objectives with this type of landowner is therefore to couple these with wildfire hazard reduction projects. Projects should be prioritized to coincide with larger multi-landowner and land manager projects in the process outlined in Management Recommendations, or with ongoing or planned wildfire hazard reduction projects conducted by DNR.

The preponderance of scientific, recreation and lands not compatible with active management in the proposed warning area include US Forest Service inventoried roadless areas, the DNR-managed Loomis Natural Resources Conservation Area, and several small reserves on the Colville Reservation. These designations afford some latitude to actively manage forest health hazards, but it is generally not the focus of management. Primarily these are high-elevation forests associated with mountain pine beetle hazard in lodgepole pine. Fewer areas overlap with the recommended warning for western spruce budworm suitable host areas. Within the framework of Landscape Recommendations, desired outcomes can be achieved without significant focus on these areas.

D.4 EXTREME WILDFIRE HAZARD

In its deliberations, the TAC assessed scientific and quantitative evidence associated with insect and disease interactions with extreme wildfire hazard, as required by RCW 76.06.180(2)(a)(ii). Insect damage and mortality changes forest structure, and therefore affect the amount, type and orientation of forest fuels that contribute to wildfire behavior. However, these are complex and variable interactions spread out over space and time. There is no singular scientific or quantitative resource to describe such interactions. Quite to the contrary, there are significantly different findings in the published research depending on the forest type, damage agent, and length of time that elapsed since stand damage occurred (Hicke et. al, 2012). Further detail on this research is presented in the Staff Report.

Communities and counties throughout eastern Washington have developed Community Wildfire Protection Plans in cooperation with DNR, local fire protection districts, the US Forest Service, the Bureau of Land Management and others. These plans, among other things, prioritize areas where homes and infrastructure are at risk from wildfires. The TAC considered these prioritized areas as a proxy for the risks of potential interactions between insect damage and increased fire hazard. Some host areas for individual insect and disease

hazards were located closer to priority areas, where others were farther away and presented a lesser threat.

The committee considers interactions between fire hazard and insect damage as a component of the Landscape and Stand Recommendations presented here. Uncharacteristically severe wildfires and uncharacteristically severe insect outbreaks are linked by the same underlying forest conditions. Resolving these conditions will benefit and attenuate both concerns. Important, however, in the context of stand-scale activities is to dispose of, or otherwise treat fine fuels and logging slash (Johnson et. al 2007). This material makes the most significant fuels-related contribution to extreme wildfire behavior, and can cause bark beetle populations to accumulate to levels that enable successful attacks on healthy green trees (Agee and Skinner 2005).

E. Environmental Risks and Alternatives

In making recommendations to the Commissioner of Public Lands, the committee must consider the environmental risks associated with recommended actions, alternative methods of achieving the desired results, and the risks of no action [RCW 76.06.170(2)(a)]. The TAC has constructed its recommendations broadly with the intent of accommodating individual landowner and manager objectives, and the need to adjust for site specific environmental considerations. A full range of management options should be considered to accomplish the recommendations. Furthermore, recommendations do not contemplate any deviation from local, state or federal requirements designed to protect public resources or the environment. The TAC considers the balance of environmental risks to be favorable toward implementing its recommendations as compared with no-action.

In dry forest types across eastern Washington frequent fire historically managed tree density and composition (favored fire tolerant species such as ponderosa pine, Douglas-fir, and western larch) and in wetter forests over longer periods regenerated them (e.g. lodgepole pine, spruce-subalpine fir). In dry forest types effective fire suppression over the last century has resulted in increased tree density and in many cases changes in forest composition and structure. The rate and extent of active forest management has not kept pace with ingrowth of tree density and composition. The result is forest conditions that are more susceptible to uncharacteristic fire and insects outbreaks.

Eastern Washington forests have evolved with periodic insect and disease-caused damage and mortality. In many cases these episodes were severe, prolonged, and caused major changes to forest conditions at the time. The recent historical record of insect and disease damage, beginning anecdotally in the early 1900s and more quantitatively since the 1950s, shows a pronounced increase in the extent and duration of activity by major insect damage agents. The average annual acres experiencing some amount of mortality or defoliation over the 50-year period of quantitative record is approximately 600,000 acres per year. The data recorded in the 2011 aerial damage survey mark the ninth consecutive year with damage levels above this average. This exceeds the previous mark of eight consecutive above-average years that occurred between 1986 and 1993, and far exceeds the next preceding prolonged damage period of five consecutive years between 1973 and 1977.

The scale of insect and disease damage is broader, and has persisted longer, than at any time in the available record. The TAC therefore concludes that the consequences of inaction are likely to be considerable, undesirable for many forest landowners and managers, and are not in the public interest as described by the Legislature (RCW 76.06.140). However, the order of damage is not equivalent to, for example, the extensive tree mortality that has occurred in British Columbia or interior western forests of the United States. Inaction will result in damage and mortality throughout the proposed warning area, but will not result in landscape-scale mortality in the immediate term.

There is a reasonable expectation that drought and temperature stress will increase through time. This creates an intersection or complex of stressors including past management practices, forest density and tree crowding, along with predicted increases in wildfire extent and severity. Wildfire acres burned in eastern Washington could increase by 50% in the

2020s and more than double by the 2040s (Littell et al, 2010). This presents a significant environmental risk that can be mitigated, in part, by a range of responsible management actions as offered in the TAC recommendations.

As part of its deliberations, the TAC evaluated the presence of values at risk that are relevant to ongoing insect and disease damage as well as future risks. In the landscapes evaluated, important environmental risks were identified that are associated with:

- State- and federally-listed wildlife and fish species;
- State-listed impaired water segments in the forested environment;
- Homes and communities that are susceptible to wildfires in the interface between forested backcountry areas and developed areas;
- The mix of forestland owners whose management objectives may be affected by undesirable forest damage.

The TAC expects that considerations relevant to these and other risks are incorporated in landowner and land managers' decisions with respect to site-specific actions to address the identified forest health hazards.

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