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Ken Gibson

Ed Lieser

Barb Ping

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## Forest Health Protection



# Report 99-7 May 1999

## BARK BEETLE OUTBREAKS FOLLOWING THE LITTLE WOLF FIRE

### Tally Lake Ranger District, Flathead National Forest

Ken Gibson<sup>1</sup>, Ed Lieser and Barb Ping<sup>2</sup>

#### Introduction

The Little Wolf Fire, beginning with a lightning strike in Little Wolf Creek drainage, Kootenai National Forest (NF) on August 12, 1994, had spread eastward onto Flathead NF by early the next day. By time of containment on August 26, and its being "controlled" on September 7, the fire had burned with varying intensities on more than 15,400 acres. Nearly 10,600 of those affected acres were on Tally Lake Ranger District (RD).

An analysis of the burned area, accomplished largely through interpretation of aerial photography taken immediately after the fire, showed most stands were of mixed conifer composition. Approximately 40 percent were classified as "spruce/fir," of which about one-third was Engelmann spruce; the remainder subalpine fir. Another 47 percent were lodgepole pine stands--many of which had been affected by mountain pine beetle outbreaks in the mid- to late-1980's. Many of the lodgepole pine stands within the fire area, and elsewhere on the District had been harvested and were in various stages of regeneration. Most stands in riparian areas still contained many beetle-killed trees. About 10 percent of the area was Douglas-fir stands, another 3 percent western larch. Most stands were some combination of the above species.

Assessments of fire intensity showed that within the 10,600-acre fire perimeter, fire effects ranged from total stand replacement to little apparent damage. Fire severity, as it appeared on aerial photographs taken immediately after the fire, was classified using the following designations:

1. **Black.** Tree boles completely blackened, foliage destroyed, boles deeply charred and understory vegetation burned--**23 percent** of the area was in this category.
2. **Black/Brown.** Predominantly blackened, but some foliage only browned-- **18 percent** of the area.
3. **Brown/Black/Some Green.** Mostly browned foliage, some blackened spots, but some green foliage as well--**15 percent** of the area.
4. **Mixed Green/Some Brown-Black.** Predominance of green foliage, but some spotty brown or

blackened areas. Ground fire of varying intensity-- **44 percent** of the area in this class.

### **Bark Beetle Conditions, 1994**

The area was first assessed for potential of insect infestations in early October. Because the fire had occurred sufficiently late in summer to miss most beetle flights, we found no trees attacked by bark beetles or wood borers in 1994. There did, however, appear to be many trees which could be susceptible to beetle attack in 1995. We noted that, dependent upon amount of fire damage they had received, roughly according to above categories, trees would be more or less likely to attract bark beetles the following year. Most in the "black" category would attract few bark beetles, and perhaps not even wood borers.

In the "black/brown" classification, some thicker-barked species such as Douglas-fir and western larch would survive direct fire effects, but be weakened enough to attract bark beetles and/or wood boring insects. Douglas-fir in this category might prove to be especially susceptible to Douglas-fir beetle attacks. Thinner barked species, such as lodgepole pine, Engelmann spruce and subalpine fir may have had inner bark damaged too severely to provide a food source for bark beetles.

We believed trees in the "brown/black/some green" category would attract the most bark beetles, providing brood sources for potentially damaging populations. Degree to which individual trees attracted bark beetles would be determined by amount and type of damage each tree received. Trees "girdled" by root collar damage which left much inner bark on remainder of bole undamaged, would attract large numbers of beetles. Most serious threats would be in fire-weakened Douglas-fir (*Dendroctonus pseudotsugae*) and Engelmann spruce (*D. rufipennis*) stands where Douglas-fir and spruce beetles (*Dendroctonus pseudotsugae* Hopkins and *D. rufipennis* [Kirby]), respectively, take great advantage of disturbances in their hosts species to build populations to epidemic levels (Holsten et al. 1989, Schmitz and Gibson 1996). Fewer threats were anticipated in lodgepole pine and subalpine fir stands because of the "secondary" nature of beetles most likely to be attracted to them.

In the final classification, "mixed green/some black-brown," the amount of bark beetle attraction would be dependent almost entirely on amount of root collar damage. In this burn category, we found numerous trees which had little evidence of fire damage to bole or crown, but had been completely girdled at ground level. Those trees, too, would likely succumb to bark beetle attack within the next year or two. A study completed by Amman and Ryan (1991) following fires of 1988 in Yellowstone National Park (NP) showed fire/beetle-related damage could extend well beyond a year or so after the fire. Bark beetles, building to outbreak proportions in fire-damaged trees, often moved into adjacent stands which had little or no direct affects from the fire itself, in subsequent years. Populations of Douglas-fir and spruce beetles remained unusually high for as long as 5-6 years after Yellowstone fires, and ultimately killed many trees totally free of fire damage (Rasmussen et al. 1996).

### **Bark Beetle Conditions, 1995**

As salvage efforts continued in the fire-affected area, we met once again to assess bark beetles status and their potential for causing tree mortality in areas not included in the burn. In July and again in August 1995, we visited several sites where stand conditions and fire effects suggested the possibility of building beetle populations. While we didn't find nearly as many infested Douglas-fir as we anticipated, we did find more down and standing Engelmann spruce infested by beetles than we had

expected.

Not only were numerous large-diameter spruce dropped in making fire lines or reducing hazard during the fire, but many fire-weakened trees had been wind-thrown during the preceding winter. Those combinations of factors made ideal conditions for dispersing spruce beetle populations in spring/summer 1995. Though "epidemic" populations of spruce beetles did not exist on the District prior to 1995, beetles were apparently attracted to potential brood sites from considerable distances. Once we began to find additional downed and infested spruce, District personnel conducted extensive surveys throughout the fire-affected area.

Surveys showed about 2,000 acres with some amount of infested spruce--generally ranging from 1-20 infested trees per acre. An additional analysis of potentially affected areas showed approximately 5,000 acres, within a 5-mile radius of the burn, which contained a predominance of large-diameter, old-growth spruce. Much of that constituted the "old-growth" component on the District. Because of logging within the past decade, in response to extreme mountain pine beetle-caused mortality, remaining old-growth stands were becoming increasingly valuable as wildlife habitat, sources of clean water for fisheries, and other amenities derived only from old-growth forest stands. The need to protect them from spruce beetle depredations became apparent.

A small advantage in working with spruce beetles is that most have a 2-year life cycle. While some beetles disperse each year due to over-lapping broods, and on some sites and in some years a few may complete their life cycle in 1 year; most in the Little Wolf area were small larvae in 1995. We anticipated we had until spring 1997 to prepare for the next major dispersal flight. In the meantime, salvage of fire-damaged and beetle-infested timber continued.

### **Bark Beetle Conditions and Management, 1996**

Following an unusually cold period in early 1996, we assessed overwintering spruce beetle populations and found most had survived low temperatures. Sanitation/salvage efforts to reduce likelihood of damaging populations in 1997 should, therefore, continue. While spruce beetle populations were of primary concern, we began to find indications of building Douglas-fir beetle populations as well.

While we had been concerned in 1996 with the potential for Douglas-fir beetle-related damage, in most areas it appeared those concerns were not being realized. During winter 1995-1996, however, there had been significant amounts of blowdown in some areas within and near the burn. Surveys conducted during summer 1996 revealed several areas where large amounts of windthrow had been infested and the likelihood of populations increasing to damaging proportions seemed high. During that summer and fall, areas of on-going and increasing salvage efforts continued. In addition, several sites were identified where trap trees were felled to help attract and concentrate both spruce and Douglas-fir beetles in spring 1997.

### **Bark Beetle Conditions and Management, 1997**

Planning for salvage was completed and operations began in 1997. The objective of the fire salvage was twofold: to salvage fire-damaged trees before their merchantability was lost, and to control bark beetle populations in a timely manner. Approximately 1,200 acres were contracted for salvage, solely

to control spruce beetle populations before spring 1997. To complicate matters, however, a preponderance of sites to be salvaged were located in riparian areas, or on soils susceptible to compaction. Consequently, helicopter logging was required on 80 percent of the area to be harvested. Mobilizing and completing those operations in such a short time proved to be impossible.

Realizing then that not all trees infested with spruce beetles, and from which adults would fly in late spring, would be removed prior to beetle emergence, we elected to install pheromone-baited funnel traps in areas where salvage logging would not be completed until late summer. In twenty areas, identified by known infested areas nearby, we installed clusters of ten traps each (Figure 1). Traps, containing spruce beetle attractants, frontalin and alpha-pinene, were installed in late May, emptied and checked weekly, and removed in late August. Though we did not accurately count all trapped beetles, a reasonable estimate suggested more than 20,000. While that is a small number compared to total beetles existing in a typical "outbreak," trapping combined with salvage efforts and removal of trap trees resulted in no new beetle-infested trees being found at season's end.

Figure 1 - ESB trap placement [map \(228k\)](#)

Throughout the season, however, increasingly high amounts of Douglas-fir beetle-infested Douglas-fir were found in stands which had been only slightly affected by the fire, and in adjacent, unaffected stands. While salvage logging continued, we realized not all of those areas could be harvested prior to beetle flight in 1998. As the field season of 1997 ended, plans were being made to install pheromone traps in beetle-infested areas in spring 1998 in order to reduce the number of beetle-killed Douglas-fir which would otherwise result.

### **Bark Beetle Conditions and Management, 1998**

After success achieved trapping spruce beetles in 1997, we were more confident in attempting a similar approach in 1998 for Douglas-fir beetles. We knew Douglas-fir beetle populations were higher and more widespread, and there would be a greater risk of mortality in nearby trees from "spill-over," still we believed we could produce a beneficial effect through judicious trap placement (Ross and Daterman 1997). And, we obtained an experimental pheromone lure, one stronger than commercially available, to enhance trap catches in some locations (Daterman, personal communication). In total, we hung 175 traps in 18, 9-trap clusters, and one each of 6 and 7 traps. We used stronger lures in 36 traps (3 traps in 12 of the 9-trap clusters). In the other 139 traps we used standard Douglas-fir beetle trap lure (Figure 2).

Traps were hung the week of April 27, baited with two different combinations of pheromone lures, and removed between August 24 and September 1. Pheromone lures were the commercially available frontalin, ethanol and methylcyclohexanol; and as a comparison, an "experimental" combination of frontalin, ethanol and seudenol. Beetles were apparently flying at the time traps were hung--we found beetles in traps on April 28. Peak beetle flight occurred between July 7-15--more than a month later than a "typical" Douglas-fir beetle flight, which usually is completed in early June. By the end of August we were collecting almost no beetles, though a few beetles may have flown after September 1. In total, we collected an estimated 860,000 beetles. In addition, about 825 Douglas-fir in stands within 200-300 feet of trap clusters were attacked. Those infested trees were removed in fall, 1998. Between trap catches--perhaps the equivalent of 1,000 attacked trees--and attacked trees removed, we believe

we have reduced beetle population, in that area, to nearly endemic levels. There are, however, beetle populations elsewhere on the District, a reflection of higher-than-normal populations throughout much of western Montana and northern Idaho. Additional surveys, salvage, and a smaller trapping effort will be conducted in 1999.

Near a few trap sites, there were three areas in which stand conditions precluded use of traps or additional salvage. Because of their old-growth character, and desire to protect present structure, we treated those 3 stands with Douglas-fir beetle anti-aggregant, methylcyclohexanone (MCH). Recently completed research has shown MCH to be effective in protecting standing, green Douglas-fir from attack by Douglas-fir beetle (Ross and Daterman 1995). MCH is formulated and applied as a liquid, encapsulated in a polymer "bubble capsule," and manufactured to elute throughout beetle flight period. Recommended rate of application is 30 bubble capsules per acre, with capsules being stapled to trees or other vegetation on about a 40-foot by 40-foot grid. In the largest area, approximately 15 acres, we placed 408 bubble capsules. In the other two we placed 142 capsules and 50 capsules, about 5 and 2 acres, respectively. Bubble capsules were installed during the first week of May, a few days after beetle flight began. Evaluations following beetle flight showed no new attacks in any treated areas.

The anti-aggregant MCH was first identified and tested successfully in the early 1970's (McGregor, et al, 1984). Since that time it has proven effective in protecting Douglas-fir from beetle attack in various formulations and application rates. Some years ago, the US Environmental Protection Agency (EPA) determined that while attractant pheromones were not subject to registration, anti-aggregants were. The registration application for MCH has been submitted and we are hopeful its registration, allowing operational use, will soon be

Figure 2 [map \(179k\)](#)

forthcoming. Until that time, it can only be used on a limited basis under the authority of an experimental use permit.

### **Bark Beetle Conditions in 1999 and Beyond**

Spruce beetle populations appear to have returned to endemic levels throughout the District. No spruce beetle-killed trees have been observed during annual aerial surveys, and only a few have been found during extensive ground surveys. Those few found in 1998 were several miles from areas treated in 1997.

Douglas-fir beetle populations, however, are still at epidemic levels throughout much of northern Idaho and western Montana as a result of large amounts of wind-thrown and storm-damaged Douglas-fir, during winter 1996-1997, and relatively mild temperatures during the past few winters. We were aware of some blowdown, in more obviously affected stands; however, we now believe there was more "scattered" windthrow which went largely undetected. It was only during field season 1998, as we began to find more areas with currently infested trees, and as trees attacked earlier began to fade--result of a hotter and drier-than-normal late summer--that we began to realize extent of current outbreaks. Aerial surveys flown in September to help define magnitude of infestations in northern Idaho and western Montana, and ground surveys to assess "build-up ratios" from 1997 to 1998, began to reveal one of the most extensive outbreaks in our Region in recent history.

During "outbreaks" which occurred in northern Idaho-western Montana from 1986-1992, a high of 27,182 infested acres and an estimated 62,000 beetle-killed Douglas-fir were recorded, in 1988. By 1993, populations had returned to endemic levels in most areas with an estimated 9,066 acres infested Region wide. Now in 1998, aerial survey estimates compiled during regular and supplemental surveys showed an estimated 78,400 acres infested and nearly 145,800 trees killed throughout the Region. Nearly 70,100 of those acres were recorded in northern Idaho. Approximately 800 of 8,300 infested acres recorded in western Montana were found on Flathead NF. That will almost certainly increase in 1999. Most areas in which ground surveys were conducted, showed 1998-attacked trees outnumbered 1997 attacks by a ratio of about 7 to 1. Even so, we believe we have significantly lowered populations in the area affected by the Little Wolf burn.

So, while trapping efforts in 1998 were successful, beetle populations elsewhere on the District were not affected and may continue for 2-3 years more--dependent upon weather and efforts to reduce populations and susceptible hosts. In that attempt, one of four alternatives may be helpful. Selection of the most appropriate one will be determined by management objectives and opportunities.

Alternatives, in decreasing order of site disturbance are:

1. Salvage infested trees. This alternative represents the most reliable means of reducing threats posed by bark beetles. Trees must be removed before beetle emergence. Early spring removal is adequate; removal the preceding fall is better. Site disturbance may be significant, but could be reduced dependent upon proximity of groups to existing roads.
1. 2. Use of "trap trees"--either downed green trees cut in early spring, or green trees baited with pheromone tree baits. Either would require removal of trap trees, and a few "spill-over" trees. Down, green trap trees may be slightly more attractive to beetles, but tree baits have the advantage of requiring only one entry to cut and remove trees. Approximately 2-4 standing baited trees, or downed trap trees per acre, dependent upon the size of the infested group, should be sufficient to attract most emerging beetles. If commitment to remove trap trees can not be made, they should not be used. To install, then not remove them, would only exacerbate an already difficult situation.
1. 3. Use of pheromone-baited funnel traps. Funnel traps have been used to successfully "trap out" small, isolated populations of beetles, as noted in this report. Not as useful for large or widespread populations, funnel traps can still be effective in many situations. They may not be as effective as trap trees or salvage, and there is the possibility of some nearby trees being attacked; but use of traps would be least expensive and result in least amount of site disturbance of several "action" alternatives. Traps, placed in clusters of 10, near infested groups of trees, would be sufficient to trap most emerging beetles. They need to be installed in early spring and emptied weekly for about 6-8 weeks, or until catches cease.
1. 4. Use of anti-aggregant MCH (for Douglas-fir beetle). Having obtained EPA registration, MCH has the potential to be a valuable tool in our efforts to reduce Douglas-fir beetle-caused mortality in high-value areas, or areas in which silvicultural manipulations are not appropriate. It 1999, it is being evaluated in a variety of situations in northern Idaho which will increase our understanding of how effectively it will protect green trees under varying conditions.

1. 5. No action. Under this alternative, potential for beetle populations increasing and killing additional large-diameter trees in nearby susceptible stands is high. Amount of standing-tree mortality corresponds to number of "high-hazard" stands in general vicinity of ongoing epidemics. While outbreaks typically don't last more than 2-4 years in an area, beetles often kill groups of trees which may total several hundred on susceptible sites--densely stocked stands containing a high percentage of older, large-diameter host trees. In general, Douglas-fir and spruce beetle outbreak trends respond to weather and amount of susceptible hosts nearby.

### **Conclusion**

In general, spruce beetle populations have returned to endemic levels on the District. A review, however, of the hazard-rating system currently used to identify threatened spruce stands will illustrate methods used to guide treatment activities in the Little Wolf area. Likewise, they are pertinent for all areas where old-growth Engelmann spruce is maintained.

Areas containing significant amounts of old-growth spruce should be assessed for impacts associated with beetle-caused mortality. Spruce beetle outbreaks could occur in areas where any amount of mortality would not present management concerns. Other areas, where high amounts of tree mortality would disrupt management objectives or adversely affect critical resources, should be hazard rated according to the currently used model. It can help identify stands most threatened by spruce beetle, and ones in which meaningful mortality could occur following outbreak initiation (Schmid and Frye 1976):

1. Stands in which average diameter of live spruce over 10 inches diameter-at-breast-height (d.b.h) is greater than 16 inches.
1. 2. Stands in which total stand basal area exceeds 150 square feet per acre.
1. 3. Stands in which proportion of spruce in the canopy exceeds 65 percent.
1. 4. Stands on well-drained sites in drainage bottoms.

Stands rated "high risk" should be scheduled for silvicultural manipulation in conjunction with overall management objectives. Long-term, large-area management plans should incorporate hazard-rating systems as a means of assisting in the maintenance of overall forest health. Schmid and Frye (1977) noted that we have sufficient knowledge regarding beetle/host interactions to prevent outbreaks if we desire. To do so successfully will require the ability to wisely integrate land-use objectives and an understanding of beetle dynamics.

The future course of Douglas-fir beetle outbreaks on the District, the Forest and throughout the Region will depend on weather conditions and our ability to respond to infested and threatened stands. While a hazard-rating system has not been developed which is applicable throughout the range of Douglas-fir beetle, a useful one was developed a few years ago for southern Idaho by Weatherby and Thier (1993). Their work showed much the same as we have observed: Douglas-fir beetle-caused mortality will be greatest in stands over 250 square feet of basal area, and which are comprised of more than 50 percent Douglas-fir which are older than 120 years and average more than 14 inches d.b.h. Over the past several years, and in Little Wolf particularly, the following guidelines have been



helpful in reducing Douglas-fir beetle-caused mortality.

First, it is crucial to realize the greatest benefits in dealing with actual or potential Douglas-fir beetle infestations are derived from efforts aimed at **preventing** outbreaks rather than **suppressing** them. To the extent possible, susceptible stands should be identified and conditions altered to make them less so, prior to some type of stand disturbance which may trigger an outbreak. Likewise, disturbances--such as blowdown (other common ones are defoliation, drought, and fire damage)--should be ameliorated as quickly as possible. In that way, beetle-caused mortality may not exceed acceptable levels. In lieu of a hazard-rating system, we must consider those stand conditions most conducive to beetle depredations, once outbreaks are generated. They are:

1. Stands in which Douglas-fir is predominant and sites on which those stands are most commonly found. Higher percentage of Douglas-fir--particularly in excess of 50-60 per cent--represents greater susceptibility. Douglas-fir habitat types on south-facing slopes and drier ridges sustain more beetle-caused mortality than others.
2. Age of Douglas-fir in the stand. As Douglas-fir becomes mature to overmature, it slows in growth and is more susceptible to beetles. Greater than 80 years is considered highly susceptible. Beyond 120 years becomes extreme.
3. Size of Douglas-fir in the stand. Usually associated with age, stand susceptibility is also reflected in size of host trees. Generally, larger trees are more susceptible. Trees less than about 16 inches d.b.h are not as likely to be attacked successfully.
4. Overall stand density. When stocking exceeds 80 percent of "normal" for the site, susceptibility to attack increases significantly. Denser stocking, which increases between-tree competition and provides cooler, more shaded environments preferred by beetles, increases probability of infestation. As stocking exceeds 150 square feet of basal area, susceptibility correspondingly increases.

Management activities which alter one or more of those stand conditions--species and/or size composition, age, or stocking--can correspondingly reduce susceptibility to Douglas-fir beetle. Where infestations occur, it is entomologically advantageous to remove currently infested trees to help reduce future beetle-caused mortality. During those entries it may also be economically desirable to salvage recently killed trees because of their propensity to quickly lose value. It would be of even greater benefit to reduce stand susceptibility through sanitation thinning as stands are entered. Where management objectives and other resource considerations permit, removing the larger, older Douglas-fir component from susceptible stands will significantly reduce future beetle-caused mortality in adjacent, less-hazardous stands.

On all sites, root disease presence or potential should be assessed. On some, particularly ones in northern Idaho and portions of western Montana, abnormally high amounts of root disease have resulted in high endemic populations of Douglas-fir beetle. In those stands, disturbances are even more likely to result in significant beetle outbreaks. In addition, where root diseases are present, partial cutting may result in a proliferation of root pathogens and unacceptable amounts of mortality in leave trees.

On some sites, particularly where root diseases are prevalent, it may be desirable to consider

long-term stand conversion to seral species less susceptible to root pathogens and Douglas-fir beetles. On many sites in the intermountain West, fire exclusion and past management activities have resulted in the proliferation of more shade-tolerant, climax tree species--often ones much more susceptible to root-disease-caused mortality. Where practicable, it would be desirable from both a silvicultural and an entomological perspective to favor seral, non-host species such as western larch, ponderosa pine or western white pine.

Beetle outbreaks resulting from the Little Wolf Fire were unique in being concentrated in a relatively confined area. As a result, control of beetle populations was more readily effected. Widespread beetle outbreaks may be more difficult to deal with because of their scattered nature. Still, on a site-by-site basis, individual outbreaks should favorably respond to efforts to reduce impacts.

Although it may not be possible to address each beetle population, which may lessen effectiveness of an overall effort, much can be done to reduce beetle-caused mortality in areas where some type of ameliorating action can be implemented. In that regard, we emphasize the need for extensive ground surveys, such as conducted by District crews during Little Wolf projects, to define extent of currently infested stands. Aerial surveys are useful, but are a year behind, at best. Add the difficulty with which year-of-attack is determined, solely from foliar characteristics, and need for ground surveys becomes obvious.

The Little Wolf Fire, while presenting extreme challenges to forest managers, also provided an opportunity for operational use of pheromone-based management strategies which had been developed and used previously only on a much smaller scale. As noted, silvicultural manipulations used to prevent bark beetle outbreaks will always be preferable to tactics used to suppress them. But occasionally, bark beetle populations will build more rapidly than our ability to either anticipate or respond. In such instances, it is of some comfort to know that strategies have been advanced and proven which will both hasten the return of outbreak populations to endemic proportions and reduce beetle-caused mortality to more acceptable levels.

### **Acknowledgements**

Without the contributions of many on Tally Lake RD, success of the salvage and bark beetle control programs over the past several years would not have been realized. Of particular note, however, are the efforts of Kristy Bly. Her interest in the project, and overall work ethic, provided a level of expertise not often encountered in duties such as trap collections and data tabulations which too quickly become routine and somewhat mundane.

We appreciate the assistance of all who worked on these programs--but especially thank Kristy for "going the extra mile" during the summers of 1997 and 1998.

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