Tumblebug Complex Fire Mortality Assessment

Methodology, Accuracy, and Results

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Introduction

The 14,570 acre Tumblebug fire in the Middle Fork Watershed of the Middle Fork Ranger District, Willamette National Forest started in September of 2009. It was ignited by a lightning storm in two locations which burned together early in the fire's development. By the time the fire was controlled in October it had burned considerable portions of the Tumblebug Creek and Echo Creek drainages and the intervening and adjacent ridgelines. Terrain within the fire perimeter can be generally characterized as steep and in places precipitous, with gentle to nearly flat slopes along the ridge tops and in the northern portion where it approached the Middle Fork valley bottom. The main drainages mentioned above are tributary to the Middle Fork of the Willamette River and flow in a northerly direction. They have many first and second order tributaries of their own, so all slope aspects occur in the fire and none are especially dominant.

This landscape consists of lands designated primarily as "Matrix" by the Northwest Forest Plan (aside from the ubiquitous riparian reserves), and allocated primarily as General Forest and several scenic management areas by the Willamette National Forest Land and Resource Management Plan. It also contains about 400 acres of a large Late-Successional Reserve (LSR, on the west edge of the fire) nine 100 acre LSRs totaling 878 acres, several comparably sized Special Wildlife Habitats, and a 1000 acre Special Interest Area centered on the Tumblebug Gorge.

Forest Plan Land Allocations

Management Area	Acres	Percent of fire
Special Interest Area – 5a (Tumblebug Gorge – Matrix)	1009	7
Special Wildlife Habitat – 9d	537	3
Scenic – modification (11a, Matrix)	4361	30
Scenic, partial retention Middleground (11c, Matrix)	303	2
Scenic, partial retention foreground (11d, Matrix)	113	1
General Forest (14a, Matrix)	6957	48
Late succession reserve (16a)	411	3
Late succession reserve – 100 acre (16b)	878	6
Total	14,569	100

Total Matrix Acres – 11,734 – 81% (not counting Riparian Reserves)

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This landscape is relatively well roaded due to past forest management (harvest) activities. About 30 percent of the fire area (some 4,200 acres) consists of plantations resulting from past even-aged harvest ranging in age from 10 to 45 years.

Soon after the Tumblebug fire was controlled, District Wildlife Biologist Dick Davis and forester Tim Bailey began mapping the extent and degree of mortality. This assessment was focused on effects to late-successional habitat, specifically established habitat parameters for the northern spotted owl. As such, only four subdivisions of mortality extent were used, as follows:

1 - 0 to less than 20% remaining live primary canopy cover;

2 - greater than or equal to 20% and less than 40% remaining live primary canopy cover;

3 - greater than or equal to 40% and less than 60% remaining live primary canopy cover;

4 – greater than or equal to 60% live primary canopy cover.

The latter category also includes areas that did not burn at all. Category 1 equates to unsuitable northern spotted owl habitat as does category 2 aside from the fact that the later will contain important constituent habitat elements as the new stands develop. Category 3 equates to owl foraging and dispersal habitat, and Category 4 equates to fully functional habitat other than the fact that in underburned areas the understory components of these stands have more or less been, at least temporarily, eliminated.

This mapping effort was done to provide a general idea of overall fire effects and to begin an effort to update the District Vegetation Database to account for effects of the fire, in addition to provide a general assessment of habitat effects. This mapping is similar to but not especially complementary of a fire severity map prepared in conjunction with the Burned Area Evaluation Report (BAER) done for this fire soon after it was controlled. The BAER mapping was done primarily from a soil effects standpoint, an effort to indicate the risk of soil and slope movement. For example, areas with full tree mortality due to crown scorch were considered to have only a moderate fire severity because the trees in these areas retained dead needles that have begun the fall to the ground and will provide protection of the bare soil. This fire severity mapping was done quickly over a 4 or 5 day period and relied heavily upon satellite imagery which was compromised by a high elevation early snowfall. Field verification was apparently not incorporated into the final fire severity mapping as the effort shows most of the ridge tops in the fire area (which is where the early snow fell) were either not burned at all or were burned with a low severity. In reality, many of these areas burned with full tree mortality. This subsequent mortality mapping effort was done from a vegetation effects standpoint and partly in response to confusion that many seemed to have that the BAER mapping reflected vegetational effects.

Methodology

When this assessment was commenced the fire was still somewhat active and visibility was poor due to smoke. Initial mapping utilized an extensive set of oblique aerial photographs taken over a period of days by aerial patrol plan observer Sonja Weber. Some of these images were smoky but Ms. Weber was able, due to the extensive time the patrol plane spent observing this fire, to obtain a large number of images during periods when prevailing winds cleared smoke from most portions of the fire. This set of oblique photos covered nearly the entire fire area, though images of a few slopes were quite oblique to the point that accurate mapping from them was problematic.

Conventional (vertical) aerial photography was not available due to poor visibility, lack of funds, and ultimately lessening solar angles. By the time the District was able to catch its breath so to speak and look into funding and scheduling an aerial photo flight, the days were getting short to the extent that had the flight gone ahead the northerly slopes (about 20% of the fire area) would have been shaded such that mortality status of the trees would not be apparent.

The above mortality classes were mapped using eyeball estimates of remaining green crown percentages as seen on the oblique aerial photos. Most slopes were covered by at least two and in some cases many views from varying angles. Resolution of mortality classes was done down to four acres; from a practical and records management standpoint, subdivisions smaller than four acres would make this mapping very convoluted and large patterns may not be readily visible. The oblique photography made it fairly difficult to map morality polygon edges very accurately in many places as more fully discussed below. It is our experience with this and other stand replacement fires that late season wildfires typically will kill all the trees in an area or just underburn the forest, though the mortality pattern created can be exceedingly intricate in a few places. Fires of this nature seldom kill a percentage of overstory trees more or less evenly throughout a stand. This is due in large part to the amount of fuel typically on the forest floor in this area, the generally dense, closed canopy nature of these forests, and the height of the base of the live crowns. If a ground fire is hot enough to kill some main canopy trees, it tends to kill all of them. In many cases slopes that were typed as having less than 20% live crown really were entirely dead aside from a few clumps or stringers of trees that escaped this effect due to topographic placement or weather/wind changes while the fire burned that particular area. Often these surviving clumps are much smaller than the 4 acre mapping resolution.

It has been our experience that, at the stand level at least, fire mortality (in mature stands) is nearly always a function of damage to the tree crown, not from root, bole, or cambium damage. Mature forests in this area generally contain trees with bark thick enough to prevent significant cambium damage from just about any intensity of ground fire. If there is enough heat to burn or heat through several inches of bark, there typically would be enough radiant heat to kill the crown of the tree. This concept is less true for high elevation tree species such as Pacific silver fir or mountain hemlock that typically have thinner bark. Young trees of any tree species, such as those found in the many plantations, also have thin bark and live crowns close to the ground, so mortality in these areas sometimes results in more of a thinning effect rather than all or no mortality.

Once the fire activity had moderated enough to make entry into the area relatively safe and the smoke had cleared to some extent, we visited the fire to verify mortality calls, especially for those few areas where photo coverage was poor due to high oblique angle or smoke. Some minor cambium sampling was also done to verify that trees with some amount of green crown indeed had a relatively undamaged cambial layer. A total of three field days were spent on this still fairly cursory verification. In addition to the on-ground field verification, we spent several hours in a helicopter go get an overall feel for the area and see into areas (particularly the Tumblebug Gorge) that are not readily visible from the road system.

Results

Mortality Class	Acreage	Percentage of fire
1 – 0 to <20% green crown	6392	44
Crown fire subset	(1985)	(14)
2 – 20% to <40% green crown	1891	13
3 – 40% to <60% green crown	3244	22
4 - 60% or > green crown	3032	21
TOTAL	14,560	100

A majority of Category 1 polygons (about 69%) were killed by radiant heat to the crowns; in other words the needles were still on the trees after the fire but were killed (along with next year's buds) and were turned brown. Within these polygons and mapped (for now) separately, 1985 acres or about 31% of full mortality areas were killed by crown fires; no needles remained on the trees. This is an important aspect of this mortality assessment as crown fire killed trees have no dead needles that will fall to the ground during the winter to provide an immediate duff layer to protect the otherwise bare soil. Additionally, crown fires typically also kill the seeds within any cones the trees might have produced during the growing season and these crown fire areas may not reforest very well on their own due to this lack of seed source. It is notable that nearly all conifer species appear to have had a very good cone crop this year; abundant seed fall has been observed in all portions if the fire aside from the interiors of those areas that burned as a crown fire. Should conventional aerial photography be accomplished next summer when conditions are more favorable, the crown fire areas would not be especially apparent as by that time the dead needles will have fallen from the stands killed by radiant heat only and will not be easily distinguished aerially from crown fire areas.

Caveats and Accuracy

As alluded to above, we found it fairly difficult to confidently draw polygons from oblique aerial photos onto a scale controlled map in many places where mortality type boundaries were not on obvious topographic features or obvious stand boundaries (such as plantation edges). It is our hope that conventional aerial photography to be flown during the summer of 2010 will provide the opportunity to check our placement of mortality category polygon boundaries and correct them if there are significant differences. We consider a polygon boundary change of greater than 200 feet to be significant.

Mortality category typing is generally considered to be accurate. The oblique photography used in this assessment was excellent for most locations and field visits verified the initial photo-based assessment. Experience with mortality typing of previous fires in similarly aged stands indicates initial assessment of mortality percentages generally does not change much with time. In other words, trees with a substantial portion of their crown remaining green (more than about 20%) immediately after the fire are alive and likely to remain so. Again due to the height of the live crown above the ground surface and dense nature of most stands, few trees experience partial crown mortality; if a ground fire is hot enough to kill the lower part of a crown that is 100 feet or more above the fire, it tends to kill the entire crown. Typically it is trees on the edge of full mortality polygons or abrupt stand boundaries that have partial crown mortality.

The mortality assessments of plantations, particularly those less than 20 years old, are the most questionable in my mind. Stands of this age typically have not closed canopy yet and regardless of species the bark on younger trees is thin enough that they can be killed by cambium damage which would not be apparent from a distance for some time. Mortality assessments of all stands of these ages should be reevaluated in late spring or summer of 2010. It could well be that this follow-up assessment may result in a further subdivision of mortality classes within these plantations.

Category 4 includes areas that were unburned with little overstory mortality as well as areas within the fire perimeter that did not burn at all. We know there are some areas in the later condition, but these areas are not at all evident on any type of aerial imagery. An accurate mapping of unburned areas will require some fairly extensive field reconnaissance. There may be some interest in such a mapping effort in terms of characterizing the behavior of the Tumblebug fire. If so, some considerable time should be made available to do the field work required to accomplish this task. From a habitat suitability or indication of management need perspective, this differentiation is of small interest.

The logical next step and maybe the primary reason for doing this mortality assessment in the first place would be to update the existing Vegetation (VEGIS) and owl habitat (OHAB) GIS databases. Such an update will necessitate, at least in places, creation of new VEGIS and OHAB polygons.

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