Disposal of Trees Affected by the Pine Beetle:

The Dilemma and why Air Curtain Burners Should Be Used

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The Problem

Forest vegetation management in many areas throughout Australia is confronted with the dilemma of how to prevent the destruction of trees by pests, such as beetles and fungi, preserve threatened trees and safely remove and destroy unsalvageable and dead trees killed by the pest. The latter problem is addressed here and it is determined that the best disposal option for both freshly felled and dead beetle infested trees is by means of above-ground air curtain burners.

The primary objective is two-fold: (1) freshly felled beetle infested trees must be disposed of in such a manner as not to foster cross-contamination, the spreading of the disease problem to healthy trees and (2) to remove dead trees under forest fuel management initiatives, as the dead standing, leaning and fallen trees otherwise would pose a bushfire hazard, most importantly near or in the wildland- urban interface where well managed defensible spaces are imperative to protect residential dwellings, businesses and other structures.

The secondary objective is to devise a method that will (a) economically and efficiently accomplish the goals set forth above and (b) in an environmentally friendly and safe way.

Background

Trees can be stricken with a number of diseases, including pest or fungal inflictions that may adversely affect their rate of growth, strength, longevity, reproduction, impact on the tree, flora and fauna community in which they stand and also their suitability for commercial harvesting. In recent years Australian forests, parks and private woodlands have suffered immensurable losses from trees that were destroyed by beetle pests, worms or fungi. For example, Myrtle Rust (Puccinia psidii s.l.) is a newly described fungus that is closely related to the Eucalyptus/Guava rusts. These rusts are serious pathogens which affect plants belonging to the family Myrtaceae including Australian natives like bottle brush, tea tree and eucalypts.

A variety of beetles, some indigenous to Australia, some world-wide pests brought to the Continent from foreign countries usually by sloppy ocean vessel cargo management practices, such as the Asian Longhorned Beetle, have killed millions of trees.

Society has a high interest and responsibility in managing and preserving the world's forests for many reasons, above all, because trees are vital for the very existence of mankind considering the balance that photosynthesis provides to the air we breathe. Healthy forests are a "carbon sink." Unfortunately, recent studies have shown that the magnitude of decaying vegetative waste resulting from beetle kills have actually reversed some forest areas from being a carbon sink to a contributor to green house gas emissions[1].

Forests provide a habitat for other vegetation and animals of a myriad of species. Forests made it possible for mankind to evolve as it has from providing shelter, building materials and firewood to hunting grounds. Finally, one cannot overlook the beauty of our trees and the forests that they comprise. Their recreational value should not be underestimated.

Non-government and non-profit endeavors that are people-driven, such as the *Champion Tree Project*[2] in the Unites States, are of paramount significance, as they raise public awareness regarding the serious issues that threaten our forests and trees and they provide educational platforms to help prepare young people to better understand the steps required to safeguard our forests for future generations and to cope with the immense dangers facing our environment in general.

About Beetles in the Forest

It should be emphasized that generally most beetles in the forest are not harmful, but rather are a vital part of the forest's ecosystem. It is often thought that the trees in our country are attacked mainly by invasive species, pests that have been imported from foreign lands and that do not have natural local predators. However, there are native beetle species as well that are responsible for massive tree mortalities.

In the US State of Colorado, for example, the *mountain pine beetle* (MPB) that is causing extensive damage at the present time and has destroyed countless numbers of trees in recent years, is native to the forests of Western North America.

It is the abundance and concentration of the beetle population that result in the massive destruction of trees. The main reason for providing the basis for such beetle abundance is the fact that many forests are severely overgrown and, as a result, are weakening their trees, because natural low-severity forest fires have not cleared out the excessive abnormal underbrush and frail trees for decades or even a century. Ever since the US Government, for example, implemented wildfire suppression mandates more than 75 years ago, the natural process of clearing out ladder fuels (underbrush or understory) and dead trees has been disturbed and forest fires have thus become much more severe[3]. For millions of years, naturally occurring wildfires have not only created a balance between various species of healthy trees, fragile trees and pests, but also provided a biological necessity for certain trees. For example, the *Lodgepole Pine* depends on heat from wildfires to open its cones to release the seeds[4], and the *California Redwood* also needs fire to survive, as without it, redwoods will not properly repopulate[5].

Trees that have been injured or otherwise weakened from droughts, unnatural high-severity wildfires, etc. are most vulnerable for beetle or fungi infestations; however, otherwise healthy appearing trees are also succumbing to an overly large beetle population, to some extent due to the adverse effect of the abnormally dense understory forest growth which makes the stands more susceptible to pest attacks.

It must furthermore be noted that beetles are selective in their host trees. For example, not all "bark beetles" invade all species of "pine trees"; they typically choose specific tree species as hosts. This is important to understand when devising eradication plans, as one type of pine may be sickened by a particular beetle attack whereas another species of pine tree next to it is just fine and must be left alone[6;7].

Eradication of (Harmful) Beetles

Beetle eradication methods are rather limited in scope: chemical pesticides that are aimed at killing the beetle and the underlying larvae are used to salvage healthy trees in danger of beetle infliction. This approach, albeit costly, makes sense in parks, residential areas and private woodlots where selective treatment is realistic, but not in vast forest lands.

The only alternative is to stem the spread of the beetle infestation from infested trees to healthy stands which means the elimination of the trees that are already infested, in order to prevent cross-contamination. Ideally, this selective felling should be coupled with the thinning of the adjacent areas of healthy trees to help strengthen them and to prevent any bushfires from reaching the tree canopies through excessive ladder fuels. Again, this operation should be considered obligatory for wildland-urban interface zones, national and state parks and other areas frequented by the public for recreational purposes or travel.

This practical approach requires the collection and disposal of the felled trees in such a manner as to guarantee the total destruction of all living beetles and larvae within or attached to the trees and associated wood debris. Numerous methods have been employed towards this goal, including burning the trees in an above-ground air curtain burner *(FireBox)*[8], chipping the trees and hauling the residue to a landfill or biomass cogeneration facility, composting the trees after grinding them, and even salvaging portions for firewood or commercial uses.

Tree Disposal Considerations

As already stated, beetle infested trees must be slated for disposal for two main reasons:

1. To prevent spreading the infestation to healthy trees and
2. To prevent or mitigate bushfires, as the dead trees would be fuel for devastating bushfires that would likely spread to healthy stands with high ladder fuels.

Time is always of the essence regarding either objective. Beetle infested trees and slash must be effectively disposed of in the shortest amount of time to keep live beetles from migrating to healthy trees and larvae from developing into mature beetles which would then fly to healthy stands. This should best take place in winter and early spring before the larvae typically hatch.

Forest patches of dead trees could be ignited by lightning, fallen rocks or human activity at any time with possibly devastating consequences. The disposal of these trees could be performed year-round.

Above-ground air curtain burners, such as the portable models S-111, S-119, S-220 or S-327 fireboxes by Air Burners, Inc. and available Australia wide from Organic Matter Solutions P/L, have been designed for the disposal of clean wood waste (vegetative waste) as an alternative to open burning. Describing how an air curtain burner works is beyond the scope of this paper and the reader is directed to a technical memorandum on the principle of operation of air curtain incineration at this Web Site: http://www.airburnertechnology.com.

Air curtain fireboxes are the most desirable and suitable machines to accomplish the disposal of beetle infested trees for the following main reasons[8]:

1. The attained high burn temperatures assure quick and total elimination of any and all beetles and larvae in or on the felled tree and collected slash.
2. The wood debris can be burned immediately upon collection, even while the freshly cut tree is still *green*. A drying-out period is not required. That gives no opportunity to any larvae population in the tree to mature into beetles that would fly away and infest healthy trees.
3. Large sections of tree trunks and brush can be loaded without excessive milling, avoiding the attraction of beetles from the release of conifer resins that may affect beetle behavior as the resins resemble beetle pheromones[7].
4. The air curtain burner achieves 97-99% mass reduction and the resultant ash residue can almost always be applied to the land on site. This eliminates any hauling by trucks.

5. The air curtain burner provides the most cost-effective solution for the disposal of wood waste, both from the capital investment angle and the direct operating costs and it has a useful life of 10-15 years.
6. The air curtain burner is environmentally friendly and its implementation has a limited operational "carbon footprint" in comparison with other disposal methods, as it only employs a small Diesel engine.
7. The air curtain firebox meets or exceeds Government regulations for air curtain burners.
8. The air curtain burner is batch loaded, is simple to operate without a dedicated attendant and has virtually no downtime for repairs.
9. The air curtain burner is portable, delivered fully assembled and it can be relocated on site simply by dragging it on its skids.

All alternative disposal options have serious drawbacks.

Chipping was historically considered the preferred option and it was advocated that all beetles and larvae would be 100% destroyed by the violent process within the grinding and chipping machines powered by huge engines. It was thought also that chipping would be the most environmentally friendly alternative and the most economical, as biomass co-generation plants could turn the beetle infested trees into electric power. These premises turned out to be mostly false.

Small-scale tests were carried out by Deborah Mc McCullough, et al, of Michigan State University in 2003 to verify that all Emerald Ash Borer (EAB) beetles and larvae would be killed, if chipping resulted in chips smaller than 1 inch (25.4mm) long[9]. The typical size of this beetle is about one half inch (13.5mm) and its larvae slightly more than 1 inch (32mm) in length[10]. The small-scale test did not appear to represent the real-life picture. Beetles and larvae do survive the chipping process. One such report in support of this finding, also from Michigan, shows that the Emerald Ash Borer infested stands of elm trees in circles around a biomass co-generation facility to which chips from Emerald Ash Borer infested trees were hauled by trucks[11]. This was later verified by a 2005 study conducted by David L. Roberts, et al, of Michigan State University Extension[12].

Another mistake often made is to refer to the Michigan State University McCullough study in order to justify that chipping trees infested with the Mountain Pine Beetle (or similar) into chips of one inch in size will suffice to kill also this beetle and its larvae. What is not considered is the fact that the certain beetles, such as the mountain pine beetles are much smaller than the Emerald Ash Borer that was used in the Michigan sample. The mountain pine beetle and its larvae is typically less than 1/5 inch (5mm) long[13]. Applying the assumptions of the McCullough study would require that trees infested with the mountain pine beetle be ground into chips smaller than about 1/10 inch (2.5mm), in order to kill the beetles and larvae effectively. Even then, it is very doubtful that all the tiny beetles and larvae would actually be hit by the cutting mechanism of the chipper or grinder. Chipping to such a small chip size would usually require more than one pass and is not practical and economical; and it is not what is actually being observed in the field today.

Also, chippers do not handle freshly cut "green" trees and brush very well, although that must be a requisite for effective beetle control. The wood waste drying time that would be required for effective chipping may give larvae ample time to mature and fly off to infest healthy trees. Another reason why the chipping and grinding of green trees would not be advisable is the fact that the chipping causes the release of large amounts of conifer resins in volatile form that attract beetles. This tends to lead to cross colonization, as the infested taken down green trees would usually be close to "leave" trees, the ones to be saved in selective felling initiatives.

Another problem plaguing the chipping operators is the fact that the chips cannot be indiscriminately applied to the forest floor on site. Chips on the forest floor are unnatural and adversely affect the forest ecosystem; that is why the layer of chips that is acceptable is limited by forest scientists. As a consequence the chipped trees will have to be hauled to a landfill at considerable cost and, again, possibly causing cross contamination on the way. Usually the chips cannot be sent to biomass cogeneration plants, because either the chip specifications are not acceptable or the transport costs to a suitable facility are too high.

Finally, a chipper is actually not as environmentally friendly as often proclaimed. The emissions from the massive chipper Diesel engine and the hauling trucks coupled with the (carcinogenic) wood dust

released have a greater negative impact on the environment than air curtain burners. Air curtain burners use a small Diesel engine that is fuel efficient and the burning of clean wood is actually a natural process that has occurred on earth for million of years. Also, the overall cost of the chipper operation is much higher when measured against air curtain burning.

The remaining tree disposal options include open pile burning, hauling to and depositing the wood debris into a landfill (usually after chipping the wood debris first to make hauling more manageable) or to compost it which also requires grinding. Little or no guarantee is provided, however, that cross-contamination is prevented during the transport over public roads and at the landfill or composting site. Composting itself has most of the drawback of chipping and more and would be the least attractive option. Open burning is usually not an option, as the burning of green trees which is difficult in itself would have to take place in close proximity to "leave" trees, as transporting the wood debris off-site would obviously be counterproductive. Smoke from open pile burning of wood waste is a serious issue. Entire valleys are known to be filled with smoke for days at a time. Open burning presents a serious bushfire danger, as a "controlled burn" often leads to an out-of-control bushfire. The May 2000 Cerro Grande Fire of Los Alamos, New Mexico, in the USA is a testimony of that. It started with a sanctioned prescribed burn and turned into a wildfire causing devastating losses. Interestingly enough, Los Alamos National Laboratory acquired several air burners, including the large S-327 firebox. They were used for several years in post bushfire clean up and bushfire mitigation work after that disaster.

Dead trees from a beetle kill that comprise large areas should be removed for wildfire prevention and rehabilitation (reforestation) as they pose a serious fire danger. In this wood waste disposal application it is the cost effectiveness alone that makes air curtain burners more desirable than any other disposal option, except possibly, open pile-burning where permitted and if the smoke impact is not considered a nuisance or hazard as already addressed.

More About Air Curtain Burners[14]

Above-ground refractory walled fireboxes by Air Burners, Inc. have a useful life of 10 to 15 years, making them a prudent capital ac-

quisition. Depending on the model, direct operating costs are modest and the operation of the machines is simple and safe. Ancillary equipment for loading the fire boxes can range from excavators to front loaders with a rake and even Bobcats, heavy equipment that usually is already on hand with experienced operators in the forest industry.

All Air Burners, Inc. air curtain burners are delivered completely assembled ready for immediate use. There is no need for set-up or tear down at all. The fireboxes are designed to be dragged on their skids and they have no bottoms, as they are placed directly onto the ground.

New products include selected fireboxes adapted so that they can be loaded and unloaded by standard roll-off trucks as are used throughout Australia for many years. The principle of loading and unloading will mirror that of standard 20-foot construction dumpsters or cans. This will further simplify the deployment of fireboxes to the landings in the deep forest and the collection sites in the wildland-urban interface zones. A single firebox could also be easily shared by several communal entities and transported by equipment that is usually already available commercially in the local area.

S-217 Firebox

S-327 Firebox

Summary

Many forests in Ausralia are being destroyed by a variety of pests, mostly fungi and beetles. One major cause is related to the weakening of the trees due to the buildup of forest understory for many years which has not been cleared by naturally occurring low-severity forest fires. These weakened stands are thus susceptible to beetle infestation. Trees killed by beetles must be removed to prevent the spreading of beetle infestations and as a wildfire mitigation and restoration effort. Beetle infested trees removed in selective felling operations must best be destroyed on site and while still green. The most effective and most commercially viable method for the disposal of these trees is the use of above-ground air curtain burners also called FireBoxes. The patented above-ground air curtain burners are manufactured by Air Burners, Inc. of Palm City, Florida and available Australia wide from Organic Matter Solutions P/L (www.organicmattersolutions.com).

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