SOUTHERN REGIONAL EXTENSION FORESTRY
FOREST HEALTH

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Bark Beetles, Drought, and Prescribed Fire

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Figure 1. Frequent low intensity prescribed fires help sustain forest health and function in many forest ecosystems.

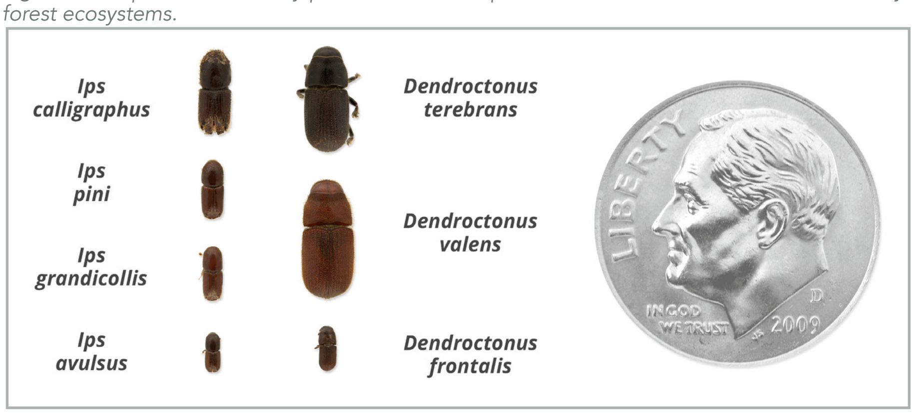

Figure 2. Commonly-encountered bark beetles in the southeastern U.S., (with a dime to show scale). Ips bark beetles are distinguished by spines/bumps on their posterior, while Dendroctonus species have smooth posteriors.

Frequent, low intensity fire is a critical part of sustaining forest health and function in southern pine ecosystems. However, some land managers may be concerned that a prescribed fire (particularly soon after a drought) may cause additional stress to trees, lead to beetle outbreaks and result in widespread tree mortality. Recent droughts in the southern U.S. have led to a decrease in acres treated with prescribed fire because of a fear of compounding tree stress. Although trees may often die during or soon after drought conditions, tree death is caused by an interaction of forest conditions and environmental factors and not solely from lack of soil moisture. Drought conditions increase tree stress which, in combination with several other stressors, can increase a tree's susceptibility to insects and diseases – factors that can ultimately lead to death. Depending on the condition and management history of the forest (fire use and frequency, thinning, etc.), a prescribed fire is not likely to significantly increase stress to southern pine stands or the likelihood of pest damage.

Bark beetles in the southeastern United States

The most common bark beetles encountered in southern pine forests are the southern pine beetle (*Dendroctonus frontalis*), Ips bark beetles (including *Ips avulsus*, *Ips calligraphus*, *Ips grandicollis*, and occasionally *Ips pini*), and the black and red turpentine beetles *Dendroctonus terebrans* and *Dendroctonus valens*, respectively. The southern pine beetle is unique in that once outbreak populations of this pest occur, they can kill healthy pine trees. For this reason they are sometimes referred to as primary pests, because they can be the primary reason a tree dies. Ips bark beetles and turpentine beetles, on the other hand, do not kill healthy trees – they require some level of tree stress before they can successfully attack a tree. They are often called secondary pests, because they are not the primary reason the tree dies. Tree death is often blamed on Ips or turpentine beetles because these beetles are commonly seen during a tree's final days, when in reality some other factor(s) weakened the trees enough that they became more susceptible to these insects.

Drought, bark beetles, and tree death

Drought can stress trees, but lack of moisture does not usually kill trees directly- at least, not quickly. Tree stress, decline, and eventual death is driven by a complex mix of predisposing factors that are site dependent; such as prior management activities, ice or snow storms, wind events, pollution, drought, and flooding. As a result, the exact mechanisms that ultimately kill a tree are complicated and sometimes unclear. There are correlations among drought, outbreaks of typically less aggressive insects (like *Ips* bark beetles), and tree mortality, but correlation does not always mean causation. It is clear, however, that trees in poor health, like those stressed by poor site conditions, overstocking, or competition from fire sensitive species like sweetgum, are more likely to die from extreme events like drought than trees in good health in well-managed stands. Drought may be the "tipping point" that causes an already stressed tree to succumb to secondary insects, such as *Ips* bark beetles or turpentine beetles. Bark beetle populations are nearly always present in the forest, but most trees in a managed forest are resistant to bark beetle attacks, until additional stressors (e.g. drought) increase their susceptibility to attacks by secondary insects. For this reason it is common to have large *Ips* bark beetle or turpentine beetle outbreaks during or after droughts, as the beetle populations can overcome the natural defenses of drought-weakened trees. Insects might be the ultimate cause of tree death (and the easiest to notice), but the trees only become vulnerable because they were unhealthy prior to the attack which led to poor resistance, vigor and resilience (Figure 4).

Figure 3. Dead trees in a forest stand.

Properly conducted prescribed fire does not increase the likelihood of secondary bark beetle attacks

Prescribed fire, when used correctly, does not pose significant threats to forest or tree health, nor does it significantly increase the vulnerability of forests to insects in well-managed stands with a history of regular prescribed fire. Fire could be considered a stressor if it caused root damage from consumption of duff, or excessive crown scorch, and/or damage to the cambium (inner bark); however, such damage is unlikely when a prescribed fire is properly used. Parameters for prescribed fire are developed to encompass a specific range of conditons that are ideal for carrying out land management objectives, while limiting potential tree stress and damage. In addition, burn objectives are defined in the prescription and ignition patterns tailored to achieve these effects. For example, if the objective is to minimize scorch, ignitions patterns are implemented to minimize crown heating. Further, southern pine stands that are *regularly* burned do not accumulate enough combustible material to drive high-intensity fires that could cause critical stem, crown, or root damage. Although southern pines tolerate some crown scorch, the risk of scorching the crown from fire can be lessened or eliminated by carefully adhering to prescribed fire guidelines including recommended weather and environmental constraints and by using proper ignition techniques. Because fire cannot be 100% controlled, there is always risk for some tree stress – but by taking proper precautions and following a good burn prescription, those risks are greatly minimized. Even in stands that need rehabilitation, a burn prescription can be designed to minimize the likelihood of tree stress.

A properly conducted prescribed fire is safe for forest health

Environmental conditions, such as soil and vegetative moisture levels, can be tracked by fire indices such as the Keetch-Byram Drought Index (KBDI), fuel moisture, energy release component, and Burning Index (BI). Each provides valuable information to determine if a stand is susceptible to stress from fire and are used to develop prescribed fire prescriptions (e.g. burn plan). The success of a prescribed fire treatment is dependent on the condition of the stand, fire use history, meteorological conditions identified in the prescription, and proper operational techniques. It may have been very dry during a recent drought, but if all the prescription parameters are met, then the stand could be considered for a prescribed burn without risk of additional stress for trees. Prescriptions are developed to minimize stress and accomplish land management objectives, and meeting prescription conditions is key when

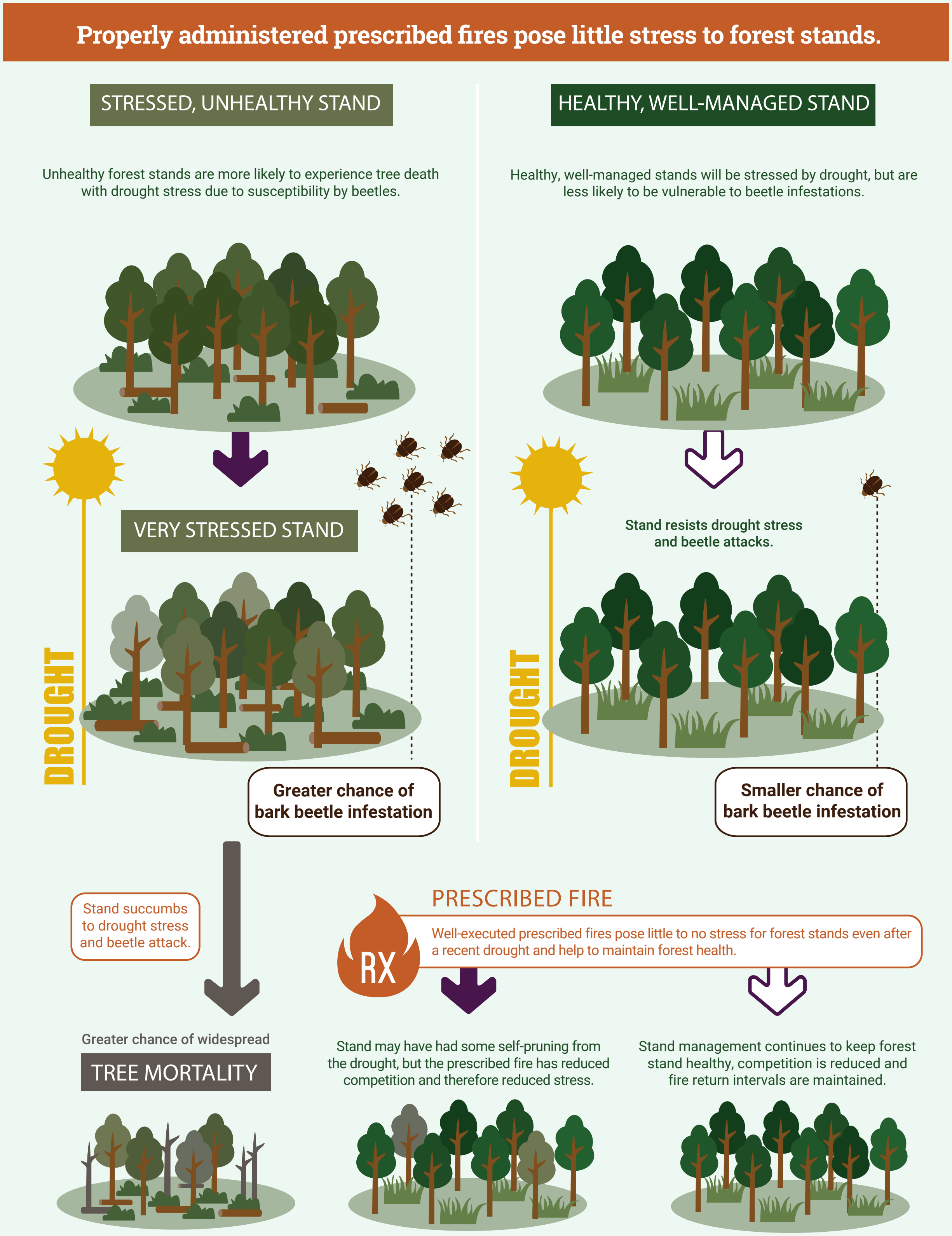

Figure 4. Stressed, unhealthy stands are more likely to be negatively affected by drought and have a great chance of bark beetle infestations while healthy, well-managed stands will experience fewer negative effects from drought and have a much smaller chance of bark beetle infestation. A prescribed fire conducted in a healthy stand, even after a recent drought, will not increase the risks of bark beetle infestation.

ONCE THE DROUGHT HAS ENDED, AND BURN BANS HAVE BEEN LIFTED, A SUCCESSFUL PRESCRIBED FIRE IS DEPENDENT ON:

- ☑ ***Stand conditions***
- ☑ ***Fire use history***
- ☑ ***Meteorological conditions identified in the prescription***
- ☑ ***Proper implementation***

conducting burns, regardless of any recent climatic challenges. Further, avoiding the use of prescribed fires during or after a drought may seem like a conservative tactic to minimize tree stress, however, if fire is completely omitted from a stand over a long period of time (and alternative practices that mimic fires' benefits are not used), it may actually do the opposite. As more burns are missed, a stand becomes more and more unhealthy due to denser vegetation and increased competition for space, sunlight, water, and nutrients. Forests also become more prone to fire damage due to heavier fuel loads which increase future fire intensity, (especially ladder fuels capable of carrying fire into tree crowns). The longer fire is excluded from a stand, the more difficult it becomes to conduct prescribed fires successfully.

Frequent prescribed fire increases forests' resistance to beetle attacks

Prescribed fire is an important management tool for reducing the build-up of fuels and competition from undesirable species. Frequently burned forests are typically healthier than those that are burned infrequently. For southern pine systems, a prescribed fire is recommended every 1-3 years (i.e. a 1-3-year fire return interval). For forests in which fire has been omitted for more than 5 years (depending on site quality), a prescribed fire should not be used without first using mechanical methods (thinning, mulching, mowing, etc.) for reducing fuel loads. Frequent prescribed fire and proper density management practices (e.g., thinning) nearly eliminate the chances that trees will succumb to bark beetles (especially southern pine beetle), disease, or be lost to wildfire. For example, the Southern Pine Beetle Prevention Program, run by the USDA Forest Service Southern Region, has provided assistance to landowners and land managers and has helped burn ~350,000 acres, as a means for reducing susceptibility to the southern pine beetle. Meeting the recommended fire return interval is challenging for most land managers, as suitable burn days are already limited and must coincide with the availability of necessary resources. There is also a substantial backlog of forest acres that need to be burned that include private, state, and federal lands, so excluding suitable burn days because of recent drought conditions can increase this backlog. There is a greater risk of beetle attacks or other threats to forest health when prescribed burns are postponed, not conducted regularly, or skipped altogether. When multiple prescribed fires are postponed, more acres would need to be burned the following year to make up the difference, which could put managers further behind in their burn cycles and lead to an increased number of stands in poor condition.

Conclusion and recommendations

Prescribed fire should not contribute to risks of bark beetle infestations or widespread tree mortality. When a prescribed fire is planned and executed with a focus on minimizing severity and the stand has been well-managed or has a history of prescribed fire, then it does not increase risks to forest health significantly. Rarely (if ever) would proper burning conditions occur during drought, but once the drought has ended and the prescription could be met, a prescribed fire would likely not cause additional stress to the trees. Reducing or limiting burning to prevent the spread of secondary beetles would likely have little impact on overall beetle populations, but if multiple burn rotations are missed, there may be significant negative impacts on tree and stand health. Conducting prescribed fires when appropriate is a key management tool that will enhance forest resiliency to drought and other stressors, and improve overall forest health. Conducting burns within the bounds of a well-developed plan will ensure that any potential stress to trees is minimal and that overall stand conditions are improved to make the trees more resilient to bark beetle infestations and other future stressors.

Resources

For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Forestry Commission:
http://www.forestry.alabama.gov/

Arkansas Forestry Commission:
http://forestry.arkansas.gov/Pages/default.aspx

Florida Forest Service:
http://www.floridaforestservice.com/

Georgia Forestry Commission:
http://www.gatrees.org/

Kentucky Division of Forestry:
http://forestry.ky.gov/Pages/default.aspx

Louisiana Department of Agriculture and Forestry:
http://www.ldaf.state.la.us/

Mississippi Forestry Commission:
http://www.mfc.ms.gov/

North Carolina Forest Service:
http://www.ncforestservice.gov/

Oklahoma Forestry Services:
http://www.forestry.ok.gov/

South Carolina Forestry Commission:
http://www.state.sc.us/forest/

Tennessee Division of Forestry:
https://www.tn.gov/agriculture/section/forests

Texas A&M Forest Service:
http://texasforestservice.tamu.edu/

Virginia Department of Forestry:
http://www.dof.virginia.gov/

For the location and phone numbers of University Extension personnel in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Cooperative Extension System:
http://www.aces.edu/main/

University of Arkansas Cooperative Extension Service:
http://www.uaex.edu/

University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS):
http://solutionsforyourlife.ufl.edu/

University of Georgia Extension: http://extension.uga.edu/

Kentucky Cooperative Extension Service:
https://extension.ca.uky.edu/

Louisiana Cooperative Extension Service:
http://www.lsuagcenter.com/

Mississippi State University Extension Service:
http://extension.msstate.edu/

North Carolina Cooperative Extension:
https://www.ces.ncsu.edu/

Oklahoma Cooperative Extension Service:
http://www.oces.okstate.edu/

Clemson Cooperative Extension (South Carolina):
http://www.clemson.edu/extension/

University of Tennessee Extension:
https://extension.tennessee.edu/

Texas A&M AgriLife Extension: http://agrilifeextension.tamu.edu/

Virginia Cooperative Extension: http://www.ext.vt.edu/

To locate a consulting forester:

Association of Consulting Foresters:
http://www.acf-foresters.org/acfweb

For more information on how to select a consulting forester, go to:

http://msucares.com/pubs/publications/p2718.pdf

http://texashelp.tamu.edu/011-disaster-by-stage/pdfs/recovery/ER-038-Selecting-a-Consulting-Forester.pdf

http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf

More resources on prescribed fire and beetles can be found at:

http://southernforesthealth.net/

http://southernfireexchange.org

http://fs.usda.gov/detail.r8.forest-grasslandhealth/insects-diseases

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Figure 4: Laura Costa and Allison Hollenshead, SREF

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