

# SOLVING “The Duff Problem”

**How scientists and managers are working together to restore fire to long unburned stands — without losing the trees that make them so valuable**

*By Laurel Kays and Dr. David Godwin, Southern Fire Exchange*

*Mechanical understory removal at Bonnie Doone. Photo by Laurel Kays.*

The basics of the longleaf pine story are familiar – an ecosystem of incredible biodiversity stretching across some 90 million acres was winnowed down to a tiny fraction of its former glory by timbering, the naval stores and other forest industries, land clearing, and fire suppression. Today, remnants of old-growth longleaf pine are few and often far between. Those old-growth stands that remain, along with younger stands that still contain large trees, are precious resources and often priorities for restoration efforts. Counterintuitively, one of the pressing threats to some stands comes from the very thing that they need the most – fire. The collaboration between scientists, managers, and science communicators to address this challenge offers a potential roadmap for addressing other complex management problems.

Reintroducing fire into old-growth longleaf stands, or younger stands containing large trees can be challenging because of the changes that take place in the absence of fire. When fire is excluded, pine needles, leaf litter, bark, and other material accumulate and form a layer of duff. This can happen surprisingly quickly due to the long growing seasons and short fire-return intervals to which longleaf ecosystems are adapted.

Duff collects most noticeably in mounds around larger, often older, trees. If fire is reintroduced without careful consideration, it can easily ignite these duff mounds, resulting in long-term smoldering that can lead to the death of these most ecologically and economically valuable trees. Mortality is often delayed, appearing 12-18 months after what may have previously appeared to be a successful burn. Duff fires can also pose significant challenges for land managers that include prolonged smoldering, lingering smoke production, difficult mop-up, and potential for unplanned reignition. Yet for all these challenges, reintroducing fire remains essential to restoring degraded longleaf stands. Inaction comes with its own, inevitable threats: a lack of longleaf regeneration that eventually converts the stand to another forest type or a wildfire that causes mortality through crown scorch or duff smoldering. This “duff problem” occurs in many areas across the United States, where mature trees historically experienced frequent, low-intensity fires and where fire has been excluded. Affected species include not only longleaf and some other southern pines, but red pine, ponderosa pine, and many others.

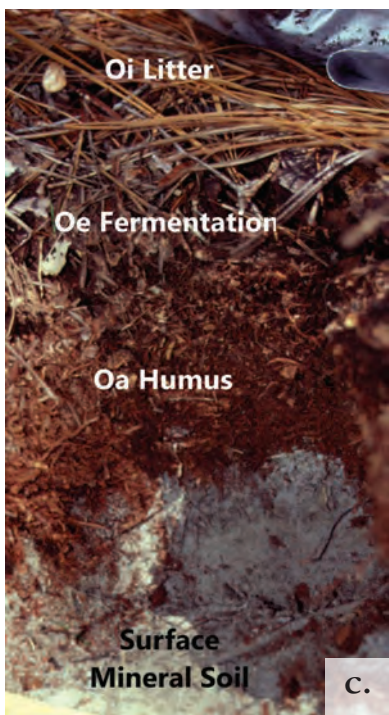




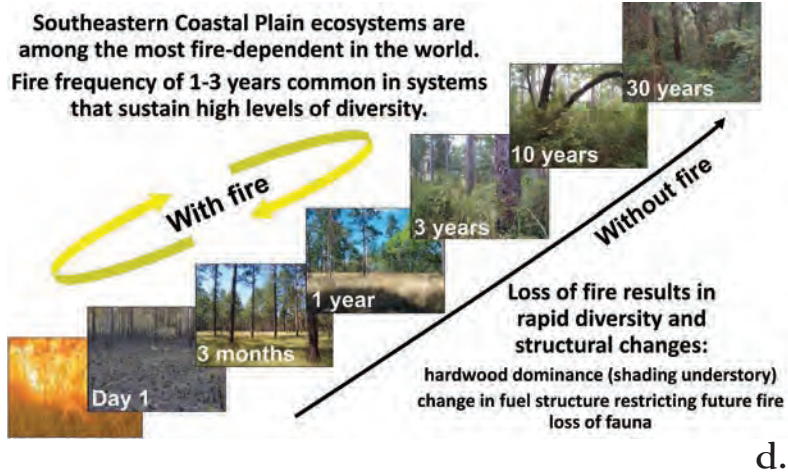
a.



b.



c.



d.



e.

a. Dr. Morgan Varner examines the duff mound of a longleaf pine on the Bonnie Doone tract. Photo by Laurel Kays. b. Participant at the first duff workshop in Florida in 2017 using a moisture meter to measure duff moisture content. Photo by Dr. David Godwin. c. Duff layer in unburned pine stand. Photo by Dr. Morgan Varner. d. Fire as a maintainer in southern pine systems. Graphic adapted from Kevin Hiers. e. Large duff mound at the base of a longleaf pine tree. Photo by Dr. David Godwin.

Fire managers in the South have been observing duff-related mortality for over two decades in southern pine species, most notably longleaf. Growing awareness of the imperilment of the longleaf ecosystem in the 1990s led to efforts not only to reestablish longleaf stands across the native range, but also to restore, maintain, and protect remaining stands. That, of course, meant reintroducing fire. In locations such as Eglin Air Force Base, home to some of the largest remaining areas of old-growth longleaf in the South (Turner et al. 2003), early fire restoration efforts led to substantial overstory tree mortality. At that time, the underlying mechanisms behind these losses and strategies to prevent them were not well understood. Scientists took note, and working together with managers

they ultimately concluded that smoldering duff led to the consumption of the tree's vital feeder roots. If too many feeder roots were burned away, the tree would perish. Managers working in areas facing significant duff-related issues also began to develop strategies to reintroduce fire without causing mortality. While there are certainly no silver bullets, managers found that a key element of successful duff reduction is burning when duff is sufficiently moist at all horizons. This means carefully tracking and assessing duff fuel moisture at multiple locations throughout the stand is crucial. Unfortunately, existing tools for tracking moisture, such as KBDI, may not be sufficient for assessing duff moisture. Experienced managers often suggest digging into the duff around multiple mature trees on a tract prior





*Catface scar at Bonnie Doone.  
Photo by Laurel Kays.*

as Dr. Morgan Varner and Kevin Hiers (both with Tall Timbers Research Station) to share their duff fire science research and management experience in ways that are accessible to the management community. This effort has included three videos, a fact sheet, a site visit, three workshops, and an additional workshop scheduled for this Spring.

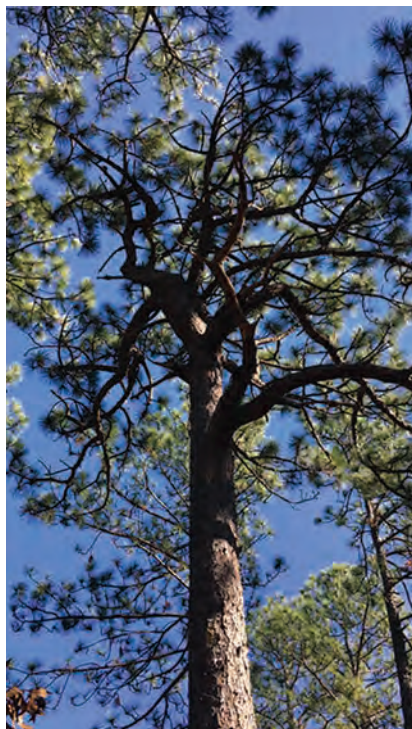
Find SFE's videos and fact sheets at [go.ncsu.edu/duffresources](http://go.ncsu.edu/duffresources)

The three workshops alone were attended by over 100 scientists, managers, landowners, and outreach professionals who collectively own, manage, or influence over 4.3 million acres. One of those workshops was specifically organized for landowner members of the NC Sandhills Area Prescribed Burn Association. These landowners were unable to attend a previous duff workshop held in the area due both to capacity restrictions and the fact that the workshop was held during weekday business hours to target land management professionals. The landowner-focused workshop allowed PBA members to learn about duff fire science and management during a shorter evening program that was tailored to suit their needs. Across all workshops, including the PBA-focused one, evaluation data indicates that many of these participants intend to change their management based on the information they learned during the workshop.

The professional-focused duff workshop held in North Carolina also included a pre-workshop visit to the kind of site where duff-related issues loom the largest. The 262-acre Bonnie Doone tract is one of the largest remaining old-growth longleaf pine stands in North Carolina. Owned by the City of Fayetteville Public Works Commission, those managing the site seek to restore it not only to provide red-cockaded woodpecker habitat and preserve the history of the area but to diminish the threat of stand loss or damage due to wildfire. The Southern Fire Exchange-led visit brought leading scientists and managers from organizations including NC State Extension Forestry, Tall Timbers Research Station, Alachua Conservation Trust, and US Forest Service together with those managing Bonnie Doone to discuss how to practically reintroduce fire to the site while minimizing the risk of losing the old trees that make it so precious. While even those duff experts had no easy answers, the conversation provided actionable steps to begin the process of

burning to assess the underlying moisture conditions. Some managers have learned to use moisture probes to rapidly assess duff moisture levels to develop site-specific quantitative moisture content thresholds to help them make burning decisions (Klaus 2016). Many managers will also suggest timing prescribed fires to burn on the margins of combustion (particularly after *and* before rain) to slowly consume small amounts of duff over a period of multiple burns.

Unfortunately, advances in understanding the “duff problem” that are documented in scientific journal articles and academic conference proceedings may hold little value for busy natural resource managers who may not be aware of or have access to such materials. Likewise, management knowledge gathered from hands-on experience may not be documented in these academic outlets. The Southern Fire Exchange, a Joint Fire Science Program funded partnership among the University of Florida, Tall Timbers Research Station, NC State University, and US Forest Service Southern Research Station, exists to bridge this gap between the fire science and natural management community in the South. Over the last three years, SFE has partnered with leading duff researchers and managers such



*Longleaf pine on the Bonnie Doone tract. Photo by Wendy Dunaway,*



reintroducing fire to Bonnie Doone. The visit also opened a line of communication for the visiting experts to continue to provide assistance to local site managers and potentially gather data to further inform scientific investigations into duff.

Smoldering duff-induced mortality and the management techniques that can effectively restore fire to long unburned stands while minimizing overstory mortality are by no means settled issues. Many questions remain, and scientific research and management practices continue to develop. It is not known, for example, how research conducted in longleaf pine systems translates to certain other pine ecosystems, such as those found in the Southern Appalachian Mountains. These questions are increasingly pressing, particularly as climate change is predicted to increase wildfire incidence and make prescribed fires progressively more challenging to conduct in the Southeast. This collaboration among science, natural resource management, and knowledge exchange partners to address “the duff problem” offers a successful model for addressing the many challenges, climate change-related and otherwise, that face the longleaf pine ecosystems of the South.

**References**

Dixon, A. K., & Robertson, K. M. (2018) Reintroducing Fire Into Long-Unburned Pine Stands: The Duff Problem.

Hood, S. M. (2010). Mitigating old tree mortality in long-unburned, fire-dependent forests: a synthesis. USDA Forest Service, Rocky Mountain Research Station. *Gen. Tech. Rep. RMRS-GTR-238*.

Klaus, Nathan. (2016) New Opportunities for Burning Duff Trees. *The Longleaf Leader*, Summer 2016, 9-10.

Tucker Jr, J. W., Hill, G. E., & Holler, N. R. (2003). Longleaf pine restoration: implications for landscape-level effects on bird communities in the Lower Gulf Coastal Plain. *Southern Journal of Applied Forestry*, 27(2), 107-121.

Varner, J. M., Kreye, J. K., & O'Brien, J. (2016). Recent advances in understanding duff consumption and post-fire longleaf pine mortality. In *In: Proceedings of the 18th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-212. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station. 614 p.* (Vol. 212, pp. 335-338).

Varner, J. M., Putz, F. E., O'Brien, J. J., Hiers, J. K., Mitchell, R. J., & Gordon, D. R. (2009). Post-fire tree stress and growth following smoldering duff fires. *Forest Ecology and Management*, 258(11), 2467-2474.



**Coastal Pine Straw**  
NATURE'S PERFECT MULCH

**Michael H. Dugan**

706.533.6072 | 2476 B McDowell Street  
tahoemd2622@yahoo.com | Augusta, Georgia 30904



**Container Loblolly and Longleaf Pine Seedlings**

**BODENHAMER FARMS & NURSERY**

910/422-8118  
FAX: 910/422-9793  
[www.bodenhamerfarms.com](http://www.bodenhamerfarms.com)

**Louie: 910/608-9823, Louie@BodenhamerFarms.com**  
**Aaron: 910/733-2760, Aaron@BodenhamerFarms.com**

Rowland, North Carolina ■ Established in 2000  
NCDA License # 5643  
Seed Lots From NC, SC & GA  
Second Generation Improved Loblolly

