



Treating fire-excluded pine woodlands with chipping and burning may be valuable restoration tools under some circumstances, but they are inappropriate tools for high-quality longleaf pine woodland, as pictured here. Credit: Florida Department of Environmental Protection.

Chipping, Burning, and the Care of Southeastern Pine Woodlands

Summary

Chipping as a land management tool is increasing in popularity to treat lands where burning presents problems, such as areas with ever growing population along the wildland-urban interface. Escaped fire, and health and nuisance hazards from smoke have caused many managers to avoid burning altogether. The researchers found chipping by itself is likely not an adequate surrogate for fire, either for restoring ecosystems to desired plant communities, or for limiting fuels, changing fire behavior, and reducing smoke as a safeguard for future wildfires. However, chipping in conjunction with fire demonstrates mostly positive benefits for limiting fuels, changing fire behavior, and reducing smoke as a safeguard from future wildfires. A single chip followed by resumption of frequent fire appears to be the best tradeoff between relatively minor but detectable negative impacts of chipping on plant biodiversity and the positive benefits of chipping in restoring fuels and structure to fire-excluded stands. In high quality sites with diverse ground layer vegetation and a history of frequent fire, chipping does more harm than good and is not recommended as a management option.

Key Findings

- Chipping is more appropriate when used as a pretreatment on long-unburned sites where ground layer plants have already been severely compromised. The benefits of reduced woody plant competition and open space for herbs outweighs the impacts to plants.
- Repeated chipping is not appropriate as a fire surrogate for maintaining ground layer plants.
- Chipping can protect against the possibility of dangerous wildfire, but it is not necessary to chip before resuming prescribed fire if initial prescribed burn conditions are carefully selected.
- Chipping appeared to protect against dangerous wildfires as long as fuel heights remained low.
- Only slightly more than half the area of the chip plots burned as compared to upwards of 80 percent in the burn-only plots.
- Chipping can greatly reduce smoke if burns are done when fuels have enough moisture.

Introduction

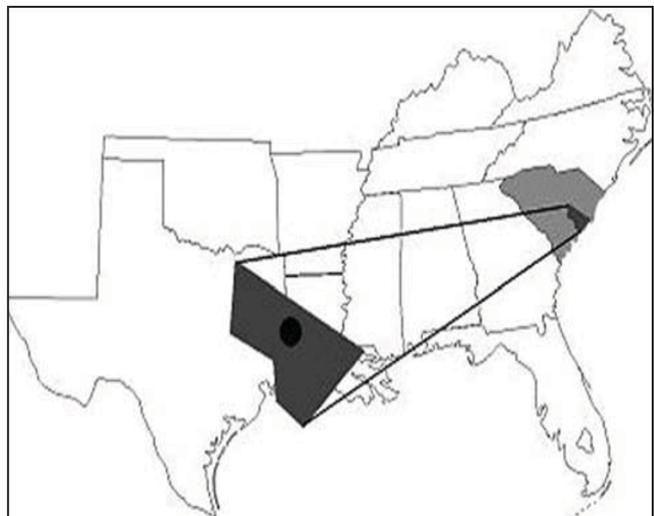
Proof can be found in ancient ice—where no human has tilled, burned or shorn the land of its vegetation—that our activities have global impacts, affecting every ecosystem on the planet. In this regard, it is no metaphor to see earth as a garden, nature altered by artifice, requiring tending. This tending may be as globally general as reducing our carbon footprint, it may be as specific as thinning overgrown tree and shrub layers in a landscape. In the Southeast, as with other areas of the United States, forests need assistance from concerned stewards. But how good are the tools we use, such as mechanical chipping, to rehabilitate our lands? Jeff Glitzenstein, researcher with the Tall Timbers Research Station, and his team wanted to know when and where is chipping appropriate in southern pine woodlands.

Chipping or burning?

We have been managing plants since we began our very first efforts thousands of years ago. Our use of fire as a tool to manage plants may be even older than that—archaeological evidence suggests that hominid ancestors may have used fire as a landscape shaping tool in the prehistory of our species. In the southern United States alone, land managers have used prescribed fire to treat 5 to 7 million acres of forest and farmlands—each year—more than any other comparable area in the United States, the scientists offer. But with populations growing ever larger, and closer, to wildlands, burning presents risks. Fire may escape due to shifting weather variables, and smoke can cause health and nuisance hazards to communities far from the burning area. Increasingly, land managers are limiting or stopping their use of fire and relying on mechanical shearing or chipping, to alter the forest structures that present fire hazard risks.

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Though chipping is widely used, as an alternative and as an adjunct to fire, its effects on modifying fire behavior, limiting smoke and healing damaged ecosystems has not received much evaluation. Glitzenstein and his team designed a study that encompassed wildlands of different ecosystems, across the range of longleaf pine. Stretching from South Carolina to eastern Texas, with the main study site in Francis Marion National Forest (FMNF) near Charleston, South Carolina, and peripheral sites at Sam Houston National Forest (near Huntsville, Texas), Blackwater River State Forest (east of Pensacola, Florida), and Savanna River Site (near Aiken, South Carolina), the team looked at the effects of chipping, and at FMNF, at chipping followed by burning, to evaluate changes to plants as communities, and changes to plants as combustibles.



Location of an experimental burn site (black dot) in the Francis Marion National Forest (dark gray) in South Carolina. Credit: USDA Forest Service, Southern Research Station.

Restoration

Managers have increasingly used mechanical chipping to open up lands choked with excessive growth and to restore open Savanna longleaf pine woodlands.



Different treatments, and combinations, can affect the way forests, overgrown and overly dense, are restored to open woodlands. (Left) Forest before thinning and (right) after thinning. Credit: Tall Timbers Research Station.

At all sites, the researchers planned to study three treatments: prescribed burn only; mechanical chip only; and a combination of chipping and burning. Circumstance and tragedy crippled portions of the study, as concerns after 9/11 shifted resources and personnel. Hurricane Ivan in 2004 and Hurricane Dennis in 2005 damaged many areas. In many of the study sites, the researchers could not carry out the intended prescribed burns; with the exception of the FMNF sites, the researchers compared two treatments only, chipping versus lack of chipping. Using different plot scales to sample abundance and uncommon species, the researchers collected data on the different plants they found in the study areas.

At the FMNF, the researchers found treatments did not disrupt pre-existing plant communities to a great extent. They found their target species (those that are longleaf ground layer plants) tended to increase after treatments. Those species that prefer disturbance events increased greatly after chipping and slightly more after chipping plus burning. The scientists point out that where an increase in weedy species is often taken as an indicator of a degraded habitat, in this study, the increases in weedy species accompanied positive responses by most other plants. “Compared to burn only treatments, chip treatments substantially reduced stem densities of both loblolly pine and hardwoods below 15cm (6 inches) dbh (the diameter of a plant at breast height),” Glitzenstein offers.

The team found hardwoods resprouted vigorously, and large numbers had reached breast height by the time the chip plus burn plots were burned the following winter. Fires in the chip plots were effective in killing large numbers of smaller loblolly pines and resprouting hardwoods. Glitzenstein notes

that in a short period of time, plots both chipped and burned began to resemble open pine woodlands. This contrasted, he noted, with plots that were chipped but not burned, where hardwood sprouts were thriving, and large numbers were already reaching a threshold where they wouldn’t be controlled by prescribed fire. The team believes these observations show that prescribed fires applied quickly after chipping is vital in altering plant communities with treatment tools. At the other study sites, the scientists found differing results, which may have to do with pre-treatment conditions found at a particular area. Chipping may be harmful on open sites that have been maintained by fire, and that already support the plant communities desired of restoration goals.



Scientists conducting vegetation sampling on fire plots. Credit: Tall Timbers Research Station.

Mechanical chipping does not massively damage plant diversity or abundance, the researchers offer. Where fire has been excluded for a long time, and a dense structure of loblolly pine and hardwoods clutter the mid-story, mechanical chipping is beneficial for quickly reworking the stand structure to an appropriate level of openness, and for reducing competition by woody plants. In this situation, the scientists urge, the positives far outweigh the negatives. While chipping is an effective tool, they explain, chipping followed by prescribed burn is the most

effective tool to restore ecosystems for the study areas. They offer this important caveat: “Sites that already possess a diverse high quality ground layer are best managed with fire only. Negative impacts of mechanical chipping in such situations are sufficiently pronounced so as to discontinue the treatments. To put it succinctly, a one-time chip in a restoration context may be appropriate but repeated chipping is probably not appropriate as a true fire surrogate for maintaining high quality ground cover.”

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Fuels, fire behavior, smoke

At FMNF, situated on the soggy-in-winter Atlantic Coastal Plain, the scientists studied treatments to reduce

fuels, modify fire behavior and limit smoke emissions. The study sites included chip and burn, and burn only treatments. Prior to the study, Hurricane Hugo massively impacted forest cover in the FMNF. The 1989 hurricane left one hundred million board feet of timber snapped and strewn in a woody mess. With so many downed trees, managers had stopped burning large areas of the National Forest, and open pine woodlands and savannas grew thick with loblolly pine and hardwood trees, choked with midstory and understory plants.

The scientists collected fuel moisture data prior to burning, and ignited the burn treatment plots. Because of thick plant growth, the team was unable to light additional strip fires across the burn only plots of the smoke experiment to facilitate burning. Even without the application of additional ignited strips, fire raced across these two plots. In the chipped plot, fire crept along, which required the team to light a number of fire strips in order to finally burn most of the plot. Most of the plots, burned on another day, had similar fire behavior with fire intensity only a slight bit higher than in the non-chip plots.

The team then looked at video of their experiments to analyze fire behavior. To examine treatment effects on fire behavior and smoke production under harsher fire conditions than they could witness in their field tests, the researchers used various fire modeling software such as BehavePlus and the First Order Fire Effects Model (FOFEM). To increase the accuracy of the predictions, the researchers provided custom fuel models based on field data. Nevertheless, the model predictions were somewhat inaccurate—the model assumes that plants, and therefore fuels, are homogenous and alike based on height. Live plants and dead fuels, including woody debris and pine needles, are recognized as similar both horizontally and vertically. “This is rarely the case in nature,” Glitzenstein explains, “and the assumption of vertical homogeneity is particularly incorrect for long-unburned stands with laddered fuel structures such as those observed in this study.”



Fire in longleaf pine forest. Credit: Tall Timbers Research Station.

Untreated fuels at the study site included a continuous understory canopy of pine and hardwood saplings and tall shrubs; underneath that grew a layer of mid-sized shrubs; and under that, the litter layer of downed logs, short shrubs, dried plants, and dead leaves and twigs. The scientists ran

the fire model to test different fuel depths for fires that would burn under various drought and wind conditions. The issue of laddered fuels was not as problematic in the treated plots since chipping had wiped out the sapling and shrub layer, resulting in a compacted litter layer.

Chip treatments reduced downed log fuels (1,000-hour fuels) significantly, but as most of the wood was rotten, the researchers feel these fuels wouldn't burn except in dry conditions. Considering sound wood only, where chipping did not completely pulverize logs, chip treatment increased 1,000-hour fuels compared to untreated plots. 100-hour fuels (large limbs) and 10-hour fuels (twigs and branches) increased fuel loads after chipping. One-hour fuels, such as pine needles, decreased in the chip plots, probably due to the removal of mid-canopy pines. Grass and forb fuels were greater in the chip plots, demonstrating the benefit of woody plant (and canopy) reduction to ground layer plants. Fuels in all plots, the scientists discovered, were practically saturated on the days of the experimental fires, exceeding the high moisture scenario provided by BehavePlus.

In the field experiment, the team observed flame lengths in the unchipped plot were less than three feet, with occasional flare-ups in shrubs. In the chip plot, they observed lower flame lengths, but this may have been due to lower wind speeds at the time of day the researchers burned the chip plot, and if the fuels contained more moisture. The researchers observed what they considered convincing evidence of treatment effects on fire behavior—the percent of the area that burned. “Only slightly more than half the area in the chip plots burned as compared to upwards of 80 percent in the burn only plots.” The burn-only plots experienced higher scorch height compared to the chip plots burned. Other measured variables reinforced their conclusion that the fires in general were low intensity with low fuel consumption. The team discovered that the lower litter layers and duff did not burn or add smoke. Through these field tests, and by running model scenarios, the scientists offer a qualified statement that chip treatments protect against dangerous wildfires, at least in the short term. “As other fuel treatment studies have also shown, the main benefit of treatment for prevention of potential dangerous wildfires is related to reductions in fuel depth,” Glitzenstein offers.

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Chipping, unlike prescribed burning, rearranges but does not consume fuel loads, the team explains. Further tests are needed to determine the rate of plant regrowth to hazardous fire conditions, and to examine the possibility that under extremely dry conditions, fire may burn into the densely compacted layer of chipped fuels and thus enhance smoke-particulate production. The scientists dispel the belief that chipping must be used as a safety measure before prescribed burns are applied to areas that have had fire withheld. This is not true for the FMNF and surrounding

area, they offer: “Despite many years of fuel accumulations, tall understory vegetation and steady winds, our prescribed burns were for the most part slow moving and with low flame lengths.” The researchers found this to be true for their chipped and unchipped plots, in an area of the world where high water tables and high fuel moistures during the winter burn season make it a challenge to burn enough of a desired treatment area. Fire running out of control is highly unlikely except under drought conditions.



Young longleaf pine shrugging off flames. Credit: Steve Shively, photographer; USDA Forest Service.

Pros and Cons

So does mechanical chipping rehabilitate the forest by reducing fuels and fire hazard? Chipping presents pros and cons depending on time scale, the scientists explain. Chipping eliminates the understory, which increases wind movement that dries out duff and litter. In a drought cycle, chipping could make duff more flammable and kill more tree roots. Over several years after chipping, duff could be reduced because the understory that produced oak leaves and pine needles is gone.

On the other hand, chipping churns duff up into the litter layer; the open canopy allows duff to decompose more quickly. More studies are needed to answer duff and litter characteristics after chipping treatments, and the scientists urge managers to burn chipped stands when weather conditions are safe, avoiding dry days.

Chipping prior to burning helped air quality, as chipped plots produced only half the amount of smoke as burned plots. This may be due, the team offers, to the area of the chipped plot that actually burned, as noted above, where a large portion of the chipped plot failed to burn at all.

Managers should consider the goal of reducing emissions over time, and using treatments that accomplish this rather than reducing areas burned that will then shift emissions released to later prescribed fires or wildfires. In the longleaf pine region, Glitzenstein explains, this is best accomplished with prescribed fires starting with conservative winter burns. Fire safety, fuels reduction, smoke reduction, restoration of plant communities—an array of goals drives land management and forest

Management Implications

- Managers should apply prescribed fire quickly after chipping to prevent dense woody regrowth, to help plants dependent on fire, and to direct plant community structure and composition (such as open understories) toward restoration goals.
- As more studies are needed to understand duff and litter characteristics after chipping, managers should burn chipped stands when weather conditions are safe, and avoid dry days.
- Managers should not reduce areas burned to as a way to reduce smoke emissions, which shifts the problem to later events; rather, treatments should accomplish emissions reductions over time.

rehabilitation. It is vital to cultivate the conditions today to yield the results we want to see tomorrow. As stewards of the future, opportunities abound.

Further Information:

Publications and Web Resources

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Scientist Profile

Dr. Jeff Glitzenstein's research interests include forest dynamics and succession, fire ecology, and restoration ecology. He is especially interested in fire ecology, management and restoration of longleaf pine habitats and ground layer vegetation. He and his wife and colleague, Dr. Donna Streng, have a rather substantial knowledge of longleaf ground-layer flora and are among the few individuals who can recognize most of the plants in vegetative condition. They have spent many years monitoring vegetation changes in longleaf habitat fire research plots and have published on effects of fire frequency and fire season. They also do much floristic survey work and work with land managers on restoration programs.



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