Ecological Restoration Inspires Humility: Mistakes Made in the Process of Trying to Restore a Longleaf Pine Savanna

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Gazing over the acre or two of partially restored longleaf pine savanna on which I’ve worked for the last 35 years, I must admire the advocates of the global goal of hundreds of millions of hectares of ecological restoration over the next decade (http://www.bonnchallenge.org/). Perhaps not all ecosystems are as hard to restore as pine savanna, but I’ve been having a deuce of a time. That my modest progress can in part be attributed to errors I’ve made is the focus of this essay and the seminar on which it is based. My hope is that by revealing some of these mistakes, other restorationists will feel better about the mistakes they’ve made and avoid mine. At best, the rocky road I’ve taken towards pine savanna restoration will be interpreted as exemplary adaptive management; at worst, readers/listeners will get a chuckle at my expense, which is fine with me. I also explore some of the challenges I still confront, with hopes that others engaged in similar pursuits and face similar problems will be grateful to know that they have company.

My motivation to invest heavily in longleaf pine savanna restoration, which formerly covered much of the Southeastern Coastal Plain of the USA, is that 97% of that ecosystem has already succumbed to plows, cows, fire exclusion, and suburban developers—worst of all, destruction of the remnants continues (e.g., Frost 2007). The Coastal Plain Floristic Province where pine savannas predominate is the world’s newest official biodiversity hotspot (Noss et al. 2015) with an estimated 5470 species of vascular plants of which 6-7% are endemic. At even a fraction of this total species list, full ecological restoration (i.e., getting the species and their interactions back) in this region is a daunting endeavor. While a bulldozer can destroy a pine savanna in minutes, restoration turns out to be the work of decades or more.

To understand the context of my mistake making, I need to describe the ecological conditions I confronted in 1985 when my longleaf pine savanna restoration efforts commenced. The acres on which I focus is a small portion of the much larger and more diverse setting that is the Flamingo Hammock Land Trust. I describe that unique property and some of the people in Finding Home in the Sandy Lands of the South (Putz 2015), but here focus on the acres I see out my window. Readers of that book will learn about other restoration efforts on the property and enjoy a graphic account of how I learned about the exponential relationship between fire rate of spread and slope, but that experience was not derived from the acres considered here and so isn’t treated.

Before I started to intervene, like many of the pine savannas of the South, much of my land had been clearcut, plowed, fertilized, plugged with exotic pasture grass, rooted up by wild hogs, and overgrazed. Most apparent in that abused pasture were the scattered loblolly pines, patches of bare sand, non-native bahiagrass, and weedy natives such as sumac, prickly pear cactus, and head-high clumps of dogfennel. Among the few desirable longleaf pine savanna species were several species of pawpaw, elephant’s foot, goldenrod, and bastard indigo, with evidence of the presence of both gopher tortoises and pocket gophers. The eastern third of my restoration area was what I refer to as junk hammock, a closed canopy forest with remnant longleaf pines, mockernut hickory, and southern red oak with up-and-coming sweetgum, pignut hickory, and laurel oak. In the understory were clusters of grapevine-draped sparkleberries, yaupon holly, and plentiful young laurel oaks.

After 35 years of restoration effort and a fair chunk of change spent on plants and herbicides, my restored acres look like a longleaf pine savanna, at least from a distance and if you excuse the scattered loblolly and loblolly x longleaf pine hybrids amongst the somewhat scraggly longleafs. Over that same period I’ve recovered about a third of the 100 or so understory species that originally graced this landscape (based on studies of intact pine savannas; e.g., Carr et al. 2010). I celebrate each newly recovered species, but new re-
introductions are becoming increasingly challenging due to lack of planting material, ecological bottlenecks, and my own lack of knowledge. Assuming that I can continue my previous pace of successful species reintroductions and don’t lose any, all the species I desire will be on site on my 113th birthday; more likely the trajectory will be asymptotic and quite a bit slower. My concern is that during the intervening years I will suffer lapses of attention with attendant resurgences of bahiagrass and worse.

Before commencing with my litany of mistakes, I should point out that I am a professional plant ecologist, have taught this topic to undergraduate and graduate students for decades, and publish original research on restoration as well. That said, ecosystems on the Southeastern Coastal Plain were new to me when I first arrived and commenced restoration, and many of my assumptions about them were based on faulty comparators. I should also point out that although restoration wasn’t new in 1985, the Society for Ecological Restoration was only founded in 1988.

The errors and quandaries provided below are arranged in roughly chronological order. The list is not exhaustive but sufficient to make clear that, over the decades of hands-on involvement in longleaf pine savanna restoration, I’ve made not a few mistakes, some of which were real zingers. In the belief that the cause of restoration will be served by explicit descriptions of what went wrong, I provide this litany of screw ups and blunders. I wish I could claim that I now know what I’m doing but, more realistically, my best hope is to make new mistakes.

1. In the pitiful pasture in which I commenced longleaf pine savanna restoration, I tried to save the scattered natives, which complicated every subsequent intervention. Perhaps I should have wiped the slate clean with heavy equipment and herbicides and started from scratch, but I didn’t want to live next to a Superfund Site and, even back then, wondered if the diminutive pawpaws were ancient.

2. My next and related mistake was to believe that after decades of plowing, fertilizing, seeding, over-grazing, pig rooting, and abandonment, I could actually wipe the slate clean. Given the presence of approximately 1000 buried dormant seeds of weedy species per square meter of soil and the abundant seed rain of ruderals from adjacent areas, slate wiping is challenging. Furthermore, just how many herbicide treatments are needed to kill the last viable nodes of bahiagrass and centipede? Finally, keeping a nearly bare slate bare would mean no lapses of attention of more than a few weeks, the time it takes for some ruderals to mature and reproduce with a vengeance.

3. As a plant ecologist trained on the glaciated lands of the North, I initially interpreted the scraggly pines, scrubby oaks, and bare sand as indicators of soil acidity and nutrient impoverishment. Given that misunderstanding of naturally nutrient-poor and severely drained ecosystems, when the local utility called to offer free slag lime from their water treatment facility, I readily accepted. When they offered to deliver that lime for free, I did some quick back-of-the-envelope calculations and requested seven cubic yards. The next afternoon, when I came home from the university with my pH kit in hand, the lime had already been delivered, a reflection on the utility’s desire to rid themselves of the stuff. To my dismay, my soil pH hovers around 6.4, which left me no recourse other than to bury that lime. Even if I’d wanted to spread it, I’m not sure how that would have been possible given that slag lime is an incredibly sticky clay.

4. Another mistake derived from my mis-diagnosis of a nitrogen deficiency; I sowed seeds of hairy indigo, an exotic but effective leguminous nitrogen fixer. Now, 35 years later, I’m still trying to eliminate this weed, having recognized that residual soil fertility—not infertility—impedes my efforts to restore the grasses and forbs native to longleaf pine savannas. The desired species tolerate oligotrophy and are outcompeted where soil resources are abundant.

5. It was a mistake to adopt the Wade Tract, managed by Tall Timbers Research Station, as my one-and-only reference site. Before turpentine tapping, logging, and messing with fire regimes, longleaf pine savannas varied tremendously in their structure and composition. Although my restoration area is small and flat, the
junk hammock portion is underlain by an ultisol, with detectable clay in the subsoil, whereas the more open area has a deep sandy entisol. This subtle soil transition helps explain the initial differences in vegetation, and warranted different reference conditions.

6. Like most land managers in the 1980s, I conducted my controlled burns in the winter. Winter burns are more comfortable to conduct, but are relatively ineffective at controlling the thin-barked hardwoods that invade longleaf pine savannas in the absence of hot fires. As a consequence, despite frequent fires, my hardwood problem hardly diminished.

7. When I realized the error of my ways and started to burn in the summer, on a very hot day I crown scorched several cherished longleaf pines. I’ve since learned to not burn when it’s too hot and prefer to burn on somewhat windy days so that the convective and radiant heat is dispersed before it cooks the pine crowns.

8. Where I reintroduced fire after decades of exclusion, I unknowingly allowed a duff fire to smolder its way around the bases of a large longleaf pine. Although soil insulates roots from the effects of fast-moving fires, several hours of smoky but not flaming combustion was enough to toast them down a foot or more, which killed my precious tree.

9. In the junk hammock portion of my restoration area, I expended great efforts before and during my controlled burns to save some native but fire-sensitive species such as sparkleberry and chinquapin. I’m still of two minds about the former, but chinquapin seems well adapted to frequent fire, often producing substantial nut crops within months of being topkilled.

10. Where thin-barked hardwoods were coming to dominate due to fire exclusion, I girdled some big laurel oaks so as to reduce my work load and to provide resources for woodpeckers and cavity-nesting species. Girdling was a mistake on at least three counts. First of all, given the frequency of large branch falls, especially during wind storms, the area was unsafe for many years. Worse is when some snags ignited during a controlled burn; felling dead trees is dangerous, but felling trees that are on fire overhead is lunacy.

11. Any list of mistakes related to restoration that involves controlled burns of fire-maintained ecosystems needs to include at least one escape; the one I will reveal here was caused by the nocturnal fall of a burning snag near the burn unit’s edge.

12. As an environmentalist of the Silent Spring generation, I initially hesitated to herbicide the stumps of unwanted hardwoods, which resprouted with a vengeance. The subsequent treatment involved crawling into coppice clusters to cut the sprouts. As an example of making lemonade when only provided lemons, we just published a paper on an unsuccessful but herbicide-free way to control hardwoods (Britez et al. 2020).

13. As with escaped fires, any account of mistakes made in restoration involving chainsaws needs to include a chainsaw mishap. Given that my primary research is on improved tropical forest management through use of reduced-impact logging practices, admitting to screwing up big time with a chainsaw is particularly painful. If you want the gory details of this personal tragedy, provide me with ample pain numbing intoxicants; 25 years later, I still can’t believe just how many rules of responsible tree felling I broke.

14. As previously mentioned, loblolly, not longleaf pine, dominated the pasture portion of my restoration area. Over the years, my relationship with loblolly has evolved, but it was and remains unclear. At issue is the fact that in these parts, loblolly is a floodplain species, but because it grows fast and produces abundant and well dispersed seeds, it’s a great colonist of abandoned agricultural clearings. When it colonizes fields in the uplands with deep sands, it’s prone to drought stress, especially when crowded. My failure to thin my off-site loblolly pines rendered them susceptible to Southern Pine Beetles, which attacked with a vengeance during the major drought at the end of the last millennium. The beetles then jumped to spruce pine, longleaf, and then slash pine, at which point forest industries got interested. I since learned to thin a lot, but am not sure
whether I should get rid of them all, or retain some for their needle cast. And if I do whack them, what should I do with the longleaf x loblolly hybrids ("Sonderegger" pine), about which I only recently became aware?

15. When I initiated restoration, I embraced what is aggravatingly known as the “Field of Dreams” myth (Hilderbrand et al. 2005) from the Kevin Costner baseball movie of that name. The main character in that story was convinced that if he built a baseball diamond in his cornfield, Shoeless Joe Jackson from the 1919 Black Sox team would miraculously arrive ("If you build it, he will come"). In my case, I assumed that once I removed the invasive hardwoods, thinned the pines, and re-instituted frequent, low-intensity controlled burns, pine savanna species would magically appear. The reality was in the absence of a nearby “donor” area of intact pine savanna, virtually all the desired species needed to be painstakingly reintroduced.

16. I believed in seeds, and suppose I still do, despite an establishment success rate that never rises above a tenth of a percent—yep, that means one in a thousand of the wildflower and grass seeds I sowed successfully matured into an adult plant. At first, my mistake was failing to guarantee that the seeds made direct contact with the mineral soil surface and dried out in the duff. After I started being sure to seed only where mineral soil was exposed by hot fires or rakes, my success rate increased, at least marginally; stomping on the seeded soil to increase seed-soil contact also helped especially where I could keep the soil moist with a lawn sprinkler. I remain pleased that plants invest in flowers and fruits, but really wonder at the frequency of successful sexual reproduction out there in the wild. Whether its seed predation by harvester ants and granivorous birds or absence of appropriate soil microbes, reproduction by seed seems exceptional in pine savannas; I still have not encountered a true pawpaw seedling.

17. It was a mistake on a hot day to spray foliar herbicides on non-native coral ardisias (Ardisia crenata) under a live oak, which resulted in the demise of the tree I was trying to save.

18. Here’s an easy one. Out of love of pretty flowers, I left one exotic mimosa (Albizia julibrissin).

19. I inadvertently introduced another exotic invasive species with a potted native plant purchased from a nursery, another with off-site mulch, and cogongrass when I had the road graded.

20. In an ill-fated plant rescue operation, I tried to transplant a paw paw (Asimina reticulata) that was fated for bulldozing. I wanted to get the entire root, but gave up when I required assistant to get out of the hole.

21. I planted longleaf pine seedlings before restoring the understory, tended them dutifully for several years, and then killed them with a fire.

22. My initial approach was to favor wiregrass (Aristida beyrichiana) always and everywhere, but recently started to wonder whether the abundance of wiregrass is a vestige of overgrazing, wiregrass being unpalatable other than as young shoots. Plus, I’m doing relatively well at reintroducing some other native grasses including lopsided indian grass (Sorghastrum secudum) and purple lovegrass (Eragrostis spectabilis).

23. The farmers and ranchers who previously owned my land struggled to eradicate saw palmetto, which I of course wanted back. My initial reintroduction approach involved rescuing them from piles of root-raked material in pine clearcuts, but that only worked near hose bibs where I could baby them for a year. Then I started collecting fruit, stripping off the flesh, scarifying the seeds with a file, and then carefully planting them. That worked but was unnecessarily labor intensive. Now I feed the fruits to my canine field assistant, who takes care of scarification, dispersal, and even fertilization.

24. I returned from a year-long sabbatical to find my partially restored savanna area inundated by tall ruderals, mostly Spanish needles, hairy indigo, ragweed, and partridge pea. In an effort to rescue the thousands of desirable but shorter-statured pine savanna plants, I endeavored to yank out those pernicious weeds. With a thousand buried dormant weed seeds per square meter, I wonder whether I thereby exacerbated the problem. I tried fire, but those tall, succulent weeds don’t burn easily, except if you first mow and let them dry for a few days. Several experts suggested I leave them alone for a few years and they’ll disappear; from what
I’ve seen, that process takes more than a decade, during which they enrich the soil seed bank and facilitate colonization by other unwanted species. I remain undecided about the best course of action, but admit that I derive some satisfaction from yanking out ragweed to let the sun shine on blazing stars.

Although many of my errors and attendant failures are attributable to ignorance, some seemed impossible to anticipate. Pine savannas are clearly complex, not just complicated and, like other complex systems, are characterized by legacy/historical effects, non-linearities and thresholds (i.e., tipping points), and, most importantly, surprises. It therefore seems like the height of hubris to assume that a system as intricate as a longleaf pine savanna can be re-created. In any case, if it’s true that restoration is the acid test of ecological understanding, then get ready for acid burns. I feel just a bit redeemed by a paper published earlier this month in Proceedings of the National Science Foundation in which the average unassisted recovery rate of the composition of old growth grasslands and savannas was estimated at 1,400 years (Nerlekar & Veldman 2020), which means that I’m actually doing pretty well.

My very limited success at restoring a pine savanna might be anomalous and other ecosystems might be easier to restore, but my experiences might also raise concern about the achievability of at least the more ambitious of global restoration goals over time scales that don’t run into the centuries. Clearly, where local stakeholders are willing, huge areas can be reforested rather quickly. In contrast, attainment of the much loftier goal of ecological restoration of the full set of native species and their interactions will require much more patience and effort, abundant ecological knowledge, some not yet available, and probably lots of money. As much as I enjoy the physical and intellectual challenges of restoration, stopping the destruction clearly needs to remain the priority for conservation.

Given the extent to which we humans have ravaged Earth, reclamation, rehabilitation, reforestation, and ecological restoration are all needed. I encourage personal participation in these efforts; there’s exercise to be had, experience to gain, mistakes to made, and humility to be reinforced, but also pleasure to be derived, so celebrate the return of every native.

**Literature Cited**


