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A Fireless Prescription, Leverage Points, and the Future

Introduction

The goal here will be to provide a framework of sustainability under which my project area (PA) can be managed. In essence, we wish to maintain and foster biodiversity and biotic habitat while making small, periodic timber harvests. Because the once pine dominated valleys of the Ouachitas have been extensively logged and converted for agricultural purposes, we realize that our small forest is an important ecosystem service within a vastly fragmented landscape.

First, I advocate the use of an uneven-aged, multi-successional (UA/MS) approach by identifying how this prescription will best serve the purpose of obtaining our goals. In addition, I discuss how the UA/MS prescription protects against stand-replacing disturbances and elaborate on how the application of biochar upon the forest floor can sustain and enhance soil quality in the absence of a fire regime. Second, we will review the UA/MS prescription as a system of leverage points as described by Meadows (1999). Lastly, we will center forests in the larger context of the earth system as a means of achieving future goals.

Goals:

Sustainable Supply of Timber over Time

If we wish to maintain a periodic yield of high quality timber, then it will be paramount to manage the PA in a fashion that harbors stands at various successional stages. For example, if the PA's forest were of even age, then there may only be a period of 10-20 years from which we will be able to obtain the desired size and quality of timber. In late succession, trees would become fewer and too large for harvest as the PA reaches old-growth and beyond. Subsequently, the land owner or his offspring would have to wait several decades until the forest once again produced timber of desired size and quality.

Autotrophic Biodiversity

Managing the PA such that it contains several successional stages will help the site maintain a diversity of vegetative species. As noted by Perry et al. (2008, p.120), the composition and dominance of vegetation changes over time as forests shift from one successional state to another. This process starts with the dominance of herbs, then gives way to secondary shrubs that eliminate pioneer herbs by shading. Next, secondary trees of lower stature begin to dominate. In our project area, this includes various oak species and eastern juniper. Finally, our primary tree, shortleaf pine, dominates the landscape.

Heterotrophic Habitat

Managing the PA such that it contains several successional stages provides a vast array of different habitats and food sources for heterotrophs. My sustainability web illustrates this concept nicely, as forest inhabitants typically prefer a particular successional stage or a small range of stages. Few species are found across all successional stages. An uneven-aged, multi-successional prescription takes advantage of two extremely beneficial structures found in ecosystems: vertical complexity and horizontal patchiness (McComb 2008, Chapter 3).

An uneven-aged stand encourages the composition of mixed-species, which often distributes foliage in many different vertical layers. Forests structured in ways that provide an understory, midstory, and overstory "tend to support more species of vertebrates than a one-layer forest" (McComb 2008, p. 30). The ecological benefits of vertical complexity should be considered before making any attempts at thinning the understory of the project area. Specifically, it has been found that the diversity of bird species in the PA's region increases with foliage height density, thereby helping achieve our goal of biodiversity (MacArthur and MacArthur 1961).

An UA/MS approach will create horizontal patchiness within stands and across the project area. McComb (2008, p. 32) points out that horizontal patchiness contributes to variability in tree size, species composition, dead wood and other habitat elements. Furthermore, birds wintering in our stands (such as the Oregon Junco) have been shown to be associated with horizontal complexity more so than species composition (Zeller and Collazo 1995).

Disturbance

Fire

Obviously, fire is of particular concern for any forest steward, especially if the manager resides on the land being managed. As Perry et al. (2008, p.95) notes, “The effects of species composition, stand age, and stand structure on fire severity are, in theory at least, predictable…” So, how does our uneven-aged, multi-successional prescription measure up against the threat of fire?

An uneven-aged stand can thwart fire severity by reducing horizontal continuity. Closely stocked, even aged stands provide the opportunity for fire to quickly jump from crown to crown and become stand-replacing (Perry et al. 2008, p.96). Although uneven-aged stands provide more vertical continuity, an avenue for fire to reach the crown, this threat is not of much concern in our project area. The secondary trees that constitute the understory are typically oak and juniper, both of which are not very flammable and whose foliage rarely overlaps with the crowns of dominate shortleaf pine. Thus, our UA/MS approach should allow for only low-severity fires (assuming fuel loads are reduced by fire regimes or manual removal).

Wind and Ice

The UA/MS approach should help minimize the impacts of wind and ice storms upon the project area. For example, by incorporating pines of various sizes into the landscape, we can minimize the impacts of a large windstorm. As pines age, their trunks become more rigid and their canopies increase in surface area. This combination puts old pines at risk for being topped or blown over by high winds. To the contrary, young pines are more flexible and have a much smaller crown, making them more tolerant of wind. Obviously, all bets are off in the face of a tornado.

Ice storms most notably affect the oaks in the Ozark-Ouachita highlands, due to their many stems, complex crown structures and stiffness. As ice collects in the canopies of oaks, so increases their canopy surface area. This process forms a positive feedback loop, whereby more ice collects within the canopies until their stems succumb to the weight of the ice, or thawing temperatures relieve them. Again, our UA/MS prescription helps thwart large-scale destruction by providing a landscape of various tree sizes and age.

Herbivores

Potentially destructive insects in the project area include most notably the gypsy moth and southern pine beetle. To date, resources indicate that the gypsy moth is absent in both Oklahoma and Arkansas (Sanford 2012). The gypsy moth is of particular concern because it is a generalist, feeding on broadleaved trees and pine when necessary. I have provided the landowner methods for identification of the gypsy moth on the project area in timely fashion; moths have emerged with spring, are now out in large numbers. The gypsy moth is thought to be less of a threat in Southeast Oklahoma, which is dominated by unappealing shortleaf pine. Nevertheless, annual monitoring of the gypsy moth could thwart a regional outbreak.

The southern pine beetle is the main source of pine mortality within the project area (personal correspondence with landowner). Although we can do nothing about the regional drought that aids their propagation, the UA/MS approach can help reduce the beetle's effect upon our project area in three ways. First, by enhancing bird habitat as previously discussed, the prescription provides a larger natural predator base for the beetle. Second, the UA/MS prevents the overstocking of pine, which is often linked to the severity of beetle-kill. Lastly, it limits the stand disturbances of wind, fire and ice as previously demonstrated. Such disturbances are often precede outbreaks of the southern pine beetle (Sanford 2012).

No Fire, Yes Biochar

Soil quality is of particular concern in the project area due to the lack of fire regime. It has been shown that over 150 herbaceous species occur in shortleaf pine stands in contrast to stands that have experienced long-term fire suppression, many of those species being nitrogen-fixing legumes (Kabrick et al. 2007). Due to the number of dwellings on the project area and their sentimental value, the landowner has expressed that prescribed fire is not an option. But not all hope is lost!

The reduction of forest floor fire fuels by manual removal has long been practiced on the project area to avoid an unnatural accumulation of ground fuels in the event of a natural or inadvertent ignition. In the past, these fuels have been assembled into burn piles in the center of the PA's pasture for ignition in a controlled fashion. My suggestion would be to replace this practice by producing biochar with an Adam Retort[1] system (Figure 1).

Figure 1 – An Adam Retort. Retrieved online 3/17/2012 from http://terrapreta.bioenergylists.org/content/freefarm-adam-retort

The International Biochar Initiative identifies the many benefits of biochar: (1) reduces emissions from open-air burning of biomass; (2) increases soil carbon; (3) improves soil fertility; (4) improves soil tilth; (5) decreases nutrient leaching due to runoff; (6) reduces N2O soil emissions; (7) reduces methane soil emissions; and, (8) biochar captures carbon[2].

It is unknown whether the distribution of biochar within the PA's forest will encourage the growth of the 150 missing species, but it certainly is a possibility. Not only may the

[1] The Adam Retort is the largest and most efficient known method of producing biochar. For more information see http://www.biocoal.org/3.html.
[2] http://www.biochar-international.org/biochar

landowner increase biodiversity using biochar in addition to the benefits listed above, but it might be possible to re-establish some nitrogen fixing legumes and help thwart climate change and the negative affects thereof.

In addition, the reestablishment of these missing autotrophs may have a bottom-up cascade effect, whereby they might encourage an increase in the diversity of herbivores and, subsequently, their predators (Perry et al. 2008, p.468). Furthermore, it may have a top-down affect that encourages the growth of mycorrhizal fungi and other soil organisms (Perry et al. 2008, p.458), thereby benefiting the growth of all other autotrophs.

Points of Leverage

Using the leverage points discussed by Meadows (1999), we can illustrate the extent to which the UA/MS prescription can be affective in land management and identify external constraints that limit the viability of the project area's forest.

At the most basic level, we can influence the PA's *parameters* by choosing how many trees to harvest. In addressing land management, Meadows (p. 5) describes this point of least leverage as "the amount of land we set aside for conservation." Obviously, to maintain sustainable timber yields, our harvests must not exceed growth (Perry et al. 2008, p.513).

Next, by encouraging an uneven-aged stand and stands in several stages of succession, we are creating a *buffer* from whole stand replacement. Meadows (p.6) likens the use of buffers to a store keeping an inventory of goods to prevent the exhaustion of stocks. Moreover, Perry et al. (2008, p. 505) describe species diversity as a buffer against changing environmental conditions.

Structure is described as “stocks and flows and their physical arrangement” (Meadows 1999, p.7). The creation of several different forest structures using the multi-successional approach is beneficial, but not very flexible. Once these physical structures are established, “changing it is rarely simple” (p. 8).

In addition, our leverage is constrained by delays in the feedback processes “relative to rates of change in the system state that the feedback loop is trying to control” (p. 8). Because it takes years or decades to understand how our UA/MS approach affects the project area, responses to feedback loops established by our prescription are delayed. For example, responses to the unknown feedbacks and consequences of creating and distributing biochar within our project area will be delayed until after these loops are established, and are most likely irreversible.

The next strongest leverage point for us is the use of a self-reinforcing positive feedback loop (p. 11). Again, our use of biochar is a great example: biochar prevents nutrient leaching to runoff, then provides these nutrients to vegetation, which in turn dies, decomposes, and returns its nutrients to the absorbent biochar. More explicitly, the terra preta of the Amazon has been shown to have regenerative properties.

Lastly, the use of information and process of learning is our post powerful point of leverage. By monitoring the affects and loops of our UA/MS prescription over time, we can make informed decisions on how to develop or apply other levers. “Missing feedback is one of the most common causes of system malfunction,” (p. 13). Because our project area is small and the landowner does not have access to expensive technological monitoring equipment, consistent visual inspections and timber cruises will be vital in assessing the success of our UA/MS prescription.

Conclusion: Self-organization, Goals, Mindsets and Paradigms

The final levers identified by Meadows (1999) are essentially addressing the ability to transform a socio-ecological system, which entails the relationship between the biosphere, humans, and our institutions.

To accomplish the goals set forth by Perry et al. (2008, p. 519): “(1) protect species and habitats that have no market value, and (2) mimic (to the degree possible) natural disturbance and successional patterns at the scale of both stands and landscapes,” we must place forests within the context of the larger earth system, and lay bear the threats to that system. Overpopulation. Pollution. Climate change.

I firmly believe these future goals can be achieved by coupling ecosystem management with the ***<u>Terrestrial Life Support System</u>*** (TLSS) approach. In essence, the TLSS approach places forests at the center of the terrestrial earth system, the process of which allows for terrestrial inhabitation. Forests are much more than simply ecosystems providing services. They are responsible for meso-scale air circulations, biogeochemical cycling, and earth's solar radiation balance. The implications of the TLSS system surpass historical notions of conservation: the TLSS approach demands afforestation with godspeed to maintain a habitable biosphere (Figure 2).

Figure 2 – For some, learning may **not** be so much fun.

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