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Pine and Oak Herbivores in the Ouachitas & Ozarks: Lessons in a Changing Climate

Here, we will evaluate the most important herbivores in my project area. Although the PA is dominated by shortleaf pine, the presence and function of the genus Quercus should not be ignored. These oaks include the southern red oak (Q. falcate), post oak (Q. stellata) and white oak (Q. alba). Therefore, we will begin by identifying the main herbivores of oak and pine in the Ouachita and Ozark highlands and discussing their ecological roles. Finally, we will address the factors that often keep these herbivore populations in check and what role climate change may play in the future.

Herbivores of Oak

Oak regeneration has been identified as an essential ecosystem component in the highlands for many reasons. Not only do oaks enhance biodiversity by providing habitat for birds and insects, acorns are a very important food source for all herbivores (Mangini and Perry 1999).

The native guild

Mangini and Perry (1999) conducted a five-year study to identify which members comprise the insect guild inhabiting white oak acorns in disturbed and undisturbed stands of the Ozark and Ouachita region. They found weevils of the genus *Curculio* and *Conotrachelus* spp. (Coleoptera: Curculionidae); filbertworm, *Melissopus latifereanus*

(Walsingham) (Lepidoptera: Tortricidae); acorn moth, *Valentinia glandulella* Riley (Lepidoptera: Blastobasidae), cynipid gall wasps (stone galls) (Hymenoptera: Cynipidae) and midge larvae (Diptera).

As seen in Figure 1, these herbivores have a large impact on the production of sound acorn. The Curculio weevils (Figure 2) were found in 26.6 percent of collected acorns, the filbertworm in 5.6 percent of specimens and other herbivores represent 7 percent of acorn inhabitation. Collectively, these insects were housed in 39.2 percent of acorn specimens and may have contributed to the 18.4 percent of acorns considered rancid. Another 10.6 percent of acorns were found to be damaged by wildlife, leaving only 31.9 percent of collected specimens to be considered sound acorns. However, because traps were set to catch acorn specimens as they dropped from the canopy, we must not assume that sound acorns escape herbivores scouring the ground (Mangini and Perry 1999). Therefore, the affects of herbivores on sound acorn production are most likely underestimated.

Preliminary research does not reveal outbreaks of the herbivores noted by Mangini and Perry (1999), nor do they show a concern for large infestations. In fact, they mention that these herbivores do not necessarily cause acorns to become unviable, and that inhabited acorns are not necessarily selected against by wildlife. In contrast, the landowner of my PA has observed selection of sound acorns by birds and squirrels. Although herbivores of acorns do not seem to pose a serious threat to oak regeneration, additional research is needed to identify potential epidemical threats that may exist on the forest floor.

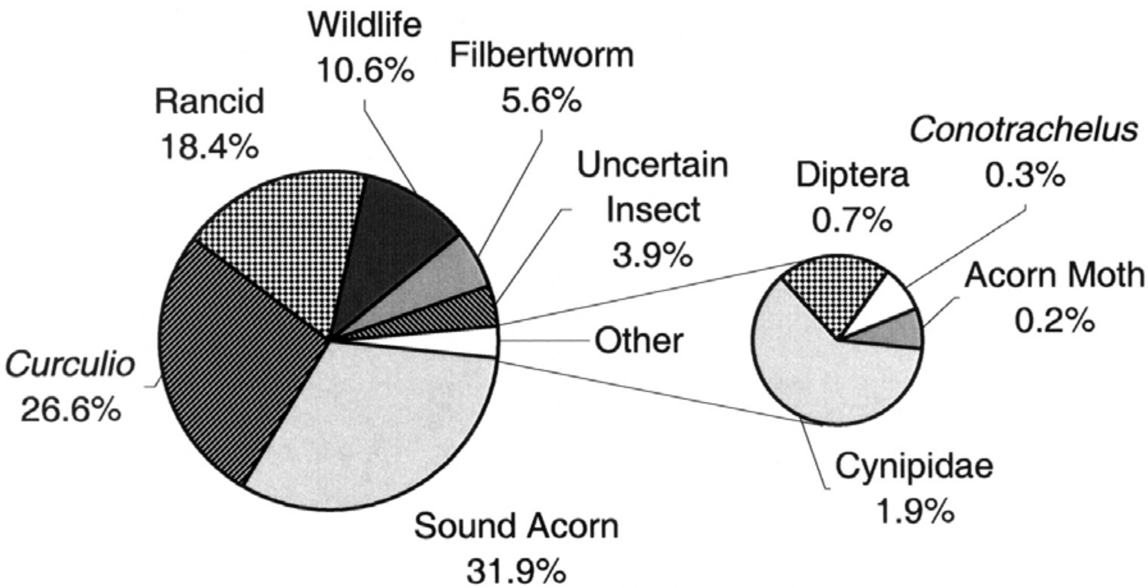

Figure 1 — Average percent of white oak acorns for each quality category, collected from traps in the Ouachita and Ozark National Forests, Arkansas. Percentages were averaged from yearly data collected from 1993 to 1997 and represent acorns collected from two single-tree selection and two unharvested mature forest stands. Source: Mangini and Perry (1999).

Figure 2 – Curculio weevil larva inside a white oak acorn. (Image Citation: Louisana State Univeristy Archive, Bugwood.org; http://www.insectimages.org/browse/detail.cfm?imgnum=0014201)

The invader from abroad

The gypsy moth (*Lymantria dispar*), introduced to North America by accidental release in 1869 (Pell and Bukenhofer 1999), has been expanding its range and has reached the Ozark and Ouachita region (Liebhold et al. 1999). Most scientist concur that there will be a general infestation of the highlands some time between 2025 and 2050 (USDA FS 1995b), and the forests of the Ozark and Ouachita have been identified as the region most susceptible to gypsy moth defoliation in North America (Liebhold et al. 1997a, 1997b). Although the gypsy moth (Figure 3) prefers broadleaf trees, they are a generalist species and will feed on pine needles when preferred food sources become scarce. Thus, if populations become established in the highlands, gypsy moth defoliation could have extreme regional, ecological and economic consequences (Liebhold et al. 1999).

Luckily, our project area lies in the least susceptible portion of the highlands due to the higher concentrations of pine and infrequency of broadleaf trees. Figure 4 illustrates that the area surrounding the PA comprises of only 20-40 percent of species preferred by gypsy moths. Unfortunately for our neighbors to the north, the Ozarks and highlands of southern Missouri are composed of 40-80 percent preferred species (Liebhold et al. 1999).

Potential infestation could be exacerbated by high winds, which can launch caterpillars (Figure 5) airborne. Spread rates for the European gypsy moth have increased from 1.8 mi/year from 1916 to 1965 to more than 12.4 mi/year from 1966 to 1990 (Liebhold and others 1992). However, human intervention has proven successful at thwarting gypsy moth invasions within the highlands. In 1983, a population was eradicated with two aerial applications carbaryl over 1500 acres; in 1993, aerial applications of an insect-growth regulator (diflubenzuron) on 600 acres of private land was successful; treatments with a biological insecticide (*Bacillus thuringiensis*) over 25,000 acres in 1994 and 18,000 acres in 1995 (Fitzgibbon 1997) eradicated the moth; and lastly, in 1995 a ground application of Bacillus thuringiensis proved successful (Brown 1997).

Currently, the Oklahoma Forestry Service assists the USDA's Animal and Plant Health Inspection Service (APHIS) to detect the gypsy moth, and reports that the invader is absent from Oklahoma lands[1]. Similarly, Arkansas and APHIS monitor the pest using a distribution of 2400 traps and reports that as of 2010, no moths have been caught for the previous six years[2].

Figure 3 – Male and female gypsy moths. Source: USDA APHIS PPQ Archive, USDA APHIS PPQ, Bugwood.org; http://www.insectimages.org/browse/detail.cfm?imgnum=2652083

[1] http://www.forestry.ok.gov/insect
[2] http://plantboard.arkansas.gov/PlantIndustry/Pages/Insects.aspx

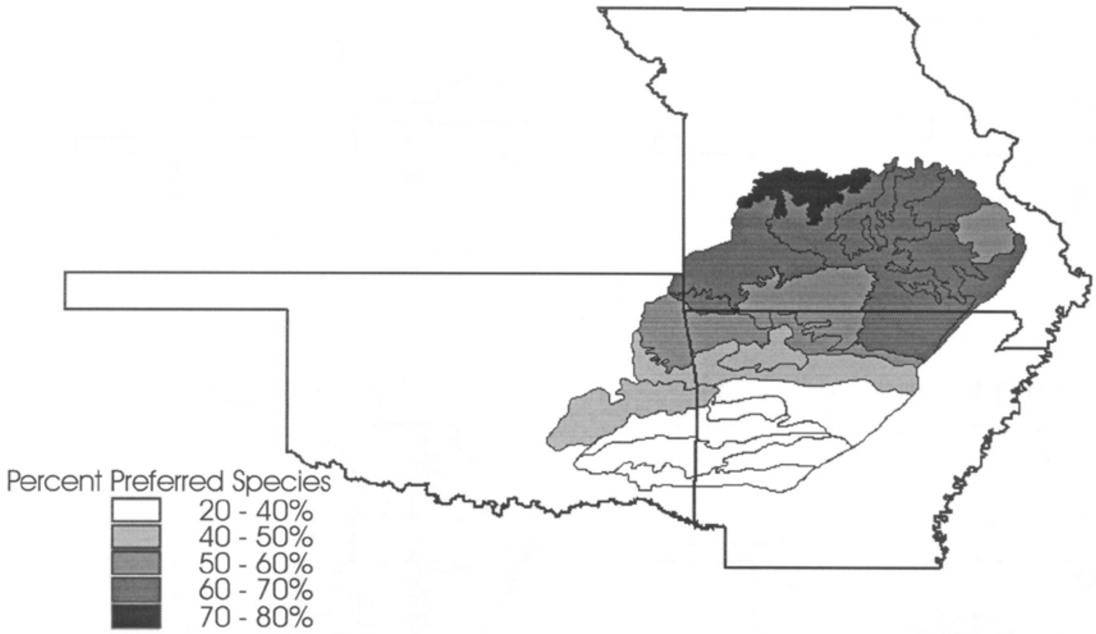

Figure 4 — Map of the Ouachita and Ozark Highlands region showing the proportion of basal area composed of tree species susceptible to the gypsy moth by ecological subsection. (Liebhold et al. 1999)

Figure 5 – Gypsy moth caterpillar feeding on a live leaf. (Source: John H. Ghent, USDA Forest Service, Bugwood.org; http://www.insectimages.org/browse/detail.cfm?imgnum=5383245)

Herbivores of Pine

Most of the once extensive, native stands of shortleaf pine have been harvested, so little is known about the pests of shortleaf pine (Pell and Bukenhofer 1999). Because shortleaf pine pathogens and pests are not a major problem in natural pine and pine-hardwood stands (Blizzard et al.), it has been generally accepted that the challenges of shortleaf pine restoration are greater than protecting the resource (Pell and Bukenhofer 1999). With the exception of the gypsy moth, most oak pests and pathogens do not affect shortleaf pine (Blizzard et al.). Below, we will focus on the most important threat to shortleaf as observed by the PA's landowner: beetles. It should be noted, however, that natural and human disturbances increase the number and diversity of pine beetles occurring in the Ozark-Ouachita highlands up to 5 or 6 years after the disturbance (Cook).[3]

Ips Bark Beetles

There are three principal *Ips* species noted for attacking the pine of the Ozark-Ouachita highlands: the small southern pine engraver, eastern six-spined and five-spined engravers. Like other beetles, their numbers rise with natural disturbances such as wildfires, droughts, lightning storms, ice storms and tornadoes (Pell and Bukenhofer 1999). However, it has been found that warm, dry weather most affect Ips population growth. The Ozark-Ouachita Assessment (1999) urges that as much as felled, infect trees be used or removed and the remainder burned to prevent the spread of Ips beetles. Obviously, intense removal practices such as these could impact the long-term nutrient cycles and

[3] Two species of seed bug, leaffooted pine seed bug, Leptoglossus corculus (Say) (Hemiptera: Coreidae) and the shieldbacked pine seed bug, Tetyra bipunctata (Herrich-Schaffer) (Hemiptera: Pentatomidae) have been found in the highlands, but have a negligible affects on regeneration. Only 4 percent of collected seeds have revealed the bug's presence (Mangini et al. 1999).

fertility within the local stands in which these techniques are utilized. Thus, chipping or burying infected remains may have a softer ecological impact.

Southern Pine Beetle

The southern pine beetle (*Dendroctonus frontalis*) is recognized as the most damaging insect to Midwestern pine forests (Guyette et al.), and serious outbreaks are expected to continue in the Ouachita section of the highlands as the beetle spreads into previously uninfected stands (Pell and Bukenhofer 1999). These cyclic outbreaks are often attributed to drought, overstocked shortleaf stands, absence of natural enemies, and stand disturbances.

Like the Ips beetles, adult southern pine beetles (Figure 7) often introduce bluestain fungus[4] when attacking their host tree. The spores are carried into egg galleries, where the spores germinate and stop the flow of water to the crown of the pine. The problem is exacerbated by the ability of southern pine beetles to produce 4 to 6 generations in a single year.

High temperatures not only enhance the rate at which the pine beetle populations grow, but it enhances the growth rate of bluestain fungus, thereby speeding the rate at which infected trees reach mortality. Moreover, beetle flights can occur in years with extended warm winters and attacks have been found in trees as small as 2 inches in diameter.

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[4] The landowner has emphasized the undesirability of bluestained lumber, despite the premium often commanded by timber suppliers. Being a master woodworker, he has noted a reduction in strength and the propensity for bluestained fibers to soak up oil like a sponge (personal correspondence, 3/10/2012).

Little is known about biological control factors for outbreaks of the southern pine beetle. Unfortunately, natural enemies have rarely been found to have a measurable affect on southern pine beetle outbreaks. These enemies include insect parasites, predators, diseases and woodpeckers. Severe cold snaps have been found to limit the southern pine beetle, as well as extended periods of heat above 90 degrees for several weeks (Pell and Bukenhofer 1999).

Furthermore, it has been a mystery as to why southern pine beetle outbreaks have not occurred in areas of Oklahoma and Arkansas that contain readily available host trees (Pell and Bukenhofer 1999). Figure 6 shows the range of infestations and epidemics since 1960, and illustrates that these infestations have remained in the southwestern portion of the Ozark-Ouachita highlands. It is very plausible that we are experiencing the "talking tree" phenomenon that has been documented in the west by David Perry, Gary Pitman and others (Perry et al. p 427; personal correspondence). Recently discovered shortleaf x loblolly hybrids may also be playing a role.

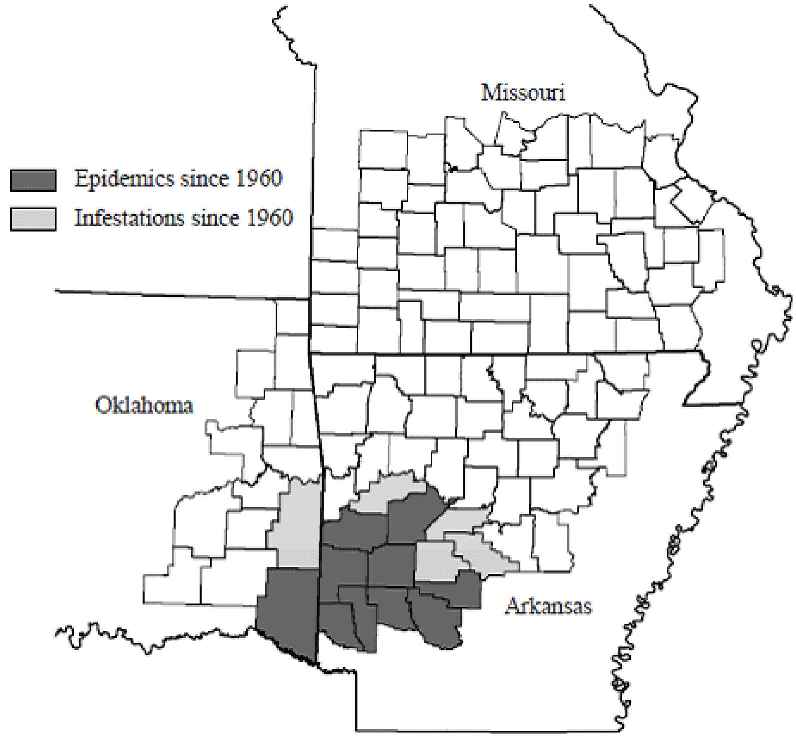

Figure 6 —The incidence of southern pine beetle outbreaks in the Ozark-Ouachita Highlands since 1960.

Source: Pell and Bukenhofer 1999

Figure 7 – A feeding adult southern pine beetle. (Source: USDA Forest Service - Region 8 - Southern Archive, USDA Forest Service, Bugwood.org; http://www.insectimages.org/browse/detail.cfm?imgnum=1510071)

Climate Change

For the United States as a whole, forest insects and pathogens dominate forest disturbance (Logan et al. 2003). Recent research reveals that “insect outbreak behavior will intensify as the climate warms” (Logan et al. 2003). As previously discussed, the gypsy moth and all species of pine beetle increase in frequency as the climate warms. Although Figure 8 shows the predicted establishment of the gypsy moth across the United States with great probability, management in the highlands has proven to be extremely effective at thwarting the invasion. However, due to the size and nature of the predicted invasion, it seems that it is only a matter of time before expansive gypsy moth establishment is a reality.

A recurring theme in the literature researched implies that the success of forest regeneration after an outbreak may depend on population and individual genetic biodiversity, as homogeneous food supplies can sustain large herbivore populations and function to enhance transportability (Perry et al. pp431-432; Natural Enemies of Forest Insects Pests video). Unfortunately, management practices incorporating biodiversity may serve to only slow the rate of invasion of generalist species, such as the gypsy moth.

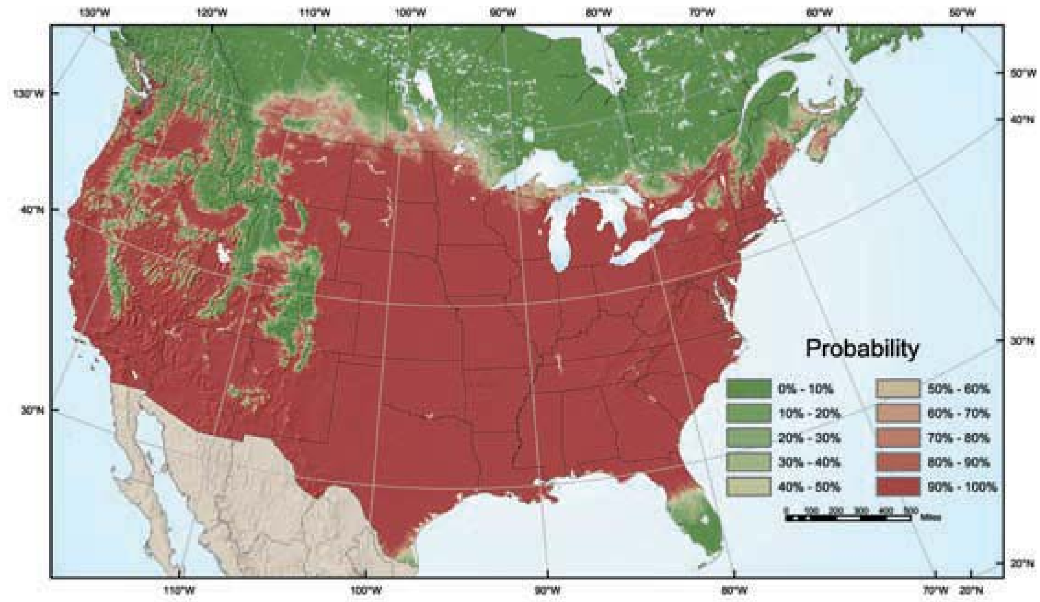

Figure 8 – Predicted map for gypsy moth establishment in North America, north of Mexico. Source: Logan et al. 2003 (Figure 5).

Conclusion

Although human intervention of herbivorous invasions has proven affective in many circumstances, the reality is that we must learn to live with these pests. Management practices should remain adaptive by consistently monitoring changes in herbivore populations, forest stand dynamics, local weather, and regional climate. Long term or widespread use of pesticides or destruction of infected stands seems unsustainable, and could have dire, unintended ecological side-affects. For the project area, management is complicated by the recent revelation that shortleaf x loblolly hybrids are widespread[5]. Research on these hybrids in relation to herbivory is nonexistent, but may provide promising insights into the future of forest structure and composition of the Ozark-Ouachita highlands.

[5] The landowner and I have run into strange shortleaf morphology for years, and in the past have attributed this variance to the genetics of the shortleaf species itself. However, we are now convinced that hybrids exist on the project area, but formal research into the hybrid morphology is needed. (An article on shortleaf x loblolly morphology was published just last month, but I haven't gotten there yet).

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