Effect of Loblolly Pine Coarse Woody Debris (CWD) on Coleoptera Species Richness

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ABSTRACT
Course Woody Debris (CWD) are considered an important ecological component and provide such services as nutrient cycling, wildlife habitat, erosion control, and maintenance of biodiversity. Removal of CWD in accordance with managed forest health practices has been correlated with reduction of beetle richness. To test this, pitfall traps were placed within plots with added Loblolly Pine CWD (ca. 1m length, 30-35cm diameter) and within control plots with no added CWD. A total of 24 plots were established in North Carolina, Mississippi, Louisiana, and Texas. Traps were placed in May 1998 and sampled twice monthly until October 1999. Beetles were preserved and sorted to morphospecies by a technician. Beetle species diversity was almost significantly higher in plots with added CWD ($p = .0544$). Information concerning total and saproxylic species richness among states, collecting dates, and treatment, as well as efficiency of morphospecies sorting is presented.

INTRODUCTION
Coarse woody debris (CWD) is an important component of the natural ecosystem. It provides habitat for many vertebrate and invertebrate species, slows erosion, and is important for nutrient cycling (Harmon, et al. 1986). However, CWD is often removed from managed forests to reduce fuel loads for forest fires, and to reduce potential habitat for invertebrates (mostly Coleoptera) and fungi that may kill or damage healthy trees (Grove 2002b, Siitonen 2001). Many authors have stated that a greater awareness of the biodiversity dependent on CWD is needed practically everywhere, especially in tropical rain forests and in the United States (Harmon et al. 1986, Grove 2002a), where well-designed studies have rarely been performed.

The National Long-Term Soil Productivity (LTSP) study was begun as a USDA Forest Service joint effort between the National Forest System and Forest Service Research to determine the impact of macroporosity reduction and organic matter removal on long-term productivity of our forest resources. The recent USDA Forest Service study entitled "Role of Coarse Woody Debris Decomposition in Sustaining Long-term Soil Productivity of Managed Loblolly Pine" looked at many aspects of nutrient cycling as well as arthropod diversity associated with CWD. This study was installed on four LTSP sites, one each in Louisiana, Mississippi, North Carolina, and Texas. These sites cover the range of rainfall and potential evapo-transpiration (PET) found on the coastal plain. Insects were collected with pitfall traps at control (without added CWD) and treatment sites. Results presented here compare Coleoptera richness across the rainfall and PET gradient and between control sites and sites with added CWD.

MATERIALS AND METHODS
This study took place at four Long-Term Soil Productivity sites: North Carolina - Croatan National Forest (NF), Craven Co.; Mississippi - DeSoto NF, Jones Co.; Louisiana - Kisatchie NF, Rapides Par.; Texas - Davy Crockett NF, Trinity Co.

A 43-year-old loblolly pine stand in the Palustris Experimental Forest, Louisiana, was used as the CWD source. At age 40, the average dbh of all live trees in the stand was 22.5 cm and the average height was 22.6 m. Logs (from trees that were 30-35 cm dbh), limbs (2.5-10 cm mid-length dia), and twigs (0.5-1.5 cm dia) were cut from the stand and used as CWD. After sizing and randomizing, the CWD was transported to the LTSP sites and all three size classes placed in 15 x 15 m replicated plots (3 per site) within the remnant mature pine stand at each site. Ten logs (each 1 m in length), 8 limbs (0.5 meter in length), and 24 twigs (25 cm in length) were randomly placed on each of the three treatment plots. Three additional mature stand plots were used as controls and contained only the woody debris already present or that fell during the study.

Pitfall traps were constructed from a 2 liter plastic bottle placed in the ground. A 150 mm plastic funnel was fastened to a hole cut in the center of a 30 x 30 cm plywood sheet. The funnel, attached to the plywood platform, fit snugly into the mouth of the 2 liter plastic bottle that was half-filled with a 1:1 mixture of low toxicity anti-freeze and 95% ethanol (to kill arthropods that fell into the trap). Each trap was sampled biweekly, from May (only Louisiana) through September, beginning with the placement of the logs. Exemplars representing each Coleoptera morphospecies from each sample were pinned, labeled, and assigned a morphospecies number by a laboratory assistant.

Only specimens identified to genus or species level were included in the statistical analysis. A series of one-way analyses of variance (ANOVA) were used to determine if overall taxa richness was significantly different between treatment and control sites.
All statistical analyses were conducted with the alpha level = 0.05.

RESULTS AND DISCUSSION
A total of 1,259 exemplar specimens representing 52 families and 248 species were identified. Seventy-nine specimens have not yet been identified below the level of family. Families represented by the greatest number of species were **Carabidae** (38 sp.), **Curculionidae** (30 sp.), **Cerambycidae** (21 sp.), **Staphylinidae** (20 sp.), and **Nitidulidae** (15 sp.).

Species of Note
Oxybleptes meridionalis Smetana (Staphylinidae) (Figure 1) was previously known from 31 specimens, all collected in Florida. The Florida specimens were taken in May, August, October, and December (Frank et al. 2005). An additional 21 specimens from Mississippi and Louisiana were collected during this research. Ten specimens were collected in July 1998, another 10 in August 1998, and a single specimen from August 1999. This represents a considerable range extension for the species.

Another species of note is ***Endeitoma* sp.** (*dentata*?) (Zopheridae) (Figure 2). A single specimen was collected from Louisiana on 19 August 1998. This specimen is clearly not *E. granulata* (Say) and differs from the single specimen of *E. dentata* held at the Louisiana State Arthropod Museum. *Endeitoma dentata* is considered a rare species, and has not been reported from Louisiana, having only been collected in Oklahoma, Mississippi, Georgia, and Florida (Stephan 1989).

Species Richness
Species richness between treatment (added CWD) and control plots (without added CWD) for all states combined approached a significant difference ($p = 0.0544$), the greater number of species having been collected from plots with added CWD. This indicates that CWD may promote or help to sustain greater species richness. Family and species richness between treatment and control plots for each state were compared (Table 1). In North Carolina control plots had significantly higher family richness, but there was no difference in species richness between plots. Both Mississippi and Louisiana sites showed no difference in family richness between plots. However, both had significantly higher species richness at treatment plots. The Texas site showed no difference in richness between plots at either the family or species level.

Species richness was compared between control and treatment plots for each month (Table 2). Species richness was significantly higher at treatment plots only in August. A possible explanation for this observation is that coarse woody debris has been shown to act as a buffer against large fluctuations in temperature and moisture (Graham 1925) and may be specifically sought as shelter in hotter, drier months. Further studies using pitfall traps near CWD should take time of year into account.

Table 1. Total family and species richness of treatment and control sites for each state. Similar letters indicate a significant difference in taxa richness ($\alpha<0.05$). CWD = Coarse Woody Debris, Control = no added CWD

	Families		Species	
	CWD	Control	CWD	Control
North Carolina	39[a]	49[a]	112	122
Mississippi	52	44	92[b]	67[b]
Louisiana	48	30	98[c]	46[c]
Texas	64	50	125	100

Table 2. Total species richness of treatment and control sites for each state separated by month. An (*) indicates a significant difference ($\alpha<0.05$). CWD = Coarse Woody Debris, Control = no added CWD

	June		July		August*		September	
	CWD	Control	CWD	Control	CWD	Control	CWD	Control
NC	32	42	29	34	25	17	14	13
MS	25	15	29	21	25	16	11	8
LA	35	11	27	13	20	11	7	4
TX	44	39	24	15	20	18	13	7

Morphospecies
A single laboratory assistant assigned the 1,259 exemplar specimens to 407 morphospecies. As stated above, the taxonomic species number is 248 named species plus not more than 10 additional unidentified species. This represents a rather large margin of error. Mistakes of both the lumping and splitting type were made, although obviously more of the latter. Her supervisor (KK) may have contributed to the over exuberant splitting into different morphospecies.

CONCLUSION
Coarse Woody Debris are directly utilized by many beetle species as well as provide structure and temperature/humidity mitigation for many other non-obligate species. Removal of, or reduction in the generation of CWD by management practices may significantly reduce beetle diversity. This research suggests that CWD is important for beetle richness across the costal plain, especially in Mississippi and Louisiana.

Additional studies should be performed to further elucidate the affect of CWD on beetle richness in North Carolina and Texas. Beetle richness of heavily managed forests with significantly reduced CWD loads should be compared with least disturbed forests to see what if any reduction in beetle richness occurs. Future studies should be targeted toward obtaining an estimate of the amount and kind of CWD needed per hectare to maintain a pre-disturbance saproxylic beetle richness (Ehnstrom 2001).

Figure 1. ***Oxybleptes meridionalis*** Smetana

Figure 2. ***Endeitoma* sp.**
A. Dorsal
B. Ventral

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