Forests **2012**, *3*, 632-652; doi:10.3390/f3030632

OPEN ACCESS

forests

ISSN 1999-4907

www.mdpi.com/journal/forests

Article

Effects of Small-Scale Dead Wood Additions on Beetles in Southeastern U.S. Pine Forests

Kier D. Klepzig [1,]*, Michael L. Ferro [2], Michael D. Ulyshen [3], Matthew L. Gimmel [4], Jolie B. Mahfouz [5], Allan E. Tiarks [5] and Chris E. Carlton [2]

1. USDA Forest Service, Southern Research Station, 200 WT Weaver Blvd, Asheville, NC 28804, USA
2. Department of Entomology, Louisiana State University, 404 Life Sciences Building, Baton Rouge, LA 70803-1710, USA; E-Mails: spongymesophyll@gmail.com (M.L.F.); ccarlt@lsu.edu (C.E.C.)
3. USDA Forest Service, Southern Research Station, 201 Lincoln Green, Starkville, MS 39759, USA; E-Mail: mulyshen@fs.fed.us
4. Department of Ecology & Evolutionary Biology, University of Kansas, Lawrence, KS 66045, USA; E-Mail: phalacrid@gmail.com
5. USDA Forest Service, Southern Research Station, 2500 Shreveport Hwy, Pineville, LA 71360, USA; E-Mails: joliemahfouz@msn.com (J.B.M.); aetiarks@att.net (A.E.T.)

* Author to whom correspondence should be addressed; E-Mail: kklepzig@fs.fed.us; Tel.: +1-828-257-4307; Fax: +1-828-257-4313.

Received: 19 June 2012; in revised form: 14 July 2012 / Accepted: 25 July 2012 / Published: 15 August 2012

Abstract: Pitfall traps were used to sample beetles (Coleoptera) in plots with or without inputs of dead loblolly pine (*Pinus taeda* L.) wood at four locations (Louisiana, Mississippi, North Carolina and Texas) on the coastal plain of the southeastern United States. The plots were established in 1998 and sampling took place in 1998, 1999, and 2002 (only 1998 for North Carolina). Overall, beetles were more species rich, abundant and diverse in dead wood addition plots than in reference plots. While these differences were greatest in 1998 and lessened thereafter, they were not found to be significant in 1998 due largely to interactions between location and treatment. Specifically, the results from North Carolina were inconsistent with those from the other three locations. When these data were excluded from the analyses, the differences in overall beetle richness for 1998 became statistically significant. Beetle diversity was significantly higher in the dead wood plots in 1999 but by 2002 there were no differences between dead wood added and control plots. The positive influence of dead wood additions on the beetle community can be largely attributed to the saproxylic fauna (species dependent on dead wood), which, when analyzed separately, were significantly more species rich and diverse in dead wood plots in 1998 and 1999. Ground beetles (Carabidae) and other species, by contrast, were not significantly affected. These results suggest manipulations of dead wood in pine forests have variable effects on beetles according to life history characteristics.

Keywords: arthropods; biodiversity; coarse woody debris; epigeic; insects; slash

1. Introduction

Logs and other woody debris on the forest floor are an essential habitat for a wide range of saproxylic arthropods [1–3], which are directly or indirectly dependent on dead and dying wood [4]. These include not only phloem and wood feeders but also their predators and species associated with wood-decaying fungi. Many non-saproxylic ground-dwelling arthropods benefit from dead wood as well. For instance, a number of studies have shown litter-dwelling arthropods and other invertebrates to be more numerous immediately next to dead wood than short distances away from it [5–17]. These results can be attributed variously to dead wood providing a relatively stable source of moisture [18–20], shelter from predators or adverse weather conditions, and an abundance of prey or other food items.

With demand for forest products continuing to rise (especially now with a growing interest in biofuel production, see [21,22]), understanding the role of dead wood in maintaining biodiversity, tree productivity and long-term forest sustainability is becoming more important in forest management. Of particular value are studies investigating the effects of dead wood manipulations on these interests. Several manipulative studies have demonstrated the positive relationship between dead wood and ground-dwelling arthropod diversity [23–25], but the question is far from resolved and has received little attention in many forest types.

The forests of the southeastern United States are among the most productive in North America with loblolly pine (*Pinus taeda* L.) being the single most important timber species in the region. One of the few efforts to measure arthropod response to dead wood manipulations made in loblolly pine plantations began on the Savannah River Site in South Carolina in 1996. In the first phase of that study, plots in which all dead wood was removed annually were compared to reference plots from which no dead wood was removed. After pitfall-sampling ground-dwelling arthropods in those plots for five years, Hanula *et al.* [26] found no differences in overall abundance or morphospecies richness. Overall arthropod diversity and evenness were significantly lower in removal plots than in reference plots, however, and several families differed in abundance between the two treatments. These differences were observed only in the first two full years of sampling, however. In the second phase of the study, beginning in 2001, arthropods were sampled in these same plots for four more years. Two new treatments were added in which sampling also took place; one involving major inputs of logs to the forest floor and the other involving major inputs of dead standing trees. Contrary to expectations, but largely consistent with the first phase of the study, there were no differences in total ground-dwelling arthropod abundance, richness, diversity or composition among treatments [27]. Only ground beetles (family Carabidae) exhibited a significant association with dead wood.

During 1998, a study was installed on four widely-separated USDA Long Term Soil Productivity (LTSP) sites in the Southeastern United States to better understand the importance of dead wood to nutrient cycling and biodiversity in pine forests. The responses of beetles, the most diverse arthropods on the forest floor, are reported here.

2. Materials and Methods

This study took place at the following four LTSP sites: Croatan National Forest, Craven Country, NC, USA; DeSoto National Forest, Jones Country, MS, USA; Kisatchie National Forest, Rapides Parish, LA, USA; Davy Crockett National Forest, Trinity Country, TX, USA. The forests were dominated by 50–60 yr pine [loblolly in LA and NC, slash (*P. elliottii* Engelm.) in MS, and loblolly and shortleaf (P. *echinata* Mill.) in TX] with an understory consisting of oak (*Quercus* sp.), hickory (*Carya* sp.), and sweetgum (*Liquidambar styraciflua* L.). For this experiment, the coarse woody debris was added to remnant mature pine stand, adjacent to the LTSP treatment plots. At each site, three of the mature stand plots were used as controls and contained only the existing woody debris already present or that which fell during the study. A 30 × 45 m rectangular area at each site was divided into six 15 × 15 m plots. The dead wood added to all of the plots came from the same 43-year-old loblolly pine stand in the Palustris Experimental Forest, Louisiana. Sections of wood were removed from the main trunk (*i.e.*, "logs", 30–35 cm dbh, 1 m long), limbs (2.5–10 cm mid-length diam, 0.5 m long), and twigs (0.5–1.5 cm diam, 0.25 m long) of loblolly pine trees felled for this purpose. Ten logs, 8 limbs, and 24 twigs were distributed across the three randomly selected dead wood plots at each site in April and May 1998. At each given site, the material was added all at once, on one date during the time frame mentioned above. At all sites, the amount of existing coarse woody debris and the vegetation on the ground were roughly the same. Our additions of material impacted the sites in a very similar manner, adding the above material to the baseline of that already onsite.

One pitfall trap (modified from [28]) was installed in each plot to sample ground-dwelling beetles. At each site, the trap was placed arbitrarily within the plot, in the immediate area of the added dead wood. Each trap consisted of a 15-cm-diameter plastic funnel fastened beneath a hole in the center of a 30 × 30 cm section of ~1.9 cm-thick plywood with bevelled edges. This assembly was positioned over a 2-liter plastic container, half-filled with a 1:1 mixture of propylene glycol and 95% ethanol, buried at ground level. Samples were collected approximately biweekly from May through September at all locations in 1998 and at all locations except for North Carolina in 1999. Additional samples were collected in all locations except for North Carolina in April and May of 2002.

Specimens not identified below family level (117 individuals were only identified to family level) were excluded from the dataset. After pooling all sampling periods for a given year, analyses of variance (ANOVA) were carried out for each year separately (due to differences in sampling intensity) to determine whether beetle abundance (log(x + 1)-transformed to achieve normality), richness, or Shannon's diversity varied between treatments. Site location (= "State") was included in the model as a blocking variable and was treated as a random effect. To provide additional information, separate analyses were performed on the following three groups: saproxylic (species directly or indirectly dependent on dead or dying wood), non-saproxylic ground beetles, and other species. These designations were based on familiarity with the taxa and information available in the literature. Voucher specimens have been deposited in the Louisiana State Arthropod Museum, Baton Rouge, Louisiana.

3. Results

The final dataset consisted of 5172 beetle specimens belonging to 55 families and 378 taxa identified to genus or species (all of which are hereafter referred to as "species", see Appendix). Of these, 47 (13%) were non-saproxylic ground beetles, 182 (48%) were saproxylic, and 149 (39%) were other species (Appendix). Texas traps yielded the most beetles in terms of both individuals (~44% of the total) and species (~60%) whereas Louisiana traps yielded the fewest (see Appendix; note that North Carolina traps were only sampled in 1998). State (block) was found to be a significant source of variation in most analyses of overall beetle richness, abundance and diversity in 1998 and 1999 but less so in 2002 (Table 1). The same was true when saproxylic species, ground beetles (which are non-saproxylic), and other species were analyzed separately (Table 1)

With respect to treatment differences, 2998 (58%) individuals and 302 (80%) species were collected from the dead wood plots compared to 2174 (42%) individuals and 261 (69%) species from the reference plots. Furthermore, 115 and 74 species were collected from the dead wood and reference plots, respectively. Overall, beetles were consistently more species rich, abundant, and diverse in the dead wood plots than in the reference plots during the entire study (Figure 1). Although these differences were greatest in 1998, significant differences were detected only in 1999 and only for diversity (Table 1). Similarly, only in 1999 were significant differences detected between treatments for saproxylic beetles, with them being more rich and diverse in dead wood plots than in references plots. No significant differences were detected in 2002 and non-saproxylic ground beetles and other beetle species, when analyzed separately, did not vary between treatments in any year (Table 1).

The large differences in mean beetle richness, abundance and diversity between treatments in 1998 (Figure 1) were not statistically significant due to strong interactions between state and treatment (Table 1). Most notably, the results from North Carolina were not consistent with those from the other states (Figures 2–4). After excluding North Carolina from the dataset, the differences in overall beetle richness ($F_{1,2} = 19.4$, $p < 0.05$), saproxylic beetle richness ($F_{1,2} = 23.8$, $p < 0.05$) and saproxylic beetle diversity ($F_{1,2} = 20.1$, $p < 0.05$) observed in 1998 were found to be significant.

Table 1. Results from analyses of variance for all species combined, saproxylic species, non-saproxylic ground beetles and other species. Note that data from North Carolina are limited to 1998. Asterisks denote significant *p*-values: * < 0.05, ** < 0.01, *** < 0.001 based on analyses of variance.

Parameter	1998 (*n* = 12)			1999 (*n* = 9)			2002 (*n* = 9)		
	State	**Treatment**	**State*treatment**	**State**	**Treatment**	**State*treatment**	**State**	**Treatment**	**State*treatment**
Richness									
All species	$F_{3,16}$ = 7.5**	$F_{1,3}$ = 3.4	$F_{3,16}$ = 3.3*	$F_{2,12}$ = 16.4***	$F_{1,2}$ = 5.9	$F_{2,12}$ = 0.1	$F_{2,12}$ = 8.1**	$F_{1,2}$ = 1.1	$F_{2,12}$ = 2.3
Saproxylic species	$F_{3,16}$ = 0.9	$F_{1,3}$ = 6.7	$F_{3,16}$ = 4.5*	$F_{2,12}$ = 18.0***	$F_{1,2}$ = 45.1*	$F_{2,12}$ = 0.1	$F_{2,12}$ = 8.9**	$F_{1,2}$ = 1.2	$F_{2,12}$ = 1.3
Ground beetles	$F_{3,16}$ = 14.3***	$F_{1,3}$ = 0.4	$F_{3,16}$ = 0.5	$F_{2,12}$ = 8.7**	$F_{1,2}$ = 0.1	$F_{2,12}$ = 0.5	$F_{2,12}$ = 1.5	$F_{1,2}$ = 1.6	$F_{2,12}$ = 1.8
Other species	$F_{3,16}$ = 28.6***	$F_{1,3}$ = 1.9	$F_{3,16}$ = 1.1	$F_{2,12}$ = 10.2**	$F_{1,2}$ = 5.8	$F_{2,12}$ = 0.1	$F_{2,12}$ = 3.9	$F_{1,2}$ = 0.6	$F_{2,12}$ = 1.7
Abundance									
All species	$F_{3,16}$ = 13.0***	$F_{1,3}$ = 8.1	$F_{3,16}$ = 2.2	$F_{2,12}$ = 18.5***	$F_{1,2}$ = 0.4	$F_{2,12}$ = 0.4	$F_{2,12}$ = 2.2	$F_{1,2}$ = 1.1	$F_{2,12}$ = 1.9
Saproxylic species	$F_{3,16}$ = 4.0*	$F_{1,3}$ = 8.3	$F_{3,16}$ = 3.6*	$F_{2,12}$ = 18.7***	$F_{1,2}$ = 1.9	$F_{2,12}$ = 0.9	$F_{2,12}$ = 6.3*	$F_{1,2}$ = 1.7	$F_{2,12}$ = 1.3
Ground beetles	$F_{3,16}$ = 18.5***	$F_{1,3}$ = 0.4	$F_{3,16}$ = 0.7	$F_{2,12}$ = 2.7	$F_{1,2}$ = 0.7	$F_{2,12}$ = 0.8	$F_{2,12}$ = 2.0	$F_{1,2}$ = 2.4	$F_{2,12}$ = 0.9
Other species	$F_{3,16}$ = 11.1***	$F_{1,3}$ = 0.0	$F_{3,16}$ = 0.4	$F_{2,12}$ = 13.3***	$F_{1,2}$ = 0.1	$F_{2,12}$ = 0.2	$F_{2,12}$ = 1.7	$F_{1,2}$ = 0.3	$F_{2,12}$ = 2.5
Diversity									
All species	$F_{3,16}$ = 5.1*	$F_{1,3}$ = 2.3	$F_{3,16}$ = 4.7*	$F_{2,12}$ = 9.9**	$F_{1,2}$ = 147.8**	$F_{2,12}$ = 0.0	$F_{2,12}$ = 0.8	$F_{1,2}$ = 1.3	$F_{2,12}$ = 1.0
Saproxylic species	$F_{3,16}$ = 1.5	$F_{1,3}$ = 4.2	$F_{3,16}$ = 4.1*	$F_{2,12}$ = 1.8	$F_{1,2}$ = 62.4*	$F_{2,12}$ = 0.1	$F_{2,12}$ = 1.8	$F_{1,2}$ = 0.8	$F_{2,12}$ = 0.6
Ground beetles	$F_{3,16}$ = 7.5**	$F_{1,3}$ = 0.1	$F_{3,16}$ = 0.4	$F_{2,12}$ = 16.3***	$F_{1,2}$ = 3.0	$F_{2,12}$ = 0.2	$F_{2,12}$ = 1.0	$F_{1,2}$ = 1.3	$F_{2,12}$ = 2.0
Other species	$F_{3,16}$ = 10.2***	$F_{1,3}$ = 0.2	$F_{3,16}$ = 1.4	$F_{2,12}$ = 10.3**	$F_{1,2}$ = 9.9	$F_{2,12}$ = 0.2	$F_{2,12}$ = 0.9	$F_{1,2}$ = 0.9	$F_{2,12}$ = 0.9

Figure 1. Mean ± SE (n = 12 for 1998 and 9 for 1999 and 2002) species richness, abundance, and Shannon's diversity of beetles collected in plots in which dead wood was added or not (open and closed circles, respectively). Results for all beetle species combined are given in the left-most column followed by saproxylic species only, ground beetles only, and other species. Asterisks denote significant p-values: * < 0.05, ** < 0.01, *** < 0.001 based on analyses of variance.

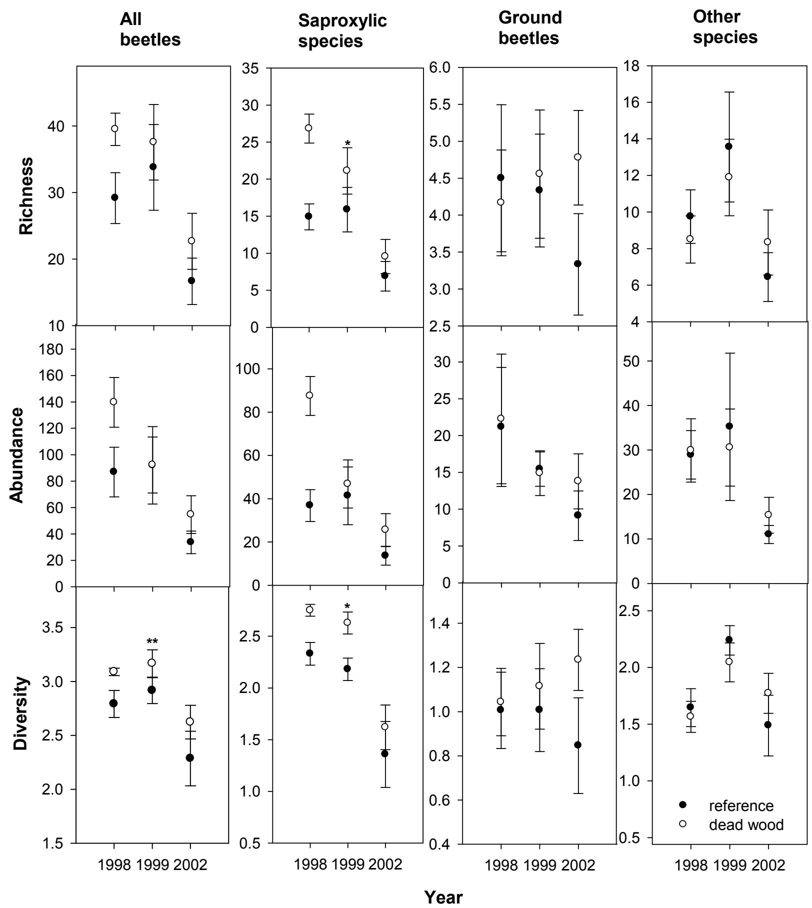


Figure 2. Mean ± SE (n = 3) saproxylic (top) and total (bottom) beetle species richness in reference and dead wood plots (closed and open circles, respectively) by state in 1998.

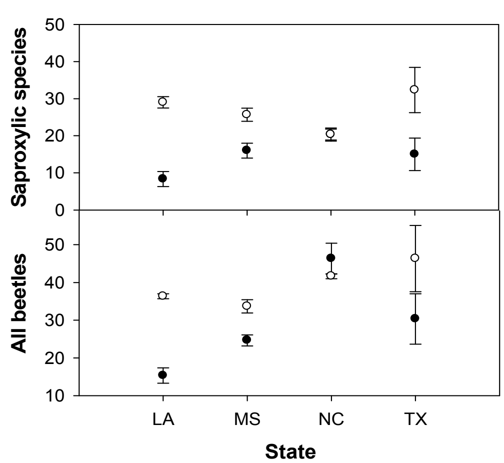


Figure 3. Mean ± SE (n = 3) saproxylic (top) and total (bottom) beetle diversity (Shannon's diversity) in reference and dead wood plots (closed and open circles, respectively) by state in 1998.

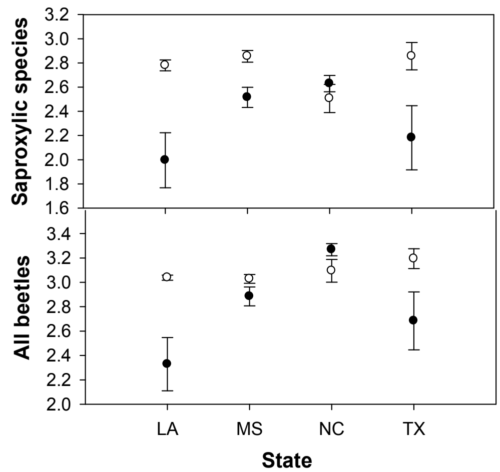
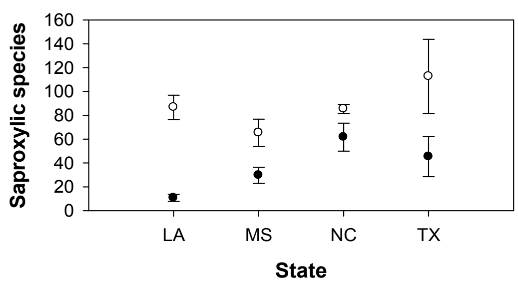


Figure 4. Mean ± SE (n = 3) saproxylic beetle abundance in reference and dead wood plots (closed and open circles, respectively) by state in 1998.



4. Discussion

Despite conflicting results from North Carolina which we are unable to explain based on this study, beetles generally responded positively to the dead wood manipulations made in this study, particularly during the first year. Saproxylic species were more abundant, whereas non-saproxylic ground beetles and other species did not noticeably differ. The increased abundance of saproxylic species is not surprising as these organisms, by definition, are dependent on dying and dead wood [4]. Many were no doubt captured as they attempted to colonize the fresh wood added to the plots. It is noteworthy that the degree to which saproxylic species were more numerous in the dead wood plots declined after the first year. This is largely due to the fact that more species are associated with the phloem of freshly-killed loblolly pine wood than later decay stages [29]. Once the phloem is gone, which happens quickly, so too are these early colonists. Ulyshen and Hanula [29] provided a list of beetle species found to be specifically associated with freshly-killed loblolly pine in South Carolina. Of those, the following genera were collected only during 1998 (the year the wood was added to the plots) in the current study: the cerambycids *Acanthocinus* and *Monochamus*; the zopherids *Colydium* and *Lasconotus*; the curculionids *Dendroctonus*, *Gnathotrichus*, *Ips*, *Orthotomicus*, and *Myoplatypus*; the tenebrionid *Corticeus*, the staphylinid *Myrmecocephalus*, and the histerid *Platysoma* (results not shown). A wide variety of other species colonize loblolly pine after the phloem stage but not in such great numbers [29]. Furthermore, many of these species are likely to re-infest the same piece of wood until it no longer provides a suitable substrate [30], thereby reducing the likelihood of being captured by pitfall traps. While the ethanol used in the trap collection jars may have attracted insects, these effects would seem to have been equal between controls and treatments, and the added wood apparently overcame any confounding effects of using this preservative.

That ground beetles were not more strongly affected by the dead wood additions is somewhat surprising considering that many previous studies have shown this group to be positively associated with dead wood [26,27,31–35]. Our results, therefore, provide little support for the idea that epigeic predators are more likely than many non-saproxylic taxa to benefit from dead wood due to its positive effect on prey abundance [27]. It is possible however that the debris in the dead wood plots impeded carabid movement enough to reduce their capture rate, thereby masking a stronger beneficial effect. Furthermore, it appears that ground beetles were becoming increasingly numerous in the dead wood plots relative to the reference plots over the course of this study (see Figure 1). Although the differences were not statistically significant, ground beetle richness and diversity had non-overlapping standard errors in 2002. These findings suggest that the benefits of dead wood to these taxa may be somewhat delayed. The results from other studies are not consistent with this conclusion, however. Within the first year after sites were clearcut in Sweden, for example, Nittérus and Gunnarsson [34] collected significantly more ground beetles in pitfall traps placed under piles of slash compared to those placed out in the open. Perhaps dead wood represents a more important source of shelter from sunlight and other desiccating conditions in clearcuts than in forested plots such as those used in the current study.

5. Conclusions

While some degree of caution is advised in interpreting the statistical tests we report here (due to the relatively close proximity of the sites to one another), our results are largely consistent with those of Hanula *et al.* [26] and Ulyshen and Hanula [27]. These studies suggest that ground-dwelling arthropods (saproxylic species notwithstanding) are little-affected by manipulations of dead wood in loblolly pine forests. This conclusion, however, is in conflict with evidence that many ground-dwelling arthropod taxa are more numerous immediately next to loblolly pine logs than short distances away from them [15]. As suggested by Ulyshen and Hanula [27], this discrepancy may indicate that dead wood has a stronger effect on how ground-dwelling arthropods are spatially distributed (*i.e.*, causing them to become more clumped) than on their abundance or species richness. Studies aimed at addressing this question would be of particular interest. More research is also needed to determine how manipulations of dead wood at larger scales and over longer time periods affect these organisms.

Acknowledgments

We thank Jacob Carpenter, Erich Vallery, Rick Stagg, and cooperators in TX, NC, and MS for technical assistance. Victoria Bayless, Stephanie Gil, Jong-Seok Park, Igor Sokolov, and Alexey

Tishechkin also assisted with identifications and curatorial support. We also thank Jim Hanula, Tim Schowalter and Cavell Brownie for commenting on an early version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Appendix

Table A1. Total beetle abundance by species, state, and treatment (reference/wood addition). Group designations are as follows: S = saproxylic (*i.e.*, directly or indirectly dependent on dead wood at some life stage); P = predator (*i.e.*, non-saproxylic ground beetles); O = other. Note that data from North Carolina are limited to 1998.

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Aderidae						
Zonantes fasciatus (Melsheimer)	S	0/0	0/0	1/0	0/0	1/0
Zonantes signatus (Haldeman)	S	0/0	0/1	0/0	0/0	0/1
Zonantes subfasciatus (LeConte)	S	0/0	1/0	0/0	0/0	1/0
Zonantes sp.	S	0/0	0/1	0/0	0/0	0/1
Agyrtidae						
Necrophilus pettitii Horn	O	0/0	5/2	0/0	0/0	5/2
Anobiidae						
Cryptoramorphus sp.	S	0/0	0/0	0/0	0/1	0/1
Euvrilletta peltata (Harris)	S	0/0	0/0	0/0	0/1	0/1
Ptinus sp.	S	0/0	1/0	0/0	1/2	2/2
Anthicidae						
Tomoderus sp.	O	0/0	2/0	0/0	0/0	2/0
Vacusus sp.	O	0/0	1/0	0/0	0/0	1/0
Attelabidae						
Pterocolus ovatus (Fabricius)	O	0/0	0/0	0/0	0/1	0/1
Biphyllidae						
Diplocoelus rudis (LeConte)	S	8/7	12/27	8/7	10/8	38/49
Bostrichidae						
Lichenophanes bicornis (Weber)	S	0/0	0/0	0/0	0/1	0/1
Melalgus plicatus (LeConte)	S	0/0	0/0	0/0	0/1	0/1
Stephanopachys sp.	S	0/0	0/0	0/0	0/1	0/1
Xylobiops basilaris (Say)	S	0/3	1/2	0/0	0/3	1/8
Bothrideridae						
Bothrideres cryptus Stephan	S	0/0	0/0	0/0	0/1	0/1
Brentidae						
Sayapion segnipes (Say)	O	0/0	1/0	0/0	0/0	1/0
Buprestidae						
Buprestis lineata Fabricius	S	0/1	0/0	0/0	0/0	0/1
Chalcophora virginiensis (Drury)	S	0/1	0/1	0/0	0/1	0/3
Cantharidae						
Rhagonycha sp.	O	3/0	0/1	0/0	0/1	3/2

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Carabidae						
Acupalpus rectangulus Chaudoir	P	0/0	0/0	0/0	1/0	1/0
Agonum punctiforme Say	P	0/0	0/0	0/0	6/15	6/15
Amara impuncticollis (Say)	P	0/0	0/0	0/0	0/1	0/1
Anisodactylus haplomus Chaudoir	P	3/0	2/0	0/0	1/0	6/0
Apenes lucidulus Chaudoir	P	0/0	0/1	0/0	0/0	0/1
Apenes sinuatus (Say)	P	0/0	0/0	0/1	0/3	0/4
Brachinus alternans Dejean	P	0/0	0/0	0/1	0/0	0/1
Brachinus americanus (LeConte)	P	0/0	0/0	0/0	0/1	0/1
Calathus opaculus LeConte	P	0/0	0/0	1/0	34/43	35/43
Calosoma scrutator (Fabricius)	P	0/0	0/0	0/0	2/2	2/2
Carabus goryi Dejean	P	0/0	0/0	1/0	0/0	1/0
Chlaenius amoenus (Dejean)	P	3/2	2/2	0/0	0/0	5/4
Chlaenius emarginatus Say	P	0/0	0/0	2/1	0/0	2/1
Chlaenius erythropus Germar	P	0/0	0/0	0/0	1/0	1/0
Clivina ferrea LeConte	P	0/0	0/1	0/0	0/0	0/1
Clivina pallida Say	P	0/0	0/1	0/0	0/0	0/1
Coptodera aerata Dejean	P	0/2	1/2	1/2	1/2	3/8
Cyclotrachelus alabamae (Van Dyke)	P	46/39	0/2	0/0	23/24	69/65
Cyclotrachelus convivus (LeConte)	P	0/0	23/30	0/0	0/0	23/30
Cyclotrachelus laevipennis (LeConte)	P	1/0	1/1	0/0	0/0	2/1
Cyclotrachelus seximpressus (LeConte)	P	1/1	0/0	0/0	0/0	1/1
Cyclotrachelus sigillatus (Say)	P	0/0	0/0	30/31	0/0	30/31
Cyclotrachelus spoliatus (Newman)	P	0/0	0/0	19/14	0/0	19/14
Cyclotrachelus texensis (Freitag)	P	6/5	0/0	0/0	42/59	48/64
Dicaelus crenatus LeConte	P	0/0	0/0	62/57	0/0	62/57
Dicaelus elongatus Bonelli	P	0/1	5/9	3/6	7/5	15/21
Dicaelus furvus Dejean	P	1/0	1/4	3/1	0/0	5/5
Dicaelus purpuratus Bonelli	P	0/0	0/0	3/1	0/0	3/1
Elaphropus granarius (Dejean)	P	0/2	0/0	0/0	0/0	0/2
Galerita bicolor Drury	P	0/0	4/10	57/82	0/0	61/92
Harpalus rufipes Degeer	P	0/0	0/0	0/0	1/0	1/0
Harpalus sp.	P	0/0	0/0	0/0	1/0	1/0
Helluomorphoides nigripennis Dejean	P	5/6	38/27	4/2	0/0	47/35
Helluomorphoides praestus bicolor (Larochelle and Lariviere)	P	0/0	0/1	0/0	0/0	0/1
Lebia ornata Say	P	0/0	0/0	0/1	0/0	0/1
Megacephala virginica (Linneaus)	P	0/1	0/0	0/0	0/0	0/1
Mioptachys flavicauda (Say)	S	1/1	0/0	0/0	0/4	1/5
Notiophilus novemstriatus LeConte	P	0/0	6/6	0/0	2/2	8/8
Panagaeus fasciatus Say	P	0/0	0/0	0/0	1/0	1/0
Pasimachus sublaevis (Beauvois)	P	0/0	0/0	2/1	0/0	2/1
Pterostichus permundus (Say)	P	0/0	0/0	0/0	4/2	4/2
Rhadine larvalis LeConte	P	0/0	0/2	0/0	0/0	0/2
Scaphinotus cavicollis (LeConte)	P	0/0	0/0	0/0	4/5	4/5

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Scaphinotus liebecki Van Dyke	P	0/0	0/0	0/0	1/0	1/0
Selenophorus ellipticus Dejean	P	1/0	0/0	0/0	0/0	1/0
Selenophorus opalinus (LeConte)	P	1/1	1/0	0/0	1/0	3/1
Selenophorus sp.	P	0/0	0/0	0/0	0/1	0/1
Sphaeroderus stenostomus (Weber)	P	0/0	0/0	2/0	0/0	2/0
Tachyta nana (Gyllenhal)	S	0/1	0/0	0/0	0/0	0/1
Cerambycidae						
Acanthocinus obsoletus (Olivier)	S	0/10	0/1	0/7	0/2	0/20
Anelaphus pumilus (Newman)	S	0/0	0/0	0/0	0/1	0/1
Arhopalus rusticus nubilus (LeConte)	S	0/1	0/0	0/0	0/0	0/1
Astylopsis perplexa (Haldeman)	S	0/1	0/0	0/0	0/0	0/1
Curius dentatus Newman	S	0/0	1/0	0/0	0/1	1/1
Distenia undata (Fabricius)	S	0/0	0/0	0/0	1/0	1/0
Eburia quadrigeminata (Say)	S	0/0	0/0	0/0	1/0	1/0
Elaphidion mucronatum (Say)	S	1/0	0/1	0/0	2/5	3/6
Enaphalodes atomarius (Drury)	S	1/0	0/0	0/0	0/0	1/0
Eupogonius tomentosus (Haldeman)	S	0/0	1/0	0/0	2/0	3/0
Graphisurus fasciatus (DeGeer)	S	0/1	0/0	1/5	3/4	4/10
Knulliana cincta (Drury)	S	0/0	0/0	0/0	1/5	1/5
Leptostylus transversus (Gyllenhal)	S	2/3	6/4	0/0	12/28	20/35
Monochamus carolinensis (Olivier)	S	0/0	0/0	0/1	0/0	0/1
Neoclytus acuminatus (Fabricius)	S	0/1	2/1	1/0	10/0	13/2
Obrium maculatum (Olivier)	S	0/1	0/0	0/0	9/7	9/8
Orthosoma brunneum (Forster)	S	0/0	1/0	0/0	2/0	3/0
Prionus pocularis Dalman	S	0/2	1/13	0/0	2/3	3/18
Sternidius alpha (Say)	S	0/0	0/0	3/1	0/0	3/1
Styloleptus biustus (LeConte)	S	0/0	1/2	0/1	3/6	4/9
Typocerus lunulatus (Swederus)	S	0/0	0/0	0/0	1/0	1/0
Typocerus velutinus (Olivier)	S	0/0	1/0	0/0	0/0	1/0
Typocerus zebra (Olivier)	S	0/0	2/2	1/0	0/0	3/2
Xylotrechus colonus (Fabricius)	S	0/0	0/0	0/0	3/4	3/4
Xylotrechus s. sagittatus (Germar)	S	0/0	0/1	0/0	0/0	0/1
Cerylonidae						
Philothermus glabriculus LeConte	S	0/0	0/1	0/0	0/1	0/2
Chrysomelidae						
Capraita circumdata (Randall)	O	0/0	0/3	0/0	0/1	0/4
Capraita obsidiana (Fabricius)	O	0/0	0/0	0/0	0/1	0/1
Capraita suturalis (Fabricius)	O	0/0	0/2	0/0	0/0	0/2
Capraita thyamoides (Crotch)	O	0/0	0/0	0/0	3/1	3/1
Capraita sp.	O	0/0	0/0	2/0	0/3	2/3
Graphops curtipennis (Melsheimer)	O	3/1	0/0	0/0	0/0	3/1
Graphops floridanus Blake	O	2/1	0/0	0/0	0/0	2/1
Metachroma pellucidum Crotch	O	0/0	0/2	0/0	0/0	0/2
Orthaltica copalina (Fabricius)	O	0/0	1/0	0/0	0/0	1/0
Paria sp.	O	0/4	0/0	0/0	12/3	12/7

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Rhabdopterus sp.	O	0/0	3/0	2/1	0/0	5/1
Ciidae						
Cis sp.	S	0/0	0/0	0/0	1/1	1/1
Cleridae						
Cymatodera wolcotti Barr	S	1/0	0/0	0/0	0/0	1/0
Neorthopleura thoracica (Say)	S	0/1	0/2	0/0	1/2	1/5
Priocera castanea (Newman)	S	0/5	0/1	0/0	0/0	0/6
Coccinellidae						
Psyllobora vigintimaculata (Say)	O	0/0	0/0	1/0	0/0	1/0
Corylophidae						
Arthrolips fasciata (Erichson)	S	0/0	0/0	0/0	0/3	0/3
Clypastracea sp.	S	0/0	0/0	0/0	0/1	0/1
Cryptophagidae						
Cryptophagus sp.	S	1/0	0/0	0/0	0/1	1/1
Curculionidae						
Acalles clavatus (Say)	S	0/1	3/19	3/3	1/2	7/25
Ambrosiodmus rubricolllis (Eichhoff)	S	1/1	5/8	11/13	3/5	20/27
Apteromechus ferratus (Say)	S	0/0	0/4	1/1	13/27	14/32
Coccotrypes distinctus (Motschulsky)	S	0/1	0/0	0/0	0/0	0/1
Conotrachelus posticatus Boheman	O	0/0	0/0	1/0	103/68	104/68
Cophes fallax (LeConte)	S	0/0	0/0	0/0	1/3	1/3
Corthylus punctatissimus (Zimmermann)	S	0/0	1/0	0/1	0/0	1/1
Cossonus corticola Say	S	0/13	1/6	0/0	5/41	6/60
Cryptorhynchus tristis LeConte	O	1/2	2/3	0/0	1/0	4/5
Cyrtepistomus castaneus (Roelofs)	O	0/0	1/0	0/0	0/0	1/0
Dendroctonus terebrans (Olivier)	S	0/0	0/0	0/0	0/6	0/6
Dryophthorus americanus Bedel	S	0/2	2/3	10/0	4/3	16/8
Dryoxylon onoharaensis (Murayama)	S	0/0	1/4	0/0	0/0	1/4
Euplatypus compositus (Say)	S	4/7	0/2	0/0	1/1	5/10
Euwallacea validus (Eichhoff)	S	0/0	0/1	0/0	0/0	0/1
Gnathotrichus materiarius (Fitch)	S	0/0	0/0	0/3	0/1	0/4
Hylastes porculus Erichson	S	0/2	0/0	0/1	0/1	0/4
Hylastes salebrosus Eichhoff	S	1/2	0/0	0/0	0/2	1/4
Hylastes tenuis Eichhoff	S	1/2	1/9	6/9	1/9	9/29
Hylobius pales (Herbst)	S	2/8	8/12	11/30	3/12	24/62
Hypothenemus sp.	S	0/0	0/0	1/1	0/1	1/2
Ips avulsus (Eichhoff)	S	0/2	1/1	0/0	1/5	2/8
Ips calligraphus (Germar)	S	0/1	0/1	0/0	0/2	0/4
Ips grandicollis (Eichhoff)	S	0/0	0/0	0/0	0/4	0/4
Lissorhoptrus oryzophilus Kuschel	O	0/1	0/0	0/0	0/0	0/1
Lissorhoptrus simplex (Say)	O	1/0	0/0	0/0	0/0	1/0
Monarthrum fasciatum (Say)	S	0/0	0/0	0/0	0/1	0/1
Monarthrum mali (Fitch)	S	0/0	0/0	0/0	2/4	2/4
Myoplatypus flavicornis (Fabricius)	S	0/15	0/3	0/25	0/19	0/62
Notaris puncticollis (LeConte)	O	0/0	1/0	0/0	0/0	1/0

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Orthotomicus caelatus (Eichhoff)	S	0/38	7/10	11/52	25/59	43/159
Pachylobius picivorus (Germar)	S	5/30	10/38	4/13	25/40	44/121
Pityophthorus confusus Blandford	S	0/1	0/0	0/0	0/0	0/1
Sphenophorus sp.	O	0/0	0/0	0/0	1/0	1/0
Stethobaris sp.	O	1/1	0/0	0/0	0/0	1/1
Xyleborinus saxeseni (Ratzeburg)	S	14/10	22/12	9/2	117/98	162/122
Xyleborus affinis Eichhoff	S	4/36	28/51	27/18	13/60	72/165
Xyleborus ferrugineus (Fabricius)	S	3/33	6/16	23/10	39/58	71/117
Xyleborus pubescens Zimmermann	S	1/3	0/0	1/1	1/5	3/9
Xyleborus xylographus (Say)	S	0/0	0/0	1/0	0/1	1/1
Xylosandrus compactus (Eichhoff)	S	0/0	1/1	22/30	1/2	24/33
Xylosandrus crassiusculus (Motschulsky)	S	1/4	9/17	9/9	0/5	19/35
Xylosandrus germanus (Blandford)	S	1/0	4/7	0/0	0/0	5/7
Dytiscidae						
Copelatus glyphicus (Say)	O	5/1	0/0	1/1	1/1	7/3
Elateridae						
Alaus myops (Fabricius)	S	0/1	0/1	0/0	0/0	0/2
Blauta cribraria (Germar)	S	0/3	0/1	0/0	0/0	0/4
Conoderus amplicollis (Gyllenhal)	S	0/1	0/0	0/0	0/0	0/1
Dicrepidius sp.	S	0/0	0/0	0/0	0/1	0/1
Glyphonyx bimarginatus Schaeffer	S	0/0	0/0	0/0	1/0	1/0
Glyphonyx ferruginosus Schaeffer	S	0/0	0/0	0/0	1/1	1/1
Glyphonyx sp.	S	0/0	0/0	0/1	0/0	0/1
Lacon discoideus (Weber)	S	0/0	0/1	0/0	0/0	0/1
Lacon impressicollis (Say)	S	0/0	0/0	0/0	0/1	0/1
Limonius quercinus Say	S	0/0	0/0	1/0	0/0	1/0
Megapenthes rufilabris (Germar)	S	1/0	0/1	0/0	0/1	1/2
Megapenthes sp.	S	0/0	0/0	0/1	0/0	0/1
Melanotus corticinus (Say)	S	0/0	0/1	0/0	0/0	0/1
Melanotus ignobilis Melsheimer	S	1/2	0/0	0/0	0/0	1/2
Melanotus insipiens (Say)	S	0/0	0/0	0/0	1/0	1/0
Melanotus piceatus Blatchley	S	0/0	0/0	2/0	0/0	2/0
Melanotus pilosus Blatchley	S	1/1	0/0	0/0	0/0	1/1
Melanotus similis group	S	0/0	1/1	0/1	0/0	1/2
Melanotus testaceus (Melsheimer)	S	0/0	0/0	0/0	1/0	1/0
Melanotus sp.	S	0/0	2/2	0/1	0/1	2/4
Mulsanteus carolinensis (Schaeffer)	S	0/0	0/0	0/0	13/2	13/2
Endomychidae						
Aphorista vittata (Fabricius)	S	1/2	2/3	0/0	4/7	7/12
Danae testacea (Ziegler)	S	0/1	2/3	7/3	4/3	13/10
Epipocus punctatus LeConte	S	1/1	0/0	0/0	0/0	1/1
Lycoperdina ferruginea LeConte	S	0/0	4/2	1/0	8/12	13/14
Mycetina perpulchra (Newman)	S	0/0	0/1	0/0	0/0	0/1

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Erotylidae						
Cryptophilus integer (Heer)	S	0/0	0/1	0/0	0/0	0/1
Triplax festiva Lacordaire	S	0/0	0/0	0/0	1/0	1/0
Tritoma affinis Lacordaire	S	2/3	11/3	0/0	8/11	21/17
Tritoma angulata Say	S	0/0	1/0	0/0	0/0	1/0
Tritoma atriventris LeConte	S	0/0	0/0	0/0	1/3	1/3
Tritoma biguttata affinis Lacordaire	S	1/2	4/4	0/0	4/3	9/9
Tritoma humeralis Fabricius	S	0/0	0/0	0/3	0/0	0/3
Eucinetidae						
Eucinetus strigosus LeConte	S	1/4	4/7	0/0	0/0	5/11
Eucnemidae						
Dromaeolus cylindricollis (Say)	S	5/0	1/2	0/0	1/2	7/4
Dromaeolus striatus (LeConte)	S	1/1	2/2	0/0	0/0	3/3
Microrhagus triangularis (Say)	S	0/0	0/0	0/0	2/1	2/1
Geotrupidae						
Bolboceras thoracicornis (Wallis)	O	0/0	0/0	1/0	0/0	1/0
Bolbocerosoma farctum (Fabricius)	O	0/0	1/1	0/0	0/0	1/1
Geotrupes blackburnii (Fabricius)	O	1/0	0/0	0/0	1/3	2/3
Geotrupes opacus Haldeman	O	0/0	0/0	0/1	6/0	6/1
Odonteus sp.	O	0/0	0/0	1/0	0/0	1/0
Histeridae						
Eblisia carolina (Paykull)	S	0/0	0/0	0/0	0/1	0/1
Paromalus seminulum Erichson	S	0/1	1/0	0/0	0/1	1/2
Platysoma coarctatum LeConte	S	0/0	0/1	0/0	0/2	0/3
Hydrophilidae						
Cercyon occallatus (Say)	O	0/0	1/0	9/4	0/0	10/4
Cercyon pubescens LeConte	O	1/0	0/0	0/0	3/0	4/0
Cymbiodyta chamberlaini Smetana	O	1/0	0/0	0/0	0/1	1/1
Laemophloeidae						
Cryptolestes punctatus (LeConte)	S	0/1	0/0	0/0	0/0	0/1
Cryptolestes sp.	S	0/0	0/0	0/0	0/1	0/1
Laemophloeus biguttatus Say	S	0/0	0/1	0/0	0/0	0/1
Placonotus modestus (Say)	S	0/0	0/2	0/0	4/2	4/4
Lampyridae						
Ellychnia corrusca (LeConte)	S	0/0	0/0	1/0	0/0	1/0
Latridiidae						
Aridius sp.	S	0/0	0/0	0/1	0/0	0/1
Corticarina sp.	S	1/2	0/0	0/0	0/0	1/2
Leiodidae						
Anisotoma basalis (LeConte)	O	0/0	0/0	1/0	0/0	1/0
Anisotoma discolor (Melsheimer)	O	0/0	0/0	1/0	1/5	2/5
Anisotoma sp.	O	0/0	0/0	0/0	1/0	1/0
Colenis bifida Peck	O	0/0	0/0	2/0	0/0	2/0
Colenis impunctata LeConte	O	2/10	0/1	5/8	19/16	26/35
Colenis ora Peck	O	0/1	2/1	0/0	15/20	17/22

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Colenis stephani Peck	O	0/0	0/0	0/0	2/1	2/1
Colenis sp.	O	0/1	0/0	0/1	0/0	0/2
Dissochaetus oblitus (LeConte)	O	0/0	0/0	0/1	0/0	0/1
Leiodes stephani Baranowski	O	0/0	0/0	0/0	4/0	4/0
Ptomaphagus consobrinus LeConte	O	4/5	0/0	0/0	3/5	7/10
Ptomaphagus sp.	O	0/0	0/0	0/0	1/0	1/0
Lucanidae						
Dorcus parallelus (Say)	S	0/0	0/0	1/1	0/0	1/1
Lycidae						
Plateros sp.	S	0/2	1/3	0/0	1/0	2/5
Melandryidae						
Dircaea liturata (LeConte)	S	0/0	0/0	0/0	0/1	0/1
Microtonus sericans LeConte	S	0/0	1/0	0/0	0/0	1/0
Mordellidae						
Mordella sp.	O	0/0	1/1	0/0	0/1	1/2
Mordellaria borealis (LeConte)	O	0/1	1/0	0/0	0/0	1/1
Mordellaria serval (Say)	O	0/0	1/0	0/0	1/3	2/3
Mordellistena pubescens (Fabricius)	O	0/0	0/1	0/0	0/0	0/1
Mycetophagidae						
Typhaea stercorea (Linnaeus)	S	0/2	1/0	0/0	17/19	18/21
Nitidulidae						
Amphicrossus ciliatus (Olivier)	O	0/0	0/1	0/0	0/0	0/1
Carpophilus antiquus Melsheimer	O	0/0	0/0	1/1	1/0	2/1
Carpophilus sp.	O	1/1	0/2	1/4	3/2	5/9
Colopterus unicolor (Say)	O	10/16	12/39	43/55	30/66	95/176
Epuraea helvola Erichson	O	0/0	1/0	3/13	0/0	4/13
Epuraea planulata Erichson	O	0/0	0/0	0/1	0/0	0/1
Epuraea rufa (Say)	O	0/0	0/0	7/4	0/0	7/4
Glischrochilus sanguinolentus (Olivier)	O	0/0	1/2	0/0	0/0	1/2
Pallodes austrinus Leschen	O	0/0	2/0	1/0	1/2	4/2
Pallodes pallidus Beauvois	O	0/0	1/3	1/3	0/0	2/6
Prometopia sexmaculata (Say)	O	0/1	0/0	0/0	1/0	1/1
Stelidota coenosa Erichson	O	8/7	2/3	1/1	23/22	34/33
Stelidota geminata (Say)	O	1/3	0/1	7/12	6/3	14/19
Stelidota octomaculata (Say)	O	0/0	0/0	0/0	0/2	0/2
Stelidota sexmaculata (Say)	O	0/0	0/0	0/0	1/0	1/0
Stelidota strigosa Schoenherr	O	0/0	1/0	0/0	6/3	7/3
Oedemeridae						
Oxycopis notoxoides (Fabricius)	O	1/0	0/0	0/0	0/0	1/0
Oxycopis sp.	S	0/0	0/0	0/0	1/0	1/0
Oxycopis thoracica (Fabricius)	S	0/0	0/1	0/0	0/0	0/1
Passandridae						
Catogenus rufus (Fabricius)	S	0/1	0/0	0/0	0/0	0/1
Ptilodactylidae						
Ptilodactyla sp.	O	0/0	0/0	0/0	2/4	2/4

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Scarabaeidae						
Anomala sp.	O	0/0	0/0	0/0	0/2	0/2
Ataenius imbricatus Melsheimer	O	0/0	0/1	0/0	0/0	0/1
Ataenius insculptus Horn	O	0/0	2/1	0/0	0/0	2/1
Ataenius sp.	O	0/0	1/0	0/0	0/0	1/0
Ateuchus histeroides Weber	O	0/0	0/0	0/0	2/1	2/1
Canthon ebenus Say	O	0/0	0/0	0/0	7/7	7/7
Canthon viridis (Beauvois)	O	0/0	0/1	0/0	1/1	1/2
Copris minutus (Drury)	O	0/0	1/0	0/2	0/0	1/2
Deltochilum gibbosum (Fabricius)	O	0/0	0/0	3/0	10/3	13/3
Digitonthophagus gazella (Fabricius)	O	0/0	1/0	0/0	0/0	1/0
Diplotaxis sp.	O	0/0	5/1	0/0	3/6	8/7
Euphoria sepulcralis (Fabricius)	O	0/0	0/0	0/0	2/7	2/7
Melanocanthon sp.	O	0/0	0/0	0/0	2/5	2/5
Onthophagus hecate (Panzer)	O	0/0	1/0	0/0	10/7	11/7
Onthophagus medorensis Brown	O	0/0	0/0	0/0	31/16	31/16
Onthophagus pennsylvanicus Harold	O	0/0	0/0	0/0	2/0	2/0
Onthophagus striatulus (Beauvois)	O	0/1	2/0	0/0	2/2	4/3
Onthophagus tuberculifrons Harold	O	0/0	0/0	0/0	0/2	0/2
Onthophagus sp.	O	0/0	0/0	0/0	0/1	0/1
Parataenius simulator (Harold)	O	0/0	0/0	0/0	0/1	0/1
Phyllophaga forsteri (Burmeister)	O	0/0	1/2	0/0	0/0	1/2
Phyllophaga prunina (LeConte)	O	2/3	0/0	0/0	0/3	2/6
Phyllophaga prununculina (Burmeister)	O	0/0	0/1	0/0	0/0	0/1
Phyllophaga scitula (Horn)	O	0/0	0/0	0/0	0/1	0/1
Phyllophaga sp.	O	1/0	0/0	1/1	0/0	2/1
Phyllophaga tristis complex	O	0/0	0/0	0/0	1/0	1/0
Platytomus longulus (Cartwright)	O	1/0	0/0	0/0	0/0	1/0
Serica sp.	O	0/0	0/0	0/0	2/0	2/0
Scraptiidae						
Scraptia sp.	O	0/0	0/0	1/0	0/0	1/0
Silphidae						
Necrophila americana (Linnaeus)	O	0/0	0/0	0/0	0/2	0/2
Silvanidae						
Ahasverus advena (Waltl)	S	0/0	0/0	0/0	0/1	0/1
Ahasverus rectus (LeConte)	S	1/12	1/6	1/0	7/14	10/32
Cathartosilvanus imbellis (LeConte)	S	0/0	0/1	0/0	0/1	0/2
Silvanoprus scuticollis (Walker)	S	0/0	0/0	0/0	0/1	0/1
Silvanus muticus Sharp	S	1/2	0/0	0/0	2/6	3/8
Sphindidae						
Sphindus sp.	S	2/0	1/0	3/0	1/4	7/4
Staphylinidae						
Achenomorphus corticinus (Gravenhorst)	O	1/0	12/11	0/4	0/1	13/16
Anotylus sp.	O	0/1	0/0	0/0	27/39	27/40
Arthmius sp.	O	0/0	0/0	1/0	0/0	1/0

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Astenus linearis (Erichson)	O	0/1	0/0	0/0	0/0	0/1
Astenus sp.	O	1/2	2/0	0/0	0/2	3/4
Baeocera laevis (Reitter)	O	0/0	0/0	0/0	1/0	1/0
Baeocera sp.	O	0/0	5/2	0/1	1/4	6/7
Belonuchus ephippiatus (Say)	O	1/0	0/1	0/0	1/0	2/1
Belonuchus rufipennis (Fabricius)	S	0/0	0/0	1/0	0/0	1/0
Bryoporus rufescens LeConte	O	0/0	3/1	0/1	0/0	3/2
Carpelimus sp.	O	0/1	0/0	0/0	0/1	0/2
Coproporus laevis LeConte	S	0/0	0/1	0/0	0/0	0/1
Coproporus ventriculus (Say)	S	1/0	0/0	0/0	0/0	1/0
Ctenisodes sp.	O	0/0	0/0	0/0	7/0	7/0
Decarthron sp.	O	1/0	0/0	0/0	0/0	1/0
Diochus schaumi Kraatz	O	0/0	0/0	0/0	0/1	0/1
Echiaster sp.	O	0/0	0/1	0/0	0/1	0/2
Erichsonius sp.	O	0/1	0/0	0/0	0/0	0/1
Euconnus sp.	O	0/1	0/0	2/0	0/1	2/2
Hesperus baltimorensis (Gravenhorst)	O	0/2	0/0	2/0	0/0	2/2
Homaeotarsus sp.	O	0/0	0/0	0/0	1/0	1/0
Hoplandria laevicollis (Notman)	O	0/0	0/0	5/3	0/0	5/3
Hoplandria sp.	O	0/0	0/1	12/19	1/0	13/20
Ischnosoma flavicolle (LeConte)	O	1/0	1/1	0/0	1/2	3/3
Myrmecocephalus concinnus (Erichson)	S	0/2	0/0	0/0	0/0	0/2
Oxybleptes davisi (Notman)	O	37/4	28/23	0/0	0/0	65/27
Oxypoda sp.	O	0/0	0/0	0/0	1/0	1/0
Palaminus sp.	S	0/0	1/2	0/0	2/0	3/2
Philonthus umbrinus (Gravenhorst)	O	0/0	0/0	1/1	0/0	1/1
Philotermes sp.	S	0/0	9/5	0/0	0/0	9/5
Pinophilus sp.	O	1/0	0/0	0/0	0/0	1/0
Platydracus fossator (Gravenhorst)	O	0/0	0/0	1/0	2/1	3/1
Platydracus sp.	O	0/0	0/0	0/0	2/1	2/1
Quedius capucinus (Gravenhorst)	O	0/0	0/0	0/0	0/1	0/1
Quedius verres Smetana	O	0/0	8/11	0/0	5/2	13/13
Rugilus sp.	O	0/0	3/0	0/0	2/9	5/9
Scaphisoma punctulatum LeConte	O	0/0	0/1	0/0	0/0	0/1
Scydmaenus sp.	O	0/0	0/0	2/0	0/0	2/0
Sepedophilus basalis (Erichson)	O	0/0	0/0	0/0	1/0	1/0
Sepedophilus crassus (Gravenhorst)	O	0/0	0/0	0/1	0/0	0/1
Sepedophilus debilis (Casey)	O	0/0	0/0	1/0	0/0	1/0
Sepedophilus sp.	O	22/18	2/2	0/1	13/19	37/40
Stenichnus sp.	O	0/0	0/0	1/0	0/0	1/0
Tachinus fimbriatus Gravenhorst	O	0/0	0/0	2/0	0/0	2/0
Thoracophorus costalis (Erichson)	S	0/0	0/0	0/0	30/26	30/26
Tmesiphorus costalis LeConte	O	0/0	0/1	0/0	0/0	0/1

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Tenebrionidae						
Alobates morio (Fabricius)	S	0/0	0/0	0/0	1/0	1/0
Alphitophagus bifasciatus (Say)	S	0/2	0/1	0/0	0/0	0/3
Anaedus brunneus (Ziegler)	O	1/0	0/1	0/0	0/0	1/1
Corticeus thoracicus (Melsheimer)	S	0/2	0/0	0/0	0/1	0/3
Gondwanocrypticus obsoletus (Say)	S	1/0	0/0	0/0	0/0	1/0
Helops cisteloides (Germar)	S	0/0	0/0	0/0	1/1	1/1
Helops sp.	S	0/0	0/0	0/0	1/0	1/0
Hymenorus sp.	S	3/4	1/2	0/0	3/5	7/11
Isomira sp.	S	0/0	0/0	0/0	0/2	0/2
Lobopoda erythrocnemis (Germar)	S	3/3	2/0	0/0	11/7	16/10
Opatrinus minimus (Beauvois)	O	0/0	0/0	0/0	1/1	1/1
Platydema micans Zimmerman	S	2/1	0/0	0/0	2/2	4/3
Platydema ruficolle Laporte and Brullé	S	0/0	0/1	0/0	2/1	2/2
Platydema ruficorne (Sturm)	S	0/1	0/1	0/0	0/0	0/2
Polypleurus perforatus (Germar)	S	0/1	1/0	0/0	4/2	5/3
Statira gagatina (Melsheimer)	O	0/0	0/1	0/0	0/0	0/1
Statira sp.	O	0/0	0/0	0/0	0/2	0/2
Uloma imberbis LeConte	S	0/0	0/0	2/0	0/1	2/1
Uloma punctulata LeConte	S	0/6	2/4	0/0	0/1	2/11
Tetratomidae						
Eustrophopsis bicolor (Fabricius)	S	1/1	0/0	0/0	0/1	1/2
Eustrophus tomentosus Say	S	0/0	0/0	0/0	1/0	1/0
Throscidae						
Aulonothroscus convergens (Horn)	O	0/0	0/4	0/0	0/0	0/4
Trogidae						
Omorgus monachus Herbst	O	0/0	0/0	0/0	0/1	0/1
Trox spinulosus Robinson	O	0/0	0/0	0/0	2/0	2/0
Trox variolatus Melsheimer	O	1/1	0/0	0/0	1/1	2/2
Trogossitidae						
Temnoscheila virescens (Fabricius)	S	0/2	0/0	0/0	1/0	1/2
Zopheridae						
Bitoma quadriguttata (Say)	S	0/0	0/1	0/0	0/0	0/1
Colydium lineola Say	S	0/0	0/0	0/0	0/1	0/1
Colydium nigripenne LeConte	S	0/3	0/9	0/0	0/3	0/15
Endeitoma dentata (Horn)	S	0/1	1/0	0/0	0/0	1/1
Endeitoma sp.	S	0/1	0/0	0/0	0/0	0/1
Hyporhagus punctulatus Thomson	S	0/0	0/0	0/0	0/1	0/1
Lasconotus pusillus LeConte	S	0/0	0/0	0/0	0/4	0/4
Microsicus parvulus (Guerin)	S	0/0	0/0	0/0	4/1	4/1
Pycnomerus haematodes (Fabricius)	S	0/0	0/0	0/0	0/1	0/1
Pycnomerus sulcicollis LeConte	S	0/4	2/9	0/0	0/1	2/14

Table A1. *Cont.*

Species	Group	Louisiana	Mississippi	North Carolina	Texas	Total
Total Individuals (reference/wood addition)		753 (269/484)	1016 (406/610)	1104 (502/602)	2299 (997/1302)	5172 (2174/2998)
Total Species (reference/wood addition)		140 (79/112)	162 (105/125)	108 (82/72)	227 (147/180)	378 (261/302)

References

1. Elton, C.S. *The Pattern of Animal Communities*; Methuen and Co. Ltd.: London, UK, 1966.
2. Siitonen, J. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecol. Bull.* **2001**, *49*, 11–41.
3. Grove, S.J. Saproxylic insect ecology and the sustainable management of forests. *Ann. Rev. Ecol. Sys.* **2002**, *33*,1–23.
4. Speight, M.C.D. *Saproxylic Invertebrates and Their Conservation*; Council of Europe: Strasbourg, France, 1989.
5. Andrew, N.; Rodgerson, L.; York, A. Frequent fuel-reduction burning: The role of logs and associated leaf litter in the conservation of ant biodiversity. *Austral Ecol.* **2000**, *25*, 99–107.
6. Evans, A.M.; Clinton, P.W.; Allen, R.B.; Frampton, C.M. The influence of logs on the spatial distribution of litter-dwelling invertebrates and forest floor processes in New Zealand forests. *For. Ecol. Manag.* **2003**, *184*, 251–262.
7. Jabin, M.; Mohr, D.; Kappes, H.; Topp, W. Influence of deadwood on density of soil macro-arthropods in a managed oak-beech forest. *For. Ecol. Manag.* **2004**, *194*, 61–69.
8. Topp, W.; Kappes, H.; Kulfan, J.; Zach, P. Litter-dwelling beetles in primeval forests of Central Europe: Does deadwood matter? *J. Insect Conserv*. **2006**, *10*, 229–239.
9. Topp, W.; Kappes, H.; Kulfan, J.; Zach, P. Distribution pattern of woodlice (Isopoda) and millipedes (Diplopoda) in four primeval forests of the western Carpathians (Central Slovakia). *Soil Biol. Biochem.* **2006**, *38*, 43–50.
10. Kappes, H. Influence of coarse woody debris on the gastropod community of a managed calcareous beech forest in western Europe. *J. Molluscan Stud.* **2005**, *71*, 85–91.
11. Kappes, H., Relations between forest management and slug assemblages (Gastropoda) of deciduous regrowth forests. *For. Ecol. Manag.* **2006**, *237*, 450–457.
12. Kappes, H.; Topp, W.; Zach, P.; Kulfan, J. Coarse woody debris, soil properties and snails (Mollusca: Gastropoda) in European primeval forests of different environmental conditions. *Eur. J. Soil Biol.* **2006**, *42*, 139–146.
13. Kappes, H.; Catalano, C.; Topp, W. Coarse woody debris ameliorates chemical and biotic soil parameters of acidified broad-leaved forests. *Appl.Soil Ecol.* **2007**, *36*, 190–198.
14. Jabin, M.; Topp, W.; Kulfan, J.; Zach, P. The distribution pattern of centipedes in four primeval forests of central Slovakia. *Biodivers. Conserv.* **2007**, *16*, 3437–3445.
15. Ulyshen, M.D.; Hanula, J.L. Litter-dwelling arthropod abundance peaks near coarse woody debris in loblolly pine forests of the southeastern United States. *Fla. Entomol*. **2009**, *92*, 163–164.

16. Castro, A.; Wise, D.H. Influence of fallen coarse woody debris on the diversity and community structure of forest-floor spiders (Arachnida: Araneae). *For. Ecol. Manag.* **2010**, *260*, 2088–2101.
17. Ulyshen, M.D.; Klooster, W.S.; Barrington, W.T.; Herms, D.A. Impacts of emerald ash borer-induced tree mortality on leaf litter arthropods and exotic earthworms. *Pedobiologia* **2011**, *54*, 261–265.
18. Maser, C.; Trappe, J.M. *The Seen and Unseen World of the Fallen Tree*; General Technical Report PNW-164; USDA Forest Service, Pacific Northwest Forest and Range Experiment Station: Portland, OR, USA, 1984.
19. Amaranthus, M.P.; Parrish, D.S.; Perry, D.A. Decaying logs as moisture reservoirs after drought and wildfire in Stewardship of soil, air and water resources. In *Proceedings of Watershed 89*, Juneau, AK, USA, 21–23 March 1989; pp. 191–194.
20. Marra, J.L.; Edmonds, R.L. Effects of coarse woody debris and soil depth on the density and diversity of soil invertebrates on clearcut and forested sites on the Olympic Peninsula, Washington. *Environ. Entomol.* **1998**, *27*, 1111–1124.
21. Tilman, D.; Socolow, R.; Foley, J.A.; Hill, J.; Larson, E.; Lynd, L.; Pacala, S.; Reilly, J.; Searchinger, T.; Somerville, C.; Williams, R. Beneficial biofuels—The food, energy, and environment trilemma. *Science* **2009**, *325*, 270–271.
22. Landis, D.A.; Werling, B.P. Arthropods and biofuel production systems in North America. *Insect Sci.* **2010**, *17*, 220–236.
23. Bengtsson, J.; Persson, T.; Lundkvist, H. Long-term effects of logging residue addition and removal on macroarthropods and enchytraeids. *J. Appl. Ecol.* **1997**, *34*, 1014–1022.
24. Barton, P.S.; Manning, A.D.; Gibb, H.; Wood, J.T.; Lindenmayer, D.B.; Cunningham, S.A. Experimental reduction of native vertebrate grazing and addition of logs benefit beetle diversity at multiple scales. *J. Appl. Ecol.* **2011**, *48*, 943–951.
25. Gunnarsson, B.; Nittérus, K.; Wirdenäs, P. Effects of logging residue removal on ground-active beetles in temperate forests. *For. Ecol. Manag.* **2004**, *201*, 229–239.
26. Grove, S.J.; Hanula, J.L. *Insect Biodiversity and Dead Wood: Proceedings of a Symposium for the 22nd International Congress of Entomology*; General Technical Report SRS-93; USDA Forest Service, Southern Research Station: Asheville, NC, USA, 2006; pp. 57–66.
27. Ulyshen, M.D.; Hanula, J.L. Responses of arthropods to large-scale manipulations of dead wood in loblolly pine stands of the southeastern United States. *Environ. Entomol*. **2009**, *38*, 1005–1012.
28. Houseweart, M.W.; Jennings, D.T.; Rea, J.C. Large capacity pitfall trap. *Entomol. News* **1979**, *90*, 51–54.
29. Ulyshen, M.D.; Hanula, J.L. Patterns of saproxylic beetle succession in loblolly pine. *Agr. For. Entomol*. **2010**, *12*, 187–194.
30. Hamilton, W.D. *Diversity of Insect Faunas. Symposia of the Royal Entomological Society of London*; Mound, L.A., Waloff, N., Eds.; Blackwell Scientific: Oxford, UK, 1978; pp. 154–175.
31. Cárcamo, H.A.; Parkinson, D. Distribution of ground beetle assemblages (Coleoptera, Carabidae) around sour gas processing plants in western Canada. *Pedobiologia* **1999**, *43*, 160–173.
32. Pearce, J.L.; Venier, L.A.; McKee, J.; Pedlar, J.; McKenney, D. Influence of habitat and microhabitat on carabid (Coleoptera: Carabidae) assemblages in four stand types. *Can. Entomol.* **2003**, *135*, 337–357.

33. Latty, E.F.; Werner, S.M.; Mladenoff, D.J.; Raffa, K.F.; Sickley, T.A. Response of ground beetles (Carabidae) assemblages to logging history in northern hardwood-hemlock forests. *For. Ecol. Manag.* **2006**, *222*, 335–347.
34. Nittérus, K.; Gunnarsson, Å.; Gunnarsson, B. Manipulated structural variability affects the habitat choice of two ground-living beetle species in a laboratory experiment. *Entomol. Fenn*. **2008**, *19*, 122–128.
35. Nittérus, K.; Gunnarsson, B. Effect of microhabitat complexity on the local distribution of arthropods in clear-cuts. *Environ. Entomol*. **2006**, *35*, 1324–1333.