Stump-harvesting for bioenergy probably has transient impacts on abundance, richness and community structure of beetle assemblages.

Karen D. Shevlin[1], Roseanne Hennessy[1], Aoife B. Dillon[2], Philip O'Dea[2], Christine T. Griffin[1] and Christopher D. Williams[3]

[1]Behavioural Ecology and Biocontrol, Department of Biology, Maynooth University, Maynooth, Co. Kildare, Ireland.

[2]Coillte Teoranta, Newtownmountkennedy, Co. Wicklow, Ireland.

[3]School of Natural Sciences and Psychology, Liverpool John Moores University, Liverpool, UK.

Abstract

1) Harvesting of tree stumps for bioenergy is popularand, whereas the environmental impact has been considered with respect to ecosystem processes, there have been fewer studies on the impact of stump-harvesting on biodiversity.

2) We carried out pitfall-trap surveys of beetle communities at eight plots across four sites (four plots were clear-fells where stumps remained and four were clear-fells where stumps were harvested). Initially, we recovered 7743 beetles when stumps were extracted but still on site (Year 1). All beetles were identified to family level and ground beetles and wood-associated beetles to species level. One year after stumps were extracted, the survey was repeated. In this collection 2898 individual beetles were recovered.

3) In Year 1, stump-harvesting had a negative impact on beetle abundance and richness. However, one year after stumps were removed there were no significant differences in these variables at any site.

4) At the community level, stump-harvesting weakly, but significantly, affected carabid composition. One year after stumps were removed, stump-harvesting had no effect on community composition.

5) Stump-harvesting initially negatively affects beetle abundance, family-richness and carabid species-richness and community structure, but that effects are not large, are site-specific and are probably not persistent.

Keywords

Stump-harvesting, Environmental impacts, Coleoptera, Species-richness, Community ecology.

Introduction

With the drive to reduce dependence on imported fossil fuels, harvesting stumps in plantation forests has been proposed by many as a sustainable solution (Eustafor, 2010). Stump-harvesting differs from the traditional stem clear-fell harvesting system in that, in the case of the former, the main bole of the stump and many of its associated roots are mechanically removed from the ground and taken off site. In Europe, stump-harvesting has been practiced since the 1970s in Scandinavian countries (Hedman, 2008) and, more recently, in Ireland and the UK (Anon, 2009). Advantages of stump-harvesting include recovering a large amount of useable biomass, reduced site cultivation costs and reduced breeding habitats for economically important pests such as the large pine weevil, *Hylobius abietis* (L.). Potential disadvantages can be economic or environmental (Walmsley and Godbold, 2010). Adverse economic impacts may include the loss of nutrients from the soil, jeopardising site fertility for the next plantation cycle (Kimmins, 1977; Mann et al., 1988, Walmsley et al., 2009) particularly for Norway spruce sites (Egnell, 2016) and the environmental impacts include possible eutrophication (Staaf and Olsson, 1994) and siltation of local water courses

(Anon, 2009). In addition, there may be a direct loss of CO_2 from the disturbed soil, which could be particularly important on clear-fells with high soil organic matter (Ågren and Hyvönen, 2003; Anon, 2009). Victorsson and Jonsell (2013a) showed that stump storage piles on the side of the road can be a severe "ecological trap" for four species of saproxylics. Also, of course, there is the potentially negative effects of stump-harvesting on biodiversity.

In a review of the effects of fuelwood harvesting on biodiversity in Europe, Bouget et al. (2012) concluded that, "large-scale fuelwood removal may, on a landscape scale, jeopardize the amounts and diversity of substrate that saproxylic organisms require as food and habitat."

Carabidae have proven to be excellent bioindicators due to extensive knowledge of their biology, in a variety of systems and are especially useful in studying disturbance (Rainio and Niemelä, 2003). A recent study by Work et al. (2014) shows that Carabidae respond, in terms of their community composition, to dead wood removal in clear-felled forests of western Quebec. Nittérus et al. (2007) examined the effects of harvesting logging residues from clear-cuts on carabid diversity and composition. They found that the number and diversity of carabid species were significantly higher in clear-cuts with slash harvest (harvest of logging residues) than in control sites where slash was left on the ground. In all clear-cuts, slash removal caused an increase in generalist species and a decline in forest species.

Although there have been studies (see above) on the effects of stump-harvesting on saproxylics there have been fewer studies on the effects of stump-harvesting on the non-saproxylic species. Kataja-aho et al. (2016) noted that the numbers of arthropods between treatments were rather similar and that, for ground beetles, open-habitat and generalists benefitted from stump-harvesting. Persson et al. (2013) found that six species / taxa had higher abundances in stumps and that Diplopoda were much more abundant in bark than soil. Malmström (2012) showed that Collembola could survive the entire forest cycle in stumps and Battigelli et al. (2004) showed severe effects of stump-harvesting on oribatid mites.

We address this gap in studies, by examining the initial and post-removaleffects of stump-harvesting on beetle families (Coleoptera), ground beetle (Carabidae) species and saproxylic species through pitfall trapping at four sites with eight paired plots (clear-felled and stump harvested plots versus clear-felled plots [control] only). Our primary objective was to look at effects on Carabidae and other non-saproxylic ground-dwelling species. However, we also separately analysed saproxylic species that we caught (even though pitfall trapping is not a recommended method of collection for such species, though it has been used to look at certain species such as pine weevil). We would expect saproxylic abundance to be highest in the first year and diversity to increase with stump age (Stenbacka et al., 2010; Jonsell et al., 2007; Lee et al., 2014). Stump-harvesting is a two-three stage process – once stumps are removed from the soil they are temporarily left on site in wind-rows to undergo a ‘weathering period’. This initial drying period can last 6-12 months, after which time stumps are moved to roadside for further weathering (a further 3-12 months), prior to dispatch to a processing facility. In the present paper we test the effects of initial stump-harvesting when harvested stumps were still present in wind-rows and also long-term effects of stump-harvesting one year after stumps had been taken off-site to a processing facility.

As the removal of stumps remove niches, our hypothesis is that stump-harvesting will adversely affect beetle abundance and/or community structure. To test this we:

1) Examined the effect of stump-harvesting on the abundance of Coleoptera in general, and Carabidae and saproxylics, in particular, on both organic and mineral soil clear-fells.
2) We also investigated whether family (coleopteran) and/or species (carabid and saproxylic) richness are also affected.

3) Finally, we determined whether the composition of beetle families, carabid species and saproxylic species are significantly different between sites where stumps are retained and where they are removed.

Our hypotheses are based on the fact that, although the stumps remain on site initially, once harvested the physical structure of the habitat is altered through disturbance to such an extent that the habitat becomes unsuitable to many beetles that normally occupy these niches.

Materials and Methods

Experiments were conducted on four sites in the south-east of Ireland (Table 1). Each site was a clear-fell of Sitka Spruce (*Picea sitchensis* [Bong.] Carr.). Logging residues (small branches and twigs etc.) were left on site throughout the entire experiment. The clear-fell site areas varied in size from 8 to 21 ha. At each site there were two areas with plots in each; a plot in the stump-harvested area and a plot in the neighbouring control area. Each plot was approximately 10000 m^2 in area. All areas were clear-felled in 2011 and stumps extracted from stump-harvested areas in the second week of May 2012 and left piled on site in wind-rows (rows of piled stumps on the site). Between 20 to 40% of stumps were left in situ in stump-harvested mineral soil trial sites, increasing to between 56 to 78% left on peat sites, where site conditions created difficulties in accessing all the stumps. These stumps were removed from the sites 6 months after extraction.

At each plot, ten pitfall traps were located in two rows of five traps. Traps were spaced out to cover the full plot with a minimum 10 m buffer at the edge to avoid edge-effects. The two rows were separated by between 6 and 12 m, and the traps in each row were separated by between 10 and 20 m depending on the shape and size of the plot. Traps on stump-harvested plots were placed between wind-rows and at the same distance apart on the associated control plots. Stump-harvested and control plots were at least 200m distant from each other. Each pitfall trap consisted of a plastic pint cup (9 cm diameter and 13 cm deep) placed so that the edge was just below the soil surface. Each trap was covered by a 15 cm x 15 cm piece of corriboard supported by four 15cm nails which acted as a rain cover. Traps contained 100 ml of ethylene glycol (20% by volume) and a small amount of detergent to break the surface tension.

Beetles were collected every 2 weeks between 4/7/2012 and 12/9/2012 (6 collections) (year 1). Six collections were also made in 2013 from 12/8/2013 until 28/10/2013 (year 2). Differences in sampling dates were due to logistical difficulties. In the second year of collections, pitfall traps were placed as close as possible to the positions of the traps in the first year's collection. Collections were preserved in 70% ethanol. All Coleoptera were identified to family level using Joy (1976) and Carabidae were identified to species level using Luff (2007). Saproxylic species were identified to species using Joy (1976). Beetles collected at different times within a year were pooled for each trap and analyses were conducted with trap as replication.

Univariate statistical analyses included using a two way analysis of variance (ANOVA) to test for the effect of site and treatment (stump-harvested versus control) and their interaction (site*treatment) on the abundance and richness (species or family) of the various coleopteran communities i.e. on total abundance of Coleoptera, Carabidae and saproxylics and on family-richness of Coleoptera, species-richness of Carabidae and species-richness of saproxylics. Univariate analyses were performed using SPSS version 19 (SPSS, 2011). We also employed a more conservative analysis to strictly avoid any psudo-replication, even though this was accounted for by the inclusion of "site" as a factor in the two way ANOVA. For this, we pooled all collections from each site and performed a generalized linear model with a Poisson error function and two levels of the factor "treatment" i.e. control versus stump-harvesting.

Multivariate analyses included Multi-response permutation-procedure (MRPP), which tests for the effect of grouping variables (site, soil type and treatment), on the dissimilarity matrix of the species or families (response variables) by comparing the within-group homogeneity (measured as the chance-corrected within-group agreement) among grouping variables. A *P* value is determined by Monte Carlo permutation of the dissimilarity matrix. Euclidean distance was used and 10,000 permutations were run. Multi-response permutation procedure (MRPP) was used to assess the effects of site, soil-type and treatment (stump harvested versus control) on the composition of the beetle communities. MRPP measures the effect-size of a particular grouping variable through chance-corrected within-group agreement, which describes the similarity of within-groups. The *P* value is obtained from Monte-Carlo permutation of the species matrix.

Indicator species analysis (ISA) is a method by which the fidelity of certain species to particular levels of a grouping variable were assessed by computation of both the relative frequency and relative abundance of the species for each level of the factor under investigation; again the *P* value is determined by a permutation procedure. For visualisation of community composition a non-metric multi-dimensional scaling (NMS) ordination was produced. These plots were labelled according to the sites from which the beetles came. Multivariate techniques were performed using PC Ord version 5 (McCune and Mefford, 1999; McCune and Grace, 2002).

Results

Effects of stump-harvesting and site on abundance and richness of Coleoptera

In year 1, a total of 7743 beetles were identified to family (20 families). Of these, 3769 ground beetles (Carabidae) were identified to species (29 species) and a further 133 individuals from families known to be saproxylic were identified to species (12 species). In year 2, 2898 beetles were identified to family level. Of these, 2299 ground beetles were identified to species (14 species). Only six individuals of the second collection were saproxylic – all were *Hylobius abietis* (L.). Complete lists of families (Coleoptera) and species (Carabidae and saproxylics) are given for both years of collection in appendices 1-5.

Table 2 gives a listing of all families of Coleoptera, all species of Carabidae and all species of saproxylics and their abundances in Stump-harvested and control traps for the two years of the study. Ten families (including the most abundant – Carabidae) were more abundant in control as compared to stump-harvested traps in Year 1; in contrast, eight families were more abundant in stump-harvested traps and one family was equally abundant in the two treatments. In Year 2, however, only three families were more abundant in control traps and seven families (including the most abundant – Carabidae) were more abundant in the stump-harvested plot.

In Year 1, 13 species of Carabidae were more abundant in control traps than stump-harvested traps and 12 species were more abundant in stump-harvested traps. One species was equally abundant in both treatments. In Year 2, in contrast, six species were more abundant in control traps and nine were more abundant in stump-harvested traps. For saproxylics, eight species were more abundant in control traps than stump-harvested traps in Year 1 and four species were more abundant in stump-harvested plots. For Year 2, only *Hylobius abietis* was collected and all six individuals came from control traps. It should be noted, however, that pitfall traps are not the best collecting method for saproxylics so results should be treated with caution.

Year 1

In year 1, treatment (stump-harvested versus control) did not have a significant effect on the total abundance of Coleoptera, though site did. There was no significant interaction between the two variables. Figure 1a shows these data and includes the results of independent T-tests conducted at each site separately. The family richness of Coleoptera was significantly affected by treatment, site, and their interaction (Table 3). With the effect of treatment on family richness being contingent on site-specific factors it is difficult to generalise on the effects of stump-harvesting on this variable. However, the sites in which family richness significantly differed between treatments (sites 1 and 4) showed a bias for control to be higher than the associated stump-harvested location (Figure 1b).

For Carabidae, treatment (stump-harvesting versus control) did not have a significant effect on total abundance, while site had a significant effect on total abundance and there was no significant interaction between the two factors (site*treatment) (Figure 2a) in Year 1 (Table 3). Carabid species-richness did not differ between treatments, but differed among sites and there was no significant site*treatment interaction (Table 3, Figure 2b).

For the wood-inhabiting (saproxylic) species identified in Year 1, species-richness and total abundance were influenced by site ($P < 0.001$ in both cases), but not the stump-harvesting treatment ($P = 0.747$ for abundance and $P = 0.649$ for species richness). There was no significant treatment*site interaction ($P = 0.281$ for abundance and $P = 0.189$ for species richness) (Figure 3).

A more conservative analysis pools traps for each treatment and applies a Generalized linear model with Poisson error distribution. In this analysis (Table 4), total abundance of Coleoptera is marginally non-significantly different between treatments ($P = 0.11$) in Year 1. However, given the results of the ANOVA we may assume that there is likely an effect given the low statistical power of the GLM.

Year 2

For year 2 (2013), treatment (stump-harvesting versus control) did not had a significant effect on the total abundance of Coleoptera collected and while site did have an effect, there was no site*treatment interaction (Table 3, Figure 4a). The family richness of Coleoptera was also only significantly affected by site, but neither treatment nor the site*treatment interaction was significant (Table 3, Figure 4b).

Similarly, for Carabidae neither treatment (stump-harvesting versus control) nor the site*treatment interaction had a significant effect on the total abundance of Carabidae collected (Table 3, Figure 5a), but site did. Carabid species richness also only significantly differed among sites (Table 3) although there was a marginally non-significant effect of treatment on carabid species richness ($P = 0.096$), but no effect of site*treatment interaction (Table 3, Figure 5b).

The only partially saproxylic family identified in Year 2 was the Curculionidae, which consisted of the large pine weevil (*Hylobius abietis*) only. This species occurred with a low abundance (only six individuals) all of which occurred only on the control plot of Site 4 (Errill).

A more conservative analysis pools traps for each treatment and applies a Generalized linear model with Poisson error distribution. In this analysis (Table 4), total abundance of Coleoptera is significantly different between treatments ($P < 0.001$) in Year 2 with stump-harvested treatments being significantly more abundant than controls.It is also significantly different between treatments with respect to total Carabidae abundance ($P = 0.029$) in Year 2 with stump-harvested treatments being more abundant than controls.

Effect of site, soil type and stump-harvesting on community composition

Treatment (stump- harvested versus control) did not significantly affect the composition of coleopteran families or saproxylic species, but it did significantly affect the composition of carabid species although only weakly structuring the community and accounting for approximately 2% of the variation in the species matrix in the first year. In the second year of collections neither coleopteran family composition nor carabid species composition was affected by stump-harvesting treatment. The analysis clearly shows that site is a major factor in determining the composition of coleopteran families, carabid species and saproxylic species explaining between 22 and 34% of the variation in the species matrix for both years of collection (Table 5). Soil type explains approximately 5% of the variation in carabid species and coleopteran family composition, but approximately 21% of the variation in saproxylic species composition in Year 1 and approximately 10% of the variation in Year 2.

Indicator species analysis was performed on all data sets, but only the carabid data-set gave significant indicators in Year 1. In Year 1, the common *Carabus granulatus* L. and *Bembidion tibale* (Duftschmid) were significant indicators of stump-harvested areas indicating, together with the MRPP, that community composition of Carabidae is likely to be affected by stump-harvesting initially. In the second year of collections, Curculionidae were a significant indicator of control sites as was the carabid *Carabus problematicus* Herbst. Also, *Loricera pilicornis* (Fabricius), *Leistus terminatus* (Hellwig in Panzer) and *Pterostichus melanarius* (Illiger) were significant indicators of stump-harvested sites in the second year of collections (Table 6). Whereas forest and heathland species were indicative of control areas, open ground species, peatland species, stream bank species, scrub and wet woodland species were indicative of areas where stumps were harvested.

To visualise carabid community composition, two non-metric multidimensional scaling (NMS) ordinations were performed – one for each year of collection. . Figures 6a and 6b show a similar dispersion of trap composition in species space with site 4 showing a widely dispersed composition relative to the tight cluster of sites 1 to 3. However, within the tight cluster of sites 1 to 3 there is a clear separation of stump-harvested traps from control traps in Year 1, but considerable overlap in Year 2. This reflects the results of the MRPP, which demonstrated compositional differences in Year 1, but not in Year 2.

Discussion

Stump-harvesting initially negatively affects beetle and carabid abundance, beetle family-richness and carabid species-richness and community structure, but effects are not large, are site-specific and are not persistent. However, it should be noted that beetles were collected later in the season in Year 2 and this may have affected beetle abundance, richness and composition. Therefore, further studies should look at cursorial invertebrates at an earlier time in the season. Also studies on sites where a higher proportion of stumps are removed should be conducted. Indicator species analysis revealed that whereas forest and heathland species were indicative of control areas (where stumps were left *in situ*), open ground species, peatland species, stream bank species, scrub and wet woodland species were indicative of areas where stumps were harvested. More individuals and species were collected in the first year of the study than the second. Differences in beetle numbers might be attributable to the loss of open-habitat species over time, but could also plausibly be explained by the later collection date of beetles in Year 2.

Clear-felled sites can support a far wider array of invertebrates than the plantations they replace (Mullen et al., 2008; Day and Carthy, 1988), though it should be noted that forest specialist species may suffer as a result of this management. The invertebrates most likely to be impacted by stump-harvesting are those that inhabit the stumps themselves, and several studies have addressed the likely impacts of stump-harvesting on these so-called saproxylic beetles in Scandinavia (Hjältén et al., 2010; Andersson et al., 2012, 2015; Ols et al, 2013). In a study investigating the longer-term (21-28 years post-harvest) impacts of stump-harvesting on beetles using window trap collections, Andersson et al. (2012) found evidence for persisting minor effects of stump-harvesting on the species richness of beetles of the family Latridiidae and fungivores, but generally the effects of stump-harvesting were small compared to the effects of surrounding landscape features. Jonsell and Schroeder (2014) quantified the proportions of landscape-wide populations of saproxylics that are recruited from clearfell stumps and Victorsson and Jonsell (2013b) compared stump faunas in stumps that were left on otherwise extracted sites and normal clearfells.

The most abundant family in our collections were ground beetles (Carabidae), accounting for 49% of the collected individuals. As they were so abundant and are of value as indicator species they were identified to species. Other Coleoptera, apart from those from known saproxylic families, were identified to family level only. Taxonomic minimalism (determining collections to taxa higher than species-level) has been critiqued (Goldstein, 1997; Goldstein, 1999), but has advantages in terms of the breadth of study made possible and the number of samples that can be determined efficiently (Oliver and Beattie, 1996). Mandelik et al. (2007) have shown that at the local level, family level identification performs poorly compared to species or genus identification. However, for beetles, “almost 70% of the variation in patterns of occurrence of beetle species were reflected in the family-level data” (Mandelik et al., 2007).

Community composition in the present study was significantly affected by site-specific factors and some of this variation could be explained by the difference in communities collected on mineral versus peaty sites. Initially, stump-harvesting weakly, but significantly, affected ground beetle (Carabidae) composition with *Bembidion tibale* and the common *Carabus granulatus* favouring stump-harvested sites. The former species is common on disturbed areas such as shingle by rivers and exposed gravel (Luff, 2007) and it is possible that the disturbance created by stump-harvesting directly favoured these species. Stump-harvesting did not appear to affect beetle family composition or saproxylic species composition though as only pitfall traps were used, this is only true with respect to cursorial saproxylics and a general reduction in saproxylics would be expected with the removal of so much habitat (Hjältén et al., 2010; Andersson et al., 2012, 2015; Ols et al, 2013). After the removal of stumps off site (Year 2 collections), there was no effect of stump-harvesting versus control on any of the variables. Hjältén et al. (2010) have shown that low stumps, i.e. stumps similar to those removed in the present study, can harbour as many saproxylics per unit volume as other substrates (high stumps and logs), so retention of surface deadwood on a site may offer some mitigation, although it should be noted that Ranius et al. (2014) have shown that it is hard to mitigate stump-harvesting by retaining other types of wood. Further mitigation measures include leaving some stumps *in situ* at sites where stump-harvesting was being undertaken. As our study relied on pitfall trapping, it is possible that many of the saproxylics initially collected on the stump-harvested areas were attracted by the large amounts of deadwood present in the wind-rows.

Walmsley and Godbold (2010) have noted that, although there have been no studies of the impact of stump-harvesting on ground-dwelling invertebrates at the time of their study (though there have been some since – see Introduction of the present paper), studies have shown that the retention of man-made high stumps (ca 3 m) can benefit saproxylic invertebrates as well as specialised fungi (Anon, 2009). Current UK Forest Research guidelines (Anon, 2009) cover potential impacts of stump-harvesting only on soil and water. The present study suggests that ground dwelling beetles can also be significantly affected initially. It should be noted that many significance tests were performed and that whereas it would be inappropriate, in this instance to perform Bonferroni correction, we should consider mass significance and this further supports our conclusion that impacts are small, site-specific and not persistent.

Our results generally agree with Andersson et al (2012) who found that long-term effects of stump-harvesting on beetles were smaller than the site-specific differences. We have shown that the initial phase of stump-harvesting has noticeable effects on beetle communities, but these effects are site-specific. In particular, the community analysis, using NMS ordination, showed that site was a far more influential factor than treatment on beetle assemblages and that a lot of this variation may be attributed to soil type (peat versus mineral) as shown in the MRPP. The ordinations also generally supported the MRPP results in that treatment effects on composition were more clear in Year 1 than Year 2. As most of the negative effects of stump-harvesting on coleopteran richness and abundance were found on a peaty site, we present tentative evidence that it is important to take soil type in to account when considering the feasibility of stump-harvesting and its effects on biodiversity.

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Tables

Table 1. Names, locations and soil types of sites in the present study

Site code	Site name	Grid reference	Soil type	Trap numbers used in Appendices
1	Coolbeggan West	IX 05774, IG 87643	Mineral	1 – 10 stump-harvested 11 – 20 control
2	Coolbeggan	IX 04024, IG 87646	Mineral	21 – 30 stump-harvested 31 – 40 control
3	Rossmore	IS 65156, IG 74825	Peat	41-50 stump-harvested 51-60 control
4	Errill	IS 19039, IG 77167	Peat	61-70 stump-harvested 71-80 control

Table 2. Abundances of Coleoptera families, Carabidae species and saproxylics in stump-harvested and control traps over two years of the study.

	Year 1		Year 2	
Family / Species	**Stump-harvested**	**Control**	**Stump-harvested**	**Control**
Coleoptera Families				
Biphyllidae	2	0	0	0
Byrrhidae	0	2	0	0
Cantharidae	0	0	2	0
Carabidae	1896	1915	1214	1098
Cerylonidae	3	4	0	0
Chrysomelidae	2	5	1	0
Coccinellidae	0	0	1	0
Colydiidae	0	0	0	1
Curculionidae	57	68	0	6
Dytiscidae	10	5	14	9
Elateridae	0	1	0	0
Endomychidae	1	0	0	0
Helodidae	3	0	0	0
Hydrophilidae	32	42	18	14
Latridiidae	0	1	0	0
Leiodidae	2	1	0	0
Ptilidae	8	0	0	0
Rhizophagidae	4	4	0	0
Scolytidae	7	0	0	0
Silphidae	36	86	120	134

Staphylinidae	128	168	176	90
Unknown family	7	3	0	0
Carabidae species				
Abax paralellepipedus	243	527	295	233
Agonum emargiuatum	1	0	0	0
Agonum fuliginosum	1	2	0	0
Agonum muelleri	1	0	0	0
Agonum viduum	2	0	0	0
Bembidion lampros	8	3	0	1
Bembidion tibale	14	2	0	0
Cychrus caraboides	1	7	1	2
Clivina fossor	4	0	0	0
Carabus granulatus	257	131	271	262
Calathus melanocephalus	0	2	0	0
Carabus problematicus	5	26	3	23
Elaphrus cupreus	10	5	0	0
Loricera pilicornis	35	51	7	1
Leistus terminatus	2	2	7	1
Miscodera arctica	0	1	0	0
Notiophilus biguttatus	30	36	1	3
Nebria brevicollis	1	6	49	45
Paranchus albipes	0	1	0	0
Pterostichus aethiops	0	0	2	0
Pterostichus madidus	108	121	36	38
Pterostichus melanarius	45	48	19	4

Pterostichus niger	463	314	450	449
Pterostichus nigrita	29	53	0	0
Pterosticus rhaeticus	0	0	54	23
Pterostichus vernalis	1	1	0	0
Trechus obtusus	3	1	0	0
Trechus rubens	0	0	6	8
Trechus secalis	88	43	0	0
T.rechus quadrastriatus	3	1	0	0
Unknown	0	2	0	0
Saproxylic species				
Agathidium marginatum	0	1	0	0
Barypithes araneiformis	42	45	0	0
Barypithes pellucidus	0	1	0	0
Dolopius marginatus	0	1	0	0
Helodes minuta	2	5	0	0
Hylastes ater	5	0	0	0
Hylobius abietis	6	5	0	6
Hylurgops palliatus	3	1	0	0
Liparus coronatus	0	1	0	0
Nargus wilkli	2	0	0	0
Otiorrhynchus singularis	1	3	0	0
Strophosomus melanogrammus	3	6	0	0

Table 3. ANOVA models for the effects of site and treatment (stump removal versus control) and their interactions on the total abundance of all Coleoptera, family richness of Coleoptera, total abundance of Carabidae and species richness of Carabidae for the two years treated separately.

Source	df	Mean Square	F ratio	*P*
Total abundance of all Coleoptera Year 1 (adj $R^2 = 0.862$)				
Model	8	39461.488	63.232	0.000
Treatment	1	143.112	0.229	0.633
Site	3	19549.346	31.326	0.000
Treatment * Site	3	1146.046	1.836	0.148
Error	72	624.071		
Total	80			
Family richness of Coleoptera Year 1 (adj $R^2 = 0.922$)				
Model	8	154.650	119.987	0.000
Treatment	1	6.050	4.694	0.034
Site	3	4.317	3.349	0.024
Treatment * Site	3	5.650	4.384	0.007
Error	72	1.289		
Total	80			
Total abundance of Carabidae Year 1 (adj $R^2 = 0.800$)				
Model	8	15056.700	40.939	0.000
Treatment	1	11.250	0.031	0.862
Site	3	8609.117	23.408	0.000
Treatment * Site	3	210.983	0.574	0.634
Error	72	367.783		
Total	80			
Species richness of Carabidae Year 1 (adj $R^2 = 0.924$)				
Model	8	346.963	122.879	0.000
Treatment	1	0.312	0.111	0.740
Site	3	130.612	46.257	0.000
Treatment * Site	3	6.079	2.153	0.101
Error	72	2.824		
Total	80			
Total abundance of all Coleoptera Year 2 (adj $R^2 = 0.869$)				
Model	8	17662.025	67.463	0.000
Treatment	1	470.450	1.797	0.184

Site	3	11651.483	44.505	0.000
Treatment * Site	3	297.083	1.135	0.341
Error	72	261.803		
Total	80			
Family richness of Coleoptera Year 2 (adj $R^2 = 0.855$)				
Model	8	57.512	60.100	0.000
Treatment	1	0.113	0.118	0.733
Site	3	13.279	13.877	0.000
Treatment * Site	3	0.513	0.536	0.659
Error	72	0.957		
Total	80			
Total abundance of Carabidae Year 2 (adj $R^2 = 0.864$)				
Model	8	10880.412	64.734	0.000
Treatment	1	137.813	0.820	0.368
Site	3	6667.479	39.669	0.000
Treatment * Site	3	278.513	1.657	0.184
Error	72	168.079		
Total	80			
Species richness of Carabidae Year 2 (adj $R^2 = 0.947$)				
Model	8	201.150	179.243	0.000
Treatment	1	3.200	2.851	0.096
Site	3	97.167	86.584	0.000
Treatment * Site	3	0.767	0.683	0.565
Error	72	1.122		
Total	80			

Table 4. Generalized linear model with Poisson error distribution and Log link function treating each site as a replicate.

Source	df	Wald Chi Square	*P*
Total abundance of all Coleoptera Year 1			
Intercept	1	180486.533	<0.001
Treatment	1	2.542	0.111
Family richness of Coleoptera Year 1			
Intercept		354.439	<0.001
Treatment		0.342	0.559
Total abundance of Carabidae Year 1			
Intercept	1	93408.444	<0.001
Treatment	1	0.328	0.567
Species richness of Carabidae Year 1			
Intercept	1	626.446	<0.001
Treatment	1	0.010	0.920
Total abundance of all Coleoptera Year 2			
Intercept	1	100090.187	<0.001
Treatment	1	12.967	<0.001
Family richness of Coleoptera Year 2			
Intercept	1	81.023	<0.001
treatment	1	0.111	0.739
Total abundance of Carabidae Year 2			
Intercept	1	73489.565	<0.001
Treatment	1	4.792	0.029

Species richness of Carabidae Year 2			
Intercept	1	124.116	<0.001
Treatment	1	0.813	0.367

Table 5. Multi-response permutation procedure showing the effects of treatment (stump harvested verus control), soil-type (peat versus mineral) and site (1-4) on the community structure of coleopteran families, carabid species and saproxylic species.

Year of sampling	Data-set	Grouping variable	Chance-corrected within-group agreement (*A*)	*P*
Year 1	Coleoptera families	Treatment	-0.0063	0.70
		Soil type	0.049	0.0042 **
		Site	0.33	$<10^{-8}$ ***
	Carabidae species	Treatment	0.017	0.023*
		Soil type	0.059	$2.2\text{x}10^{-5}$ ***
		Site	0.24	$<10^{-8}$ ***
	Saproxylic species	Treatment	-0.0048	0.52
		Soil type	0.21	$1.1\text{x}10^{-7}$ ***
		Site	0.22	$1.4\text{x}10^{-6}$ ***
Year 2	Coleoptera families	Treatment	-0.00463	0.616
		Soil type	0.0981	$1.277\ \text{x}10^{-5}$ ***
		Site	0.346	$<10^{-8}$ ***
	Carabidae species	Treatment	-0.00352	0.617
		Soil type	0.0957	$2.3\ \text{x}10^{-7}$ ***
		Site	0.288	$<10^{-8}$ ***

Table 6. Indicator species analysis showing significant ($P < 0.1$) carabid indicators of control and stump-harvested treatments and showing the sole significant family indicator in Year 1 and Year 2.

Species	Species classification	Maximum group	% perfect indication	*P*
Year 1				
Abax parallelipipedus	Eurytopic / Forest	Control	42.4	0.0672
Carabus problematicus	Heath / Forest	Control	18.8	0.0470
Carabus granulatus	Peatland	Stump harvested	48.0	0.0236
Bembidion tibale	Stream banks	Stump harvested	15.8	0.0348
Bembidion lampros	Eurytopic / Heath	Stump harvested	11.3	0.0986
Year 2				
Carabus problematicus	Heath / Forest	Control	20.9	0.0366
Loricera pilicornis	Open habitats	Stump-harvested	11.9	0.0804
Leistus terminatus	Scrub / Heath	Stump-harvested	14.2	0.0496
Pterostichus melanarius	Wet woodland	Stump-harvested	17.9	0.0774
Curculionidae	Forest	Control	12.8	0.0518

Figure Legends

Figure 1. Mean ± SE abundance (a) and family richness (b) of beetles at the different sites. Year 1.

Figure 2. Mean ± SE abundance (a) and species richness (b) of ground beetles (Carabidae) at the different sites. Year 1.

Figure 3. Mean ± SE abundance (a) and species richness (b) of wood-inhabiting (saproxylic) species at each site. Year 1.

Figure 4. Mean ± SE abundance (a) and family richness (b) of beetles at the different sites. Year 2.

Figure 5. Mean ± SE abundance (a) and species richness (b) of ground beetles (Carabidae) at the different sites. Year 2.

Figure 6. Non-metric multidimensional scaling ordination of pitfall traps in Carabidae species-space overlaid with site showing that most of the compositional differences were as a result of site-specific differences (a) year 1. Axis 1 accounted for approximately 55.9% of the variation and axis 2 accounted for 20.9% as measured by the correlation coefficient between the distance in ordination space and in the original species space. Orthogonality between axis 1 and 2 was 95.6%. (b) year 2. Axis 1 accounted for approximately 73.6% of the variation and axis 2 accounted for 17.2% as measured by

the correlation coefficient between the distance in ordination space and in the original species space. Orthogonality between axis 1 and 2 was 91.9%.

Fig 1 (a)

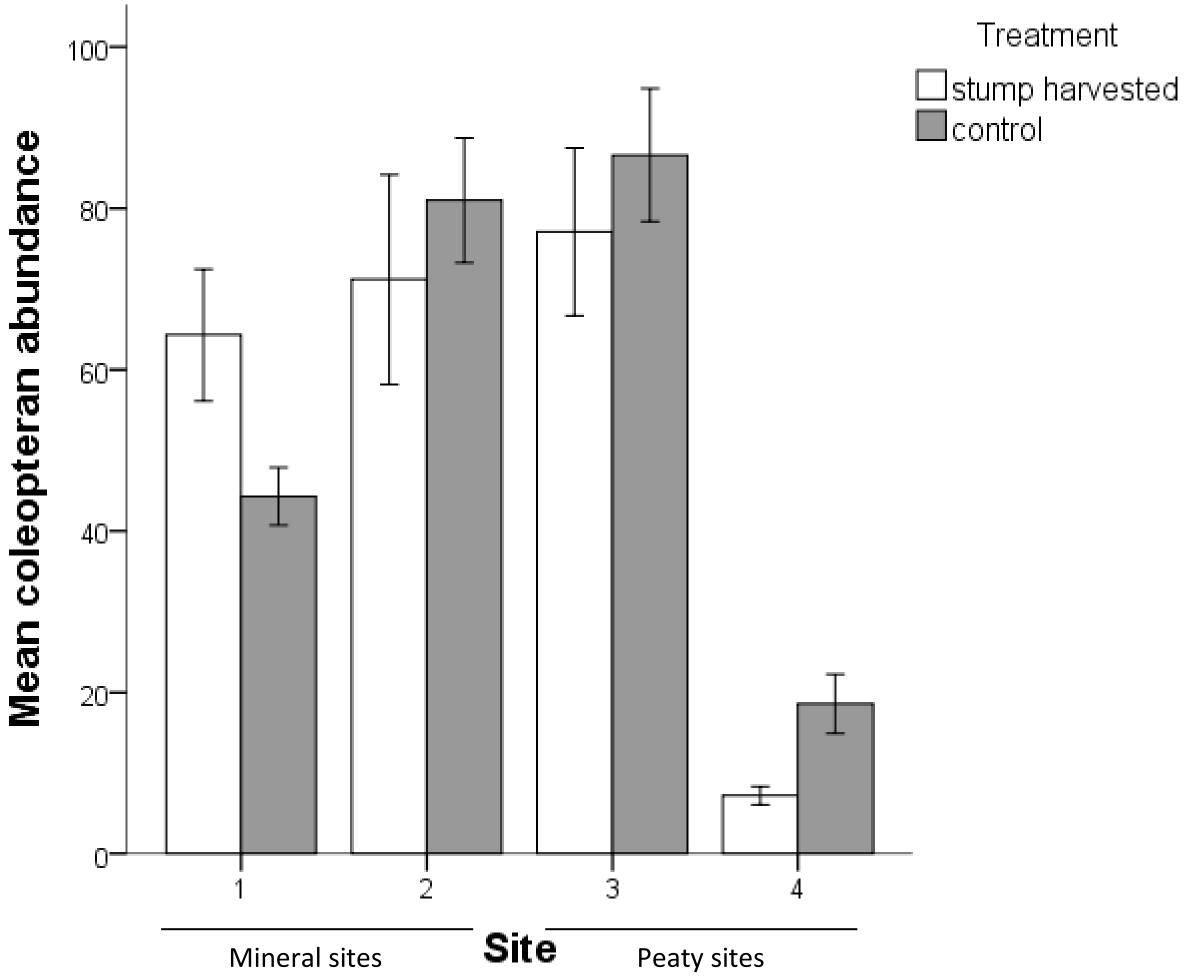

Treatment
stump harvested
control
Mean coleopteran abundance
100
80
60
40
20
0
1
2
3
4
Site
Mineral sites
Peaty sites

Fig 1 (b)

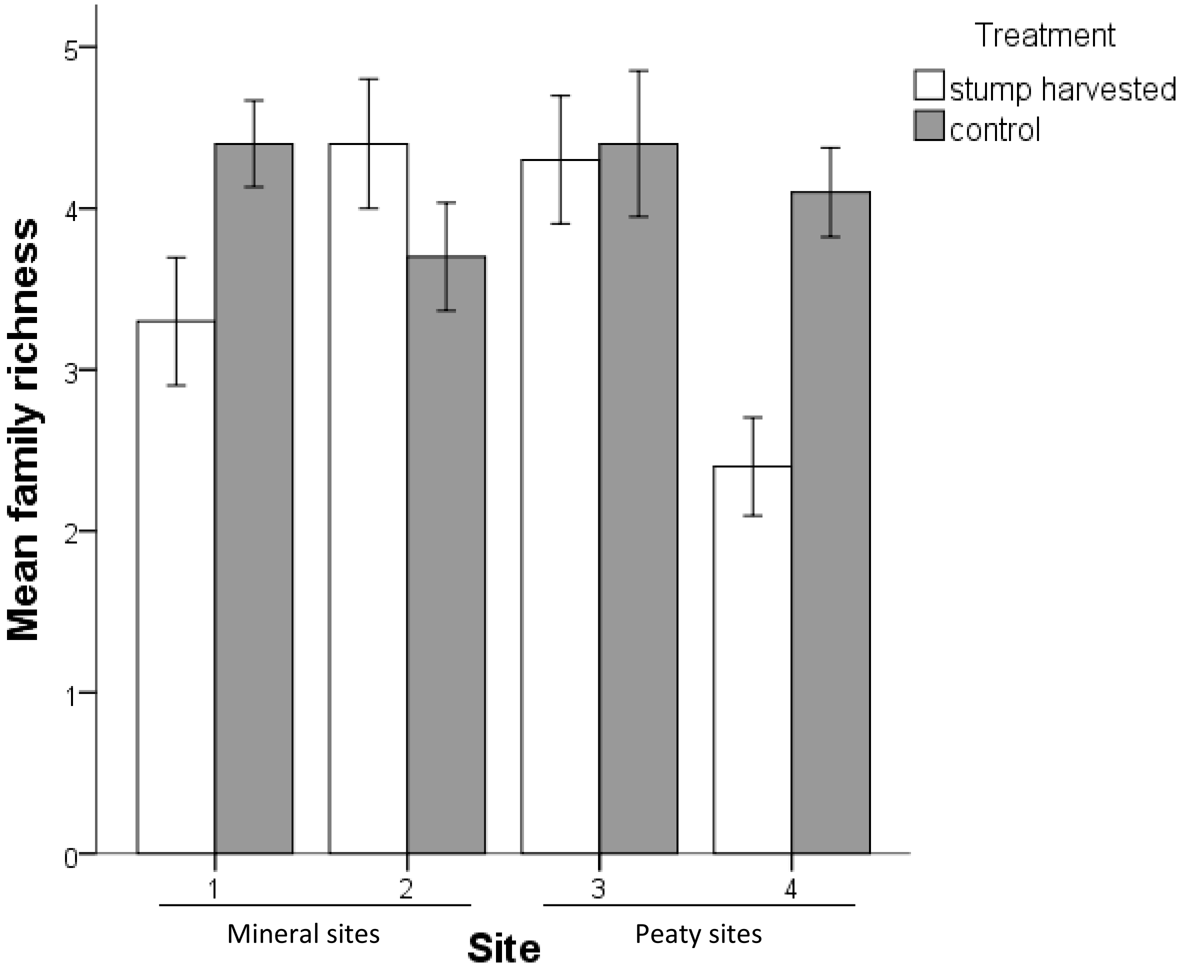

Treatment
stump harvested
control
Mean family richness
0
1
2
3
4
5
1
2
3
4
Mineral sites
Peaty sites
Site

Fig 2 (a)

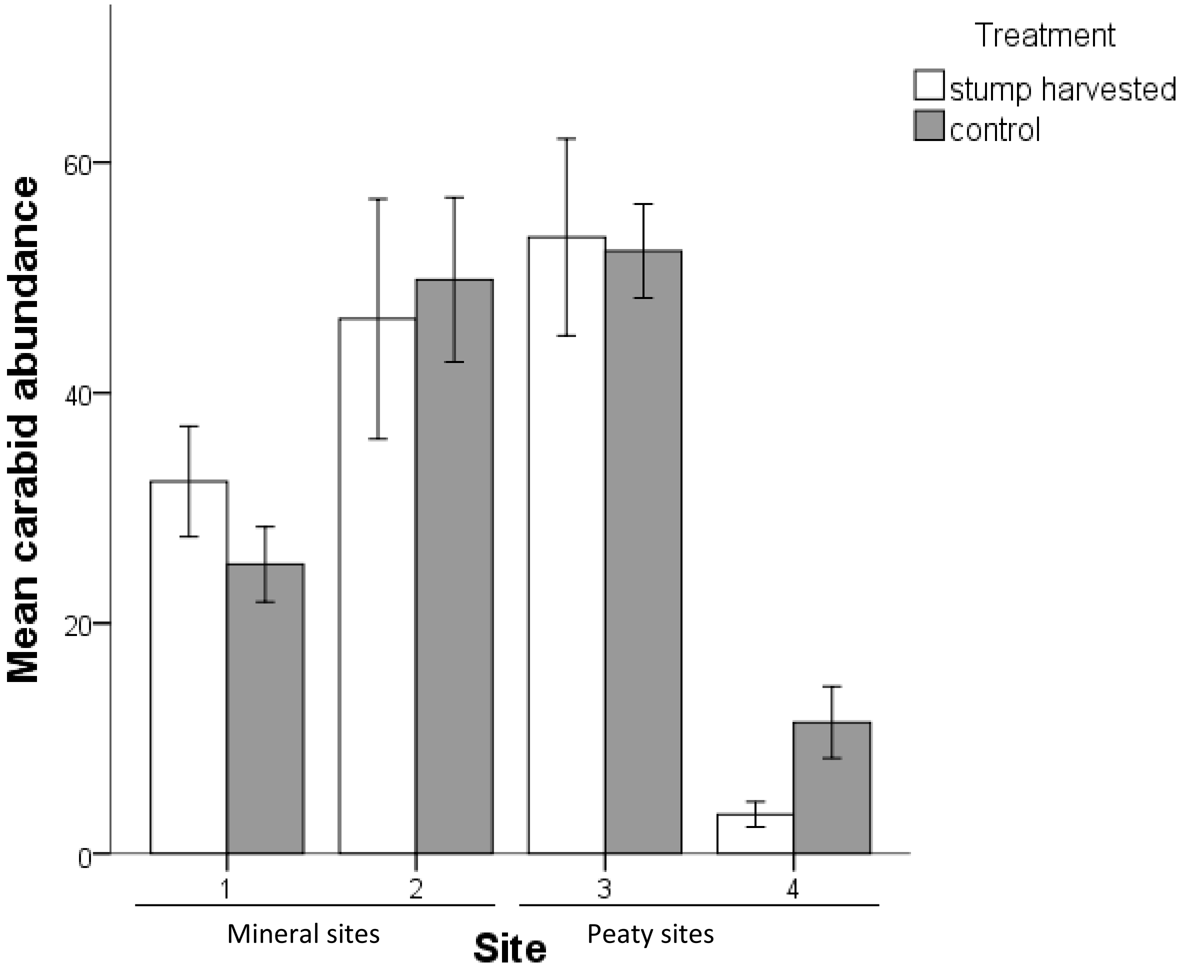

Treatment
stump harvested
control
Mean carabid abundance
0
20
40
60
1
2
3
4
Mineral sites
Peaty sites
Site

Fig 2 (b)

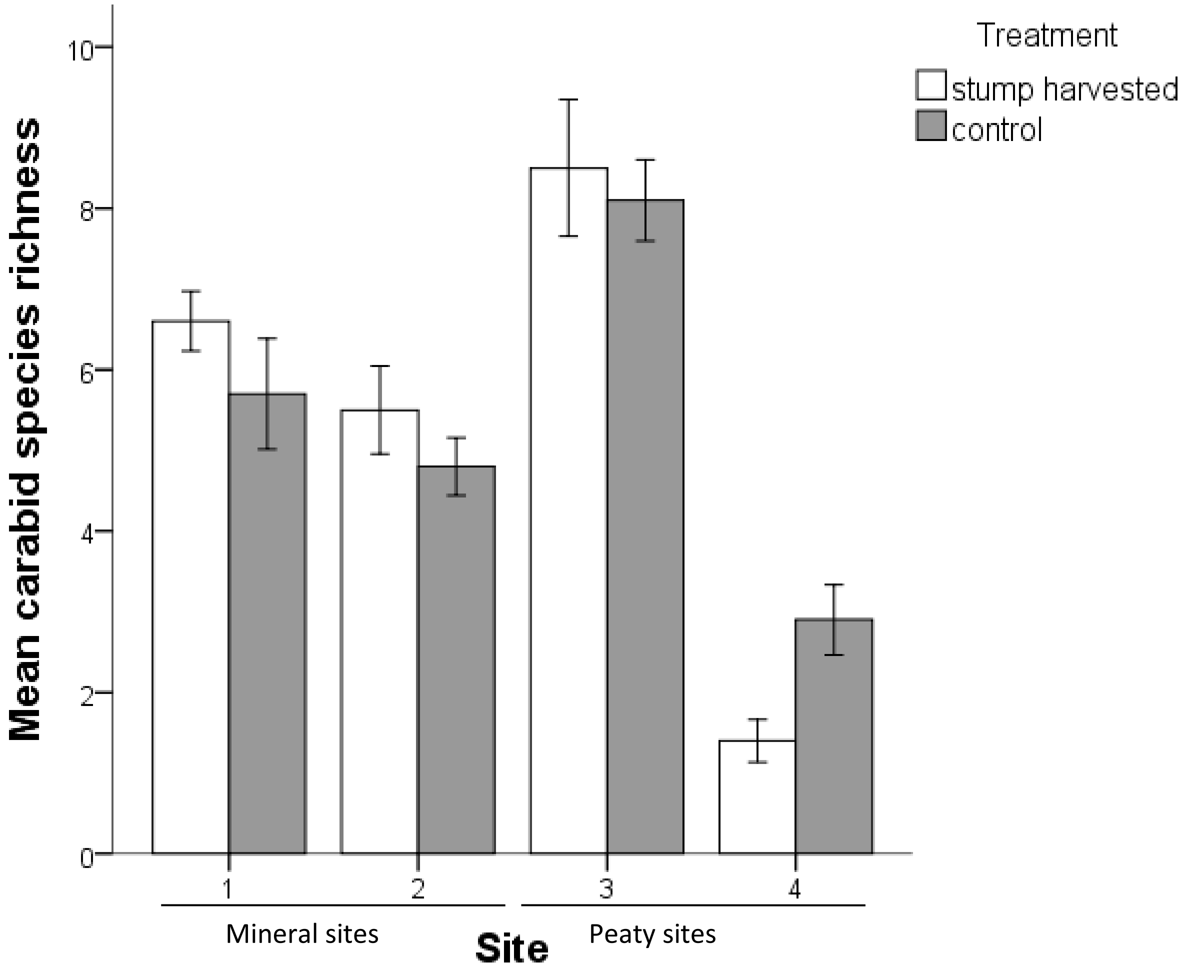
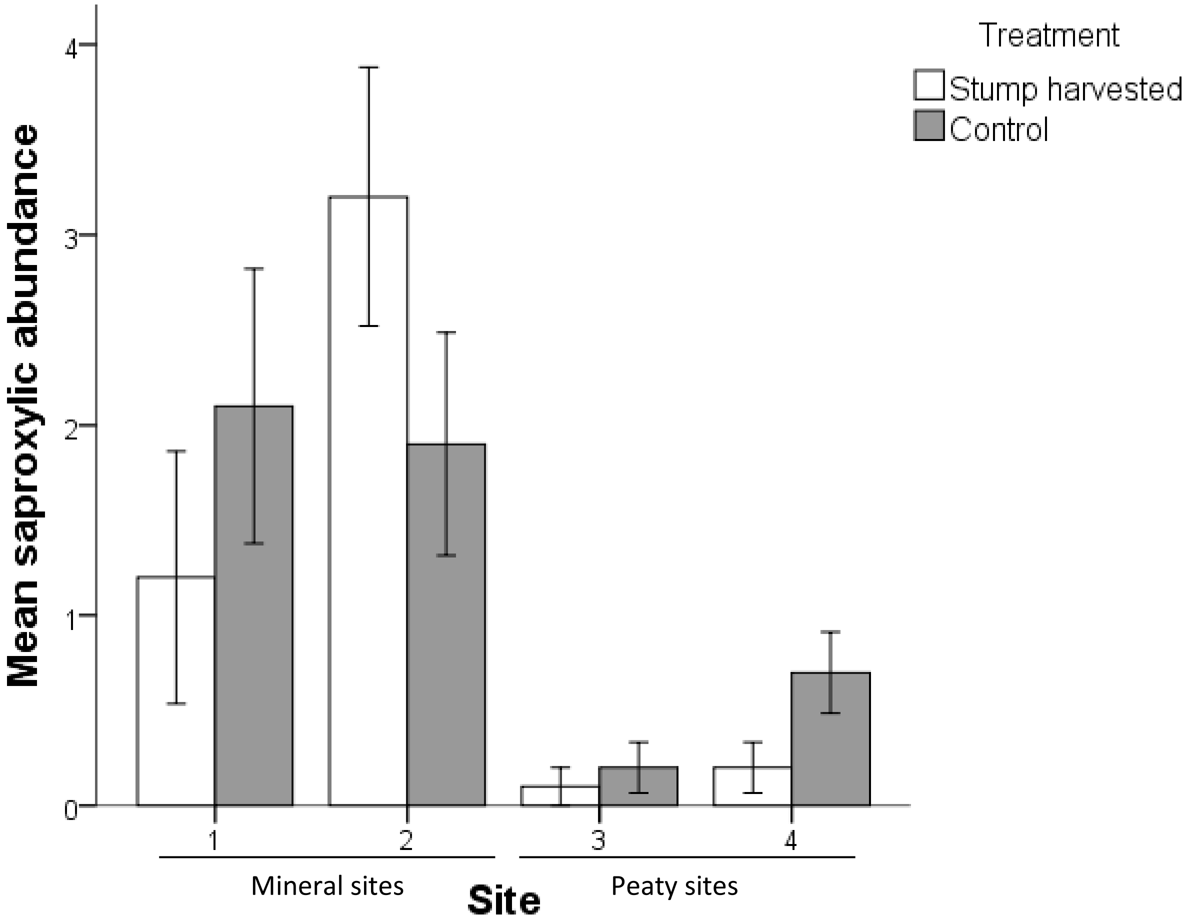

Mean carabid species richness
0
2
4
6
8
10
Treatment
stump harvested
control
1
2
3
4
Mineral sites
Peaty sites
Site

Fig 3 (a)



Treatment
Stump harvested
Control
Mean saproxylic abundance
0
1
2
3
4
1
2
3
4
Mineral sites
Site
Peaty sites

Fig 3 (b)

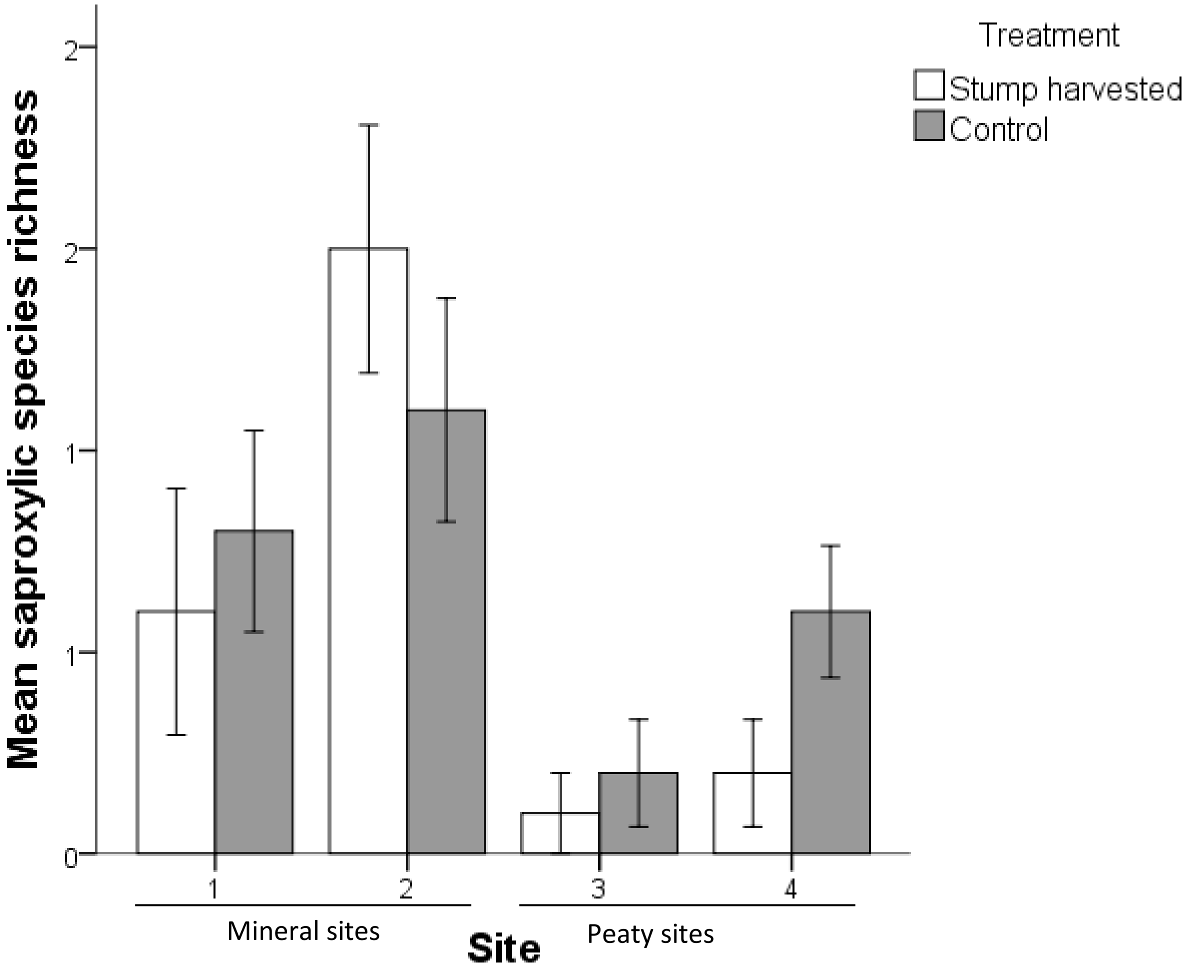

Treatment
☐ Stump harvested
▨ Control
Mean saproxylic species richness
2
2
1
1
0
1
2
3
4
Mineral sites
Peaty sites
Site

Fig 4 (a)

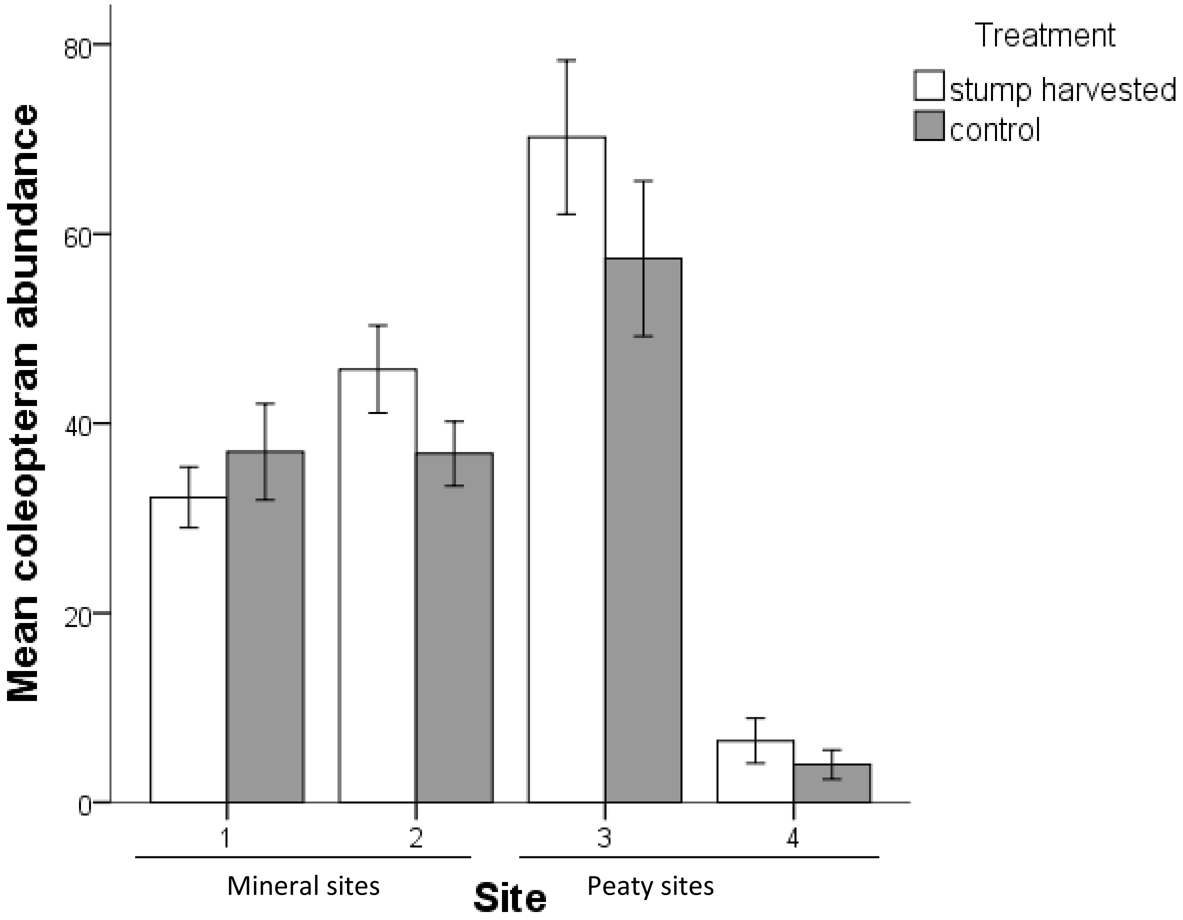
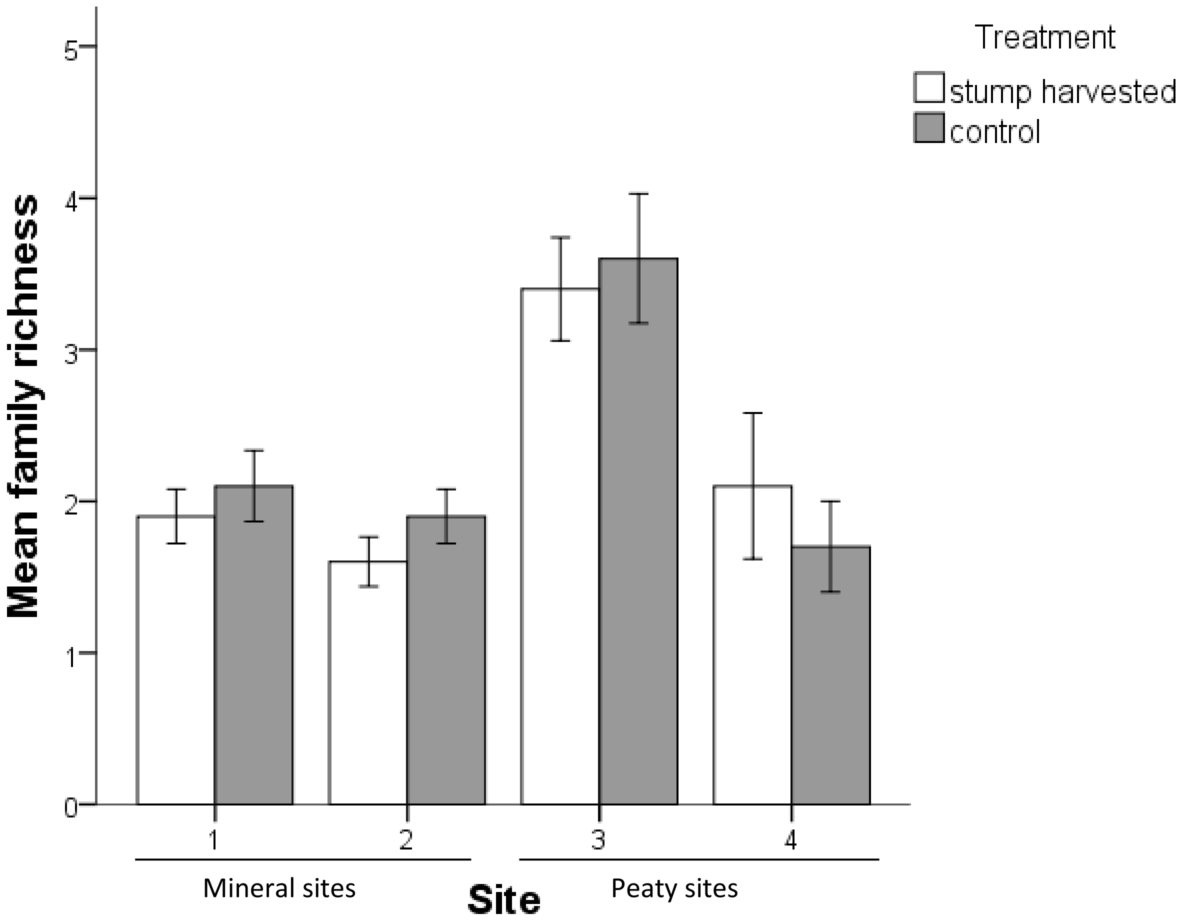
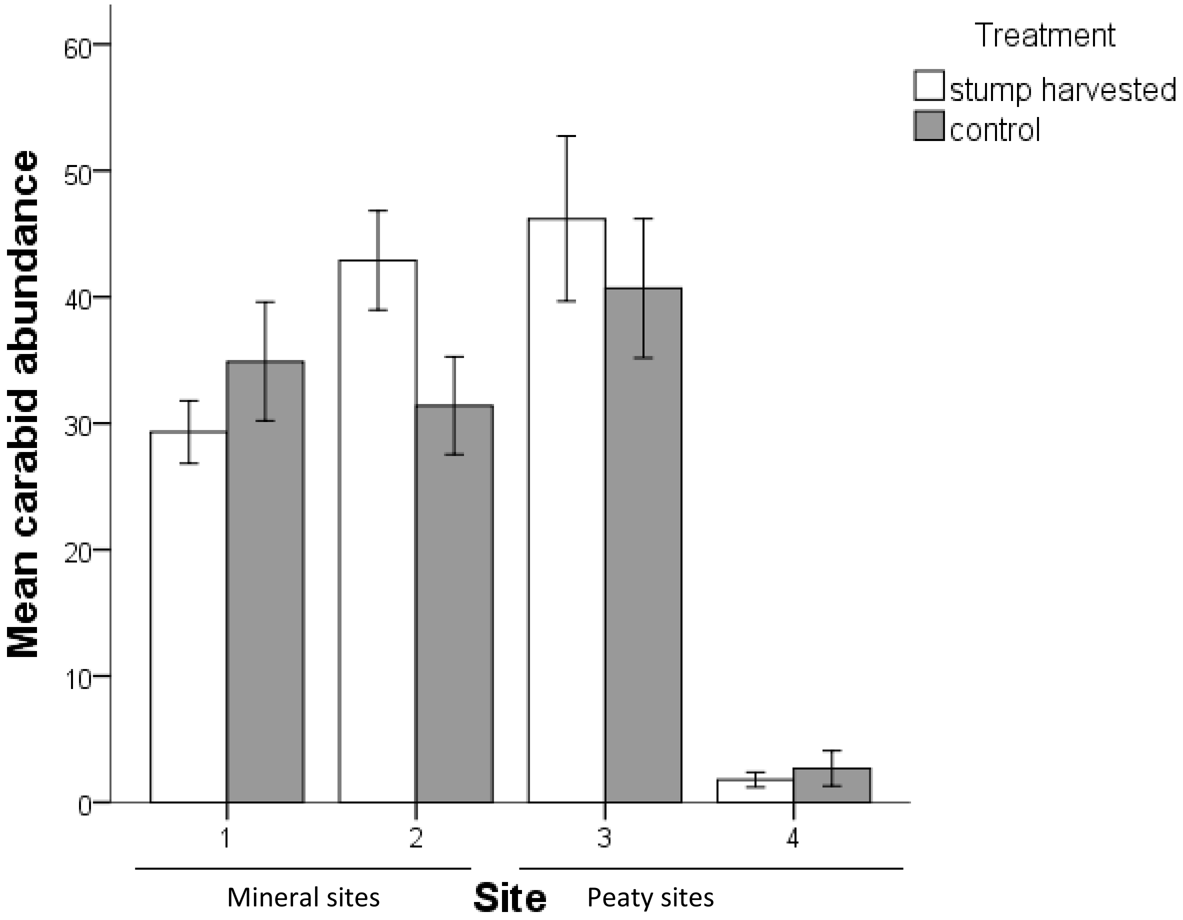

Treatment
stump harvested
control
Mean coleopteran abundance
80
60
40
20
0
1
2
3
4
Mineral sites
Peaty sites
Site

Fig 4 (b)



Treatment
stump harvested
control
Mean family richness
0
1
2
3
4
5
1
2
3
4
Mineral sites
Site
Peaty sites

Fig 5 (a)



Treatment
stump harvested
control
Mean carabid abundance
60
50
40
30
20
10
0
1
2
3
4
Mineral sites
Site
Peaty sites

Fig 5 (b)

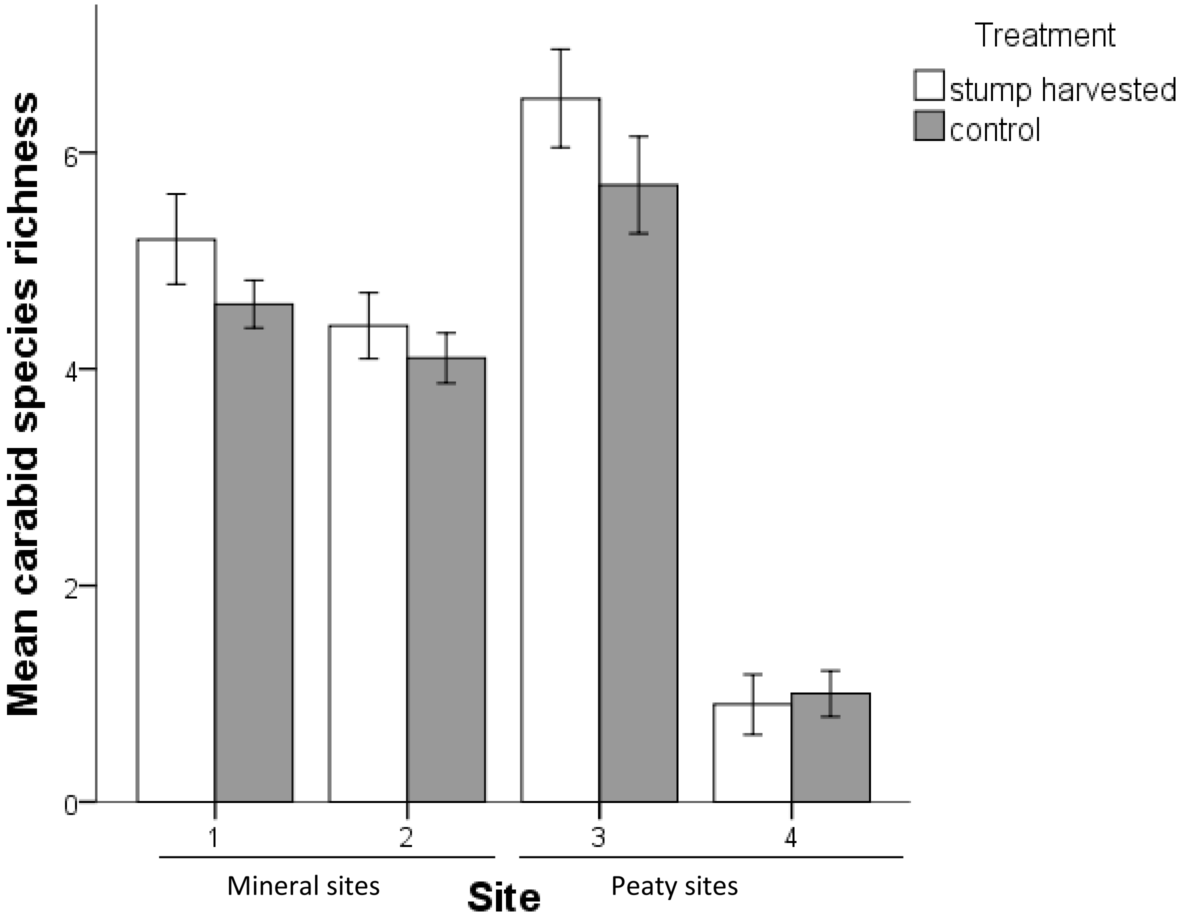
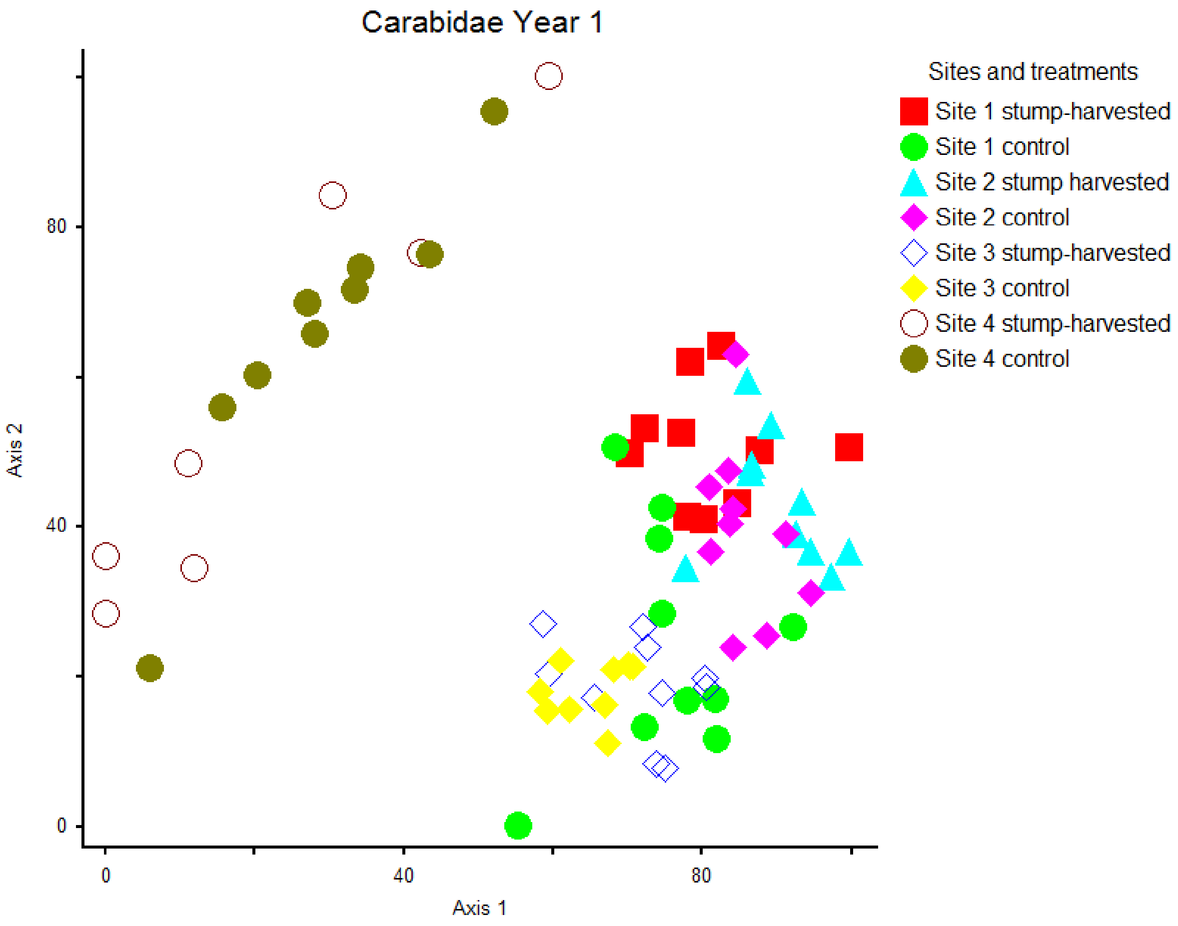
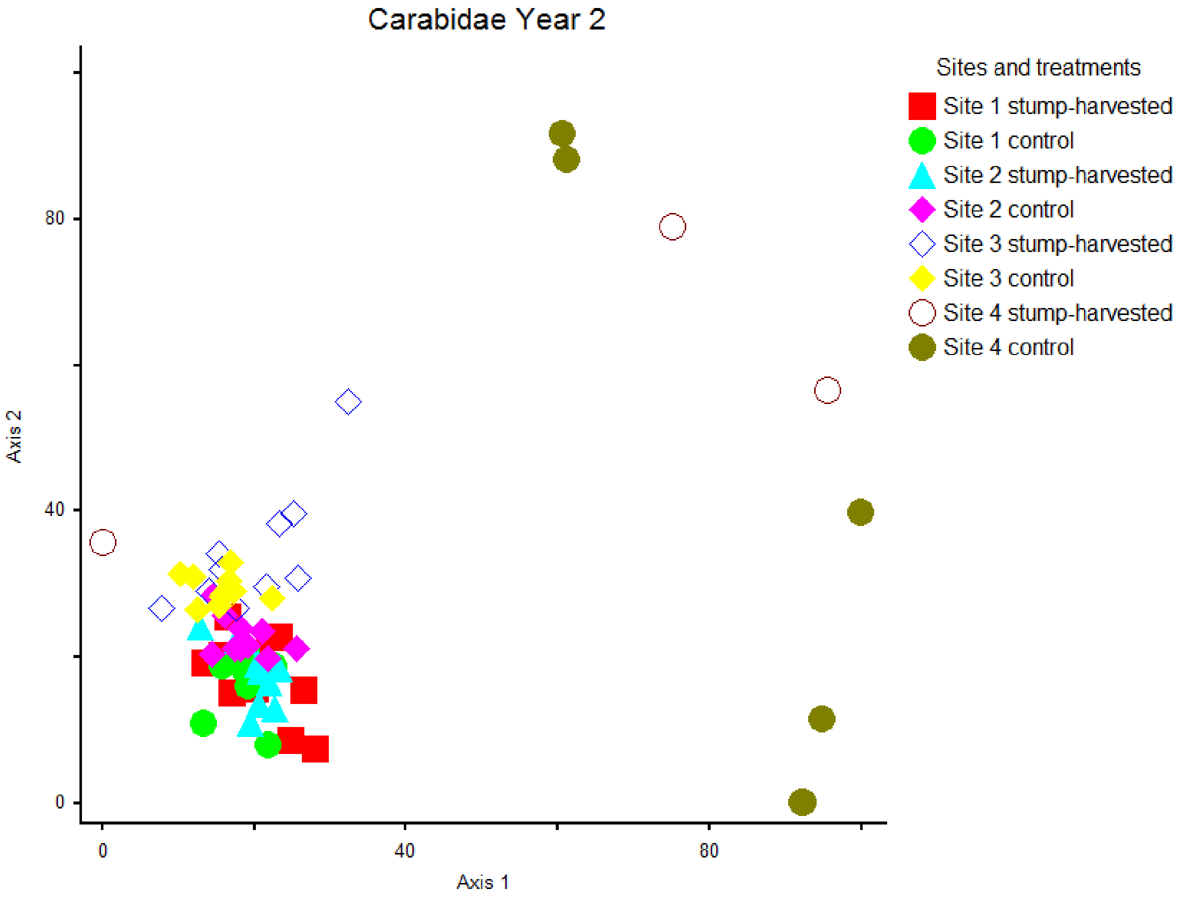

Treatment
stump harvested
control
Mean carabid species richness
6
4
2
0
1
2
3
4
Mineral sites
Site
Peaty sites

Fig 6 (a)



Carabidae Year 1

Fig 6 (b)


Carabidae Year 2
Axis 2
Axis 1
0
40
80
0
40
80
Sites and treatments
Site 1 stump-harvested
Site 1 control
Site 2 stump-harvested
Site 2 control
Site 3 stump-harvested
Site 3 control
Site 4 stump-harvested
Site 4 control

Appendix 1: Abundance of families of Coleoptera collected at each trap (Year 1)

Trap no.	Biphyllidae	Byrrhidae	Carabidae	Cerylonidae	Chrysomelidae	Coccinellidae	Curculionidae	Dytiscidae	Elateridae	Endomychidae	Helodidae	Hydrophilidae	Latridiidae	Leiodidae	Ptiliidae	Rhizophagidae	Scolytidae	Silphidae	Staphylinidae	Unknown family	TOTAL
Site 1 Stump-harvested																					
1	0	0	48	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	3	0	54
2	0	0	65	0	0	0	1	0	0	0	1	1	0	0	0	0	0	2	3	0	73
3	0	0	18	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	3	0	28
4	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	36
5	0	0	76	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0	84
6	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	87
7	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	52
8	0	0	42	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	43
9	0	0	99	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	5	0	109
10	0	0	62	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	12	0	77
Site 1 Control																					
11	0	0	38	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	9	0	49
12	0	0	25	0	0	0	2	1	0	0	0	0	0	0	0	0	0	7	6	0	41
13	0	0	6	0	0	0	7	0	0	0	0	1	0	0	0	0	0	2	3	0	19
14	0	0	34	0	0	0	0	0	0	0	0	3	0	0	0	0	0	5	4	0	46
15	0	0	25	0	0	0	6	0	0	0	0	0	0	0	0	0	0	2	1	0	34
16	0	0	42	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	12	0	56
17	0	0	34	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	10	0	46
18	0	0	40	0	0	0	2	0	0	0	0	1	0	0	0	1	0	2	13	0	59
19	0	0	42	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	3	0	49
20	0	0	32	0	0	0	4	0	0	0	0	1	0	0	0	0	0	3	4	0	44
Site 2 Stump-harvested																					
21	0	0	68	0	0	0	3	0	0	0	0	0	0	0	0	0	2	0	1	0	74
22	0	0	165	1	0	0	4	0	0	0	0	1	0	0	0	0	1	2	1	0	175
23	0	0	18	1	0	0	9	0	0	0	0	0	0	0	0	0	0	1	1	1	31
24	0	0	38	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	42
25	0	0	66	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	73
26	0	0	74	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	6	0	83
27	2	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	31
28	0	0	67	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	1	0	72
29	0	0	51	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	3	0	58
30	0	0	56	0	0	0	3	1	0	0	0	0	0	0	0	0	1	0	12	0	73
Site 2 Control																					
31	0	0	101	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	1	0	106
32	0	0	69	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	4	0	75
33	0	0	16	0	1	0	1	0	0	0	0	0	0	0	0	0	0	5	2	0	25
34	0	0	46	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	9	1	58
35	0	0	90	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	2	0	98
36	0	0	61	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	7	0	76
37	0	0	74	1	0	0	1	0	0	0	0	0	0	0	0	0	0	7	7	0	90
38	0	0	99	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	104
39	0	0	78	0	0	0	5	0	0	0	0	0	0	0	0	0	0	2	0	0	85
40	0	0	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	93
Site 3 Stump-harvested																					
41	0	0	29	1	0	0	0	2	0	0	0	0	0	0	0	0	0	3	7	5	47
42	0	0	20	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	22

43	0	0	61	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	3	0	66
44	0	0	103	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	2	0	113
45	0	0	99	0	0	0	0	2	0	0	0	0	0	0	7	0	0	0	10	0	118
46	0	0	55	0	0	0	0	1	0	0	1	2	0	2	0	0	0	0	20	0	81
47	0	0	105	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	3	0	115
48	0	0	62	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	66
49	0	0	42	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	0	48
50	0	0	80	0	0	0	1	2	0	0	0	6	0	0	0	0	0	2	4	0	95
Site 3																					
Control																					
51	0	0	68	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	22	0	97
52	0	0	54	0	0	0	0	2	0	0	0	1	0	0	0	0	0	11	6	0	74
53	0	0	75	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	12	0	89
54	0	0	125	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	3	0	130
55	0	2	87	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	3	0	96
56	0	0	101	2	1	0	1	0	0	0	0	1	0	0	0	0	0	2	2	0	110
57	0	0	35	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	0	40
58	0	0	73	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	77
59	0	0	89	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	4	0	97
60	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	56
Site 4																					
Stump-harvested																					
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
62	0	0	8	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	11
63	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	7
64	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
65	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	7
66	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	3
67	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	10
68	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	12
69	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	9
70	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0	8
Site 4																					
Control																					
71	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	1	0	3	0	0	7
72	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	6
73	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	22
74	0	0	6	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8
75	0	0	18	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	3	0	24
76	0	0	31	0	0	0	0	0	0	0	0	9	0	0	0	2	0	0	1	0	43
77	0	0	3	0	1	0	0	1	0	0	0	12	1	0	0	0	0	0	0	0	18
78	0	0	21	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	3	0	30
79	0	0	8	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	12
80	0	0	10	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	3	1	16
Family totals:	2	2	3811	7	7	0	125	15	1	1	3	74	1	3	8	8	7	122	296	10	

Appendix 2: Abundance of families of Coleoptera collected at each trap (Year 2)

Trap no.	Carabidae	Silphidae	Staphylinidae	Hydrophilidae	Dytiscidae	Curculionidae	Chrysomelidae	Coccinellidae	Cantharidae	Colydiidae	Total
Site 1 Stump-harvested											
1	20	1	0	0	0	0	0	0	0	0	21
2	34	0	0	0	0	0	0	0	0	0	34
3	42	10	1	0	0	0	0	0	0	0	53
4	38	0	1	0	0	0	0	0	0	0	39
5	32	0	1	0	0	0	0	0	0	0	33
6	22	0	2	0	0	0	0	0	0	0	24
7	28	0	1	0	0	0	0	0	0	0	29
8	19	0	1	0	0	0	0	0	0	0	20
9	40	0	1	0	0	0	0	0	0	0	41
10	28	0	0	0	0	0	0	0	0	0	28
Site 1 Control											
11	23	1	1	0	0	0	0	0	0	0	25
12	46	1	1	0	0	0	0	0	0	0	48
13	58	9	0	0	0	0	0	0	0	0	67
14	33	0	1	0	0	0	0	0	0	0	34
15	34	0	2	0	0	0	0	0	0	0	36
16	16	1	1	0	0	0	0	0	0	0	18
17	29	0	0	0	0	0	0	0	0	0	29
18	21	0	2	0	0	0	0	0	0	0	23
19	59	0	0	0	0	0	0	0	0	0	59
20	30	0	1	0	0	0	0	0	0	0	31
Site 2 Stump-harvested											
21	37	0	1	0	0	0	0	0	0	0	38
22	46	19	0	0	0	0	0	0	0	0	65
23	27	0	0	0	0	0	0	0	0	0	27
24	33	0	0	0	0	0	0	1	0	0	34
25	60	4	0	0	0	0	0	0	0	0	64
26	64	0	0	0	0	0	0	0	0	0	64
27	46	0	0	0	0	0	0	0	0	0	46
28	38	2	0	0	0	0	0	0	0	0	40
29	49	0	1	0	0	0	0	0	0	0	50
30	29	0	0	0	0	0	0	0	0	0	29
Site 2 Control											
31	31	0	1	0	0	0	0	0	0	0	32
32	18	0	0	0	0	0	0	0	0	0	18
33	42	6	0	0	0	0	0	0	0	0	48
34	30	8	0	0	0	0	0	0	0	0	38
35	49	2	0	0	0	0	0	0	0	0	51
36	24	3	1	0	0	0	0	0	0	0	28

37	45	0	3	0	0	0	0	0	0	0	48
38	39	0	0	0	0	0	0	0	0	0	39
39	25	15	0	0	0	0	0	0	0	0	40
40	11	15	0	0	0	0	0	0	0	0	26
Site 3 Stump-harvested											
41	87	5	3	0	0	0	0	0	0	0	95
42	50	6	3	0	0	0	0	0	0	0	59
43	19	1	13	0	0	0	0	0	0	0	33
44	36	9	20	0	0	0	0	0	0	0	65
45	37	15	23	8	1	0	0	0	0	0	84
46	32	10	47	3	5	0	0	0	0	0	97
47	60	9	10	2	0	0	0	0	0	0	81
48	24	0	6	0	0	0	0	0	0	0	30
49	53	0	4	0	0	0	0	0	0	0	57
50	64	13	23	0	1	0	0	0	0	0	101
Site 3 Control											
51	47	20	8	3	3	0	0	0	0	0	81
52	59	1	0	1	0	0	0	0	0	0	61
53	19	3	5	1	0	0	0	0	0	0	28
54	63	8	32	2	0	0	0	0	0	0	105
55	24	0	7	0	0	0	0	0	0	0	31
56	57	4	3	2	0	0	0	0	0	0	66
57	19	10	6	1	1	0	0	0	0	0	37
58	59	5	13	1	3	0	0	0	0	0	81
59	26	22	0	1	0	0	0	0	0	0	49
60	35	0	0	0	0	0	0	0	0	0	35
Site 4 Stump-harvested											
61	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0
63	2	0	0	1	0	0	0	0	0	0	3
64	1	16	3	0	0	0	1	0	0	0	21
65	1	0	1	0	0	0	0	0	0	0	2
66	5	0	1	1	1	0	0	0	0	0	8
67	2	0	0	0	2	0	0	0	0	0	4
68	1	0	0	0	0	0	0	0	0	0	1
69	4	0	9	3	0	0	0	0	2	0	18
70	4	0	0	0	4	0	0	0	0	0	8
Site 4 Control											
71	2	0	0	0	0	1	0	0	0	0	3
72	1	0	0	0	0	0	0	0	0	0	1
73	2	0	0	0	0	0	0	0	0	0	2
74	2	0	2	0	0	1	0	0	0	0	5
75	0	0	0	0	2	2	0	0	0	1	5
76	0	0	0	0	0	0	0	0	0	0	0
77	3	0	0	0	0	1	0	0	0	0	4
78	1	0	0	0	0	1	0	0	0	0	2
79	15	0	0	2	0	0	0	0	0	0	17
80	1	0	0	0	0	0	0	0	0	0	1

Appendix 3: Abundance of species of Carabidae collected at each trap (Year 1)

Trap no.	Abax paralellepipedus	Agonum emargiuatum	Agonum fuliginosum	Agonum muelleri	Agonum viduum	Bembidion lampros	Bembidion tibale	Cychrus caraboides	Clivina fossor	Carabus granulatus	C.alathus melanocephalus	Carabus problematicus	Elaphrus cupreus	Loricera pilicornis	Leistus terminatus	Miscodera arctica	Notiophilus biguttatus	Nebria brevicollis	Paranchus albipes	Pterostichus madidus	Pterostichus melanarius	Pterostichus niger	Pterostichus nigrita	Pterostichus vernalis	Trechus obtusus	Trechus secalis	T.rechus quadrastriatus	Unknown	Total
Site 1																													
Stump-harvested																													
1	13	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	3	0	0	9	0	2	0	0	0	3	0	0	33
2	21	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	15	0	7	5	0	3	1	0	0	59
3	2	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	11
4	4	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	1	0	0	6	1	2	0	0	0	0	0	0	20
5	8	0	0	0	0	0	0	0	0	6	0	0	0	1	1	0	5	0	0	6	0	6	0	0	0	0	0	0	33
6	3	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	5	0	15	0	0	0	0	0	0	26
7	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	2	0	5	0	0	0	1	0	0	17
8	4	0	0	0	0	0	0	0	0	13	0	0	0	1	0	0	3	1	0	8	0	5	0	0	0	0	0	0	35
9	7	0	0	0	0	1	0	0	0	18	0	0	0	0	0	0	0	0	0	10	1	17	0	0	0	0	0	0	54
10	8	0	0	0	0	3	1	1	0	4	0	0	0	0	0	0	2	0	0	4	0	10	0	0	0	2	0	0	35
Site 1																													
Control																													
11	7	0	1	0	0	3	2	0	0	2	0	0	0	1	0	0	0	0	0	5	0	15	0	0	0	0	0	0	36
12	7	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	4	0	4	0	0	0	0	0	0	18
13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	6
14	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8	0	0	0	1	0	0	21
15	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	3	0	0	17
16	7	0	0	0	0	0	0	0	0	3	1	0	0	2	0	0	0	0	1	11	0	10	0	0	0	0	1	0	36
17	12	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	7	0	0	0	1	0	0	23
18	3	0	0	0	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	1	3	0	0	0	11	0	1	23
19	13	0	0	0	0	0	0	0	0	7	0	0	0	3	0	0	0	0	0	1	3	8	0	0	0	2	0	0	37
20	10	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	13	0	0	0	8	0	0	34
Site 2																													

Stump-harvested																													
21	19	0	0	0	0	0	0	0	0	23	0	0	0	1	0	0	1	0	0	5	0	13	0	0	0	0	3	0	65
22	29	0	0	0	0	0	0	0	0	48	0	0	0	4	1	0	1	0	0	5	0	39	0	1	0	0	0	0	128
23	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	12
24	4	0	0	0	0	1	0	0	0	11	0	0	0	1	0	0	2	0	0	3	0	12	0	0	0	0	0	0	34
25	9	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	57
26	14	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	1	0	0	48
27	5	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	2	0	9	0	0	0	0	0	0	21
28	4	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	1	0	19	0	0	0	0	0	0	37
29	5	0	0	0	0	0	1	0	0	12	0	0	0	0	0	0	0	0	0	5	3	11	0	0	0	0	0	0	37
30	2	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	2	0	0	3	0	8	0	0	0	0	0	0	24
Site 2																													
Control																													
31	29	0	0	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	8	0	17	0	0	0	0	0	1	67
32	18	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	14	0	13	0	0	0	0	0	0	57
33	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0	0	0	0	15
34	11	0	0	0	0	0	0	0	0	9	0	0	0	1	0	0	0	0	0	10	0	15	0	0	0	0	0	0	46
35	25	0	0	0	0	0	0	2	0	14	0	0	0	0	0	0	0	0	0	10	0	14	0	0	0	0	0	0	65
36	8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	12	0	0	0	0	0	0	23
37	19	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	0	0	7	0	17	0	0	0	0	0	0	56
38	20	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	5	0	22	0	0	1	0	0	0	70
39	12	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	21
40	13	0	1	0	0	0	0	2	0	22	0	0	0	0	0	0	0	0	0	0	1	38	0	1	0	0	0	0	78
Site 3																													
Stump-harvested																													
41	4	0	0	0	0	0	2	0	1	2	0	1	0	0	0	0	0	0	0	1	1	9	2	0	0	3	0	0	26
42	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	8
43	4	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3	2	25	0	0	0	9	0	0	45
44	3	0	1	1	1	0	3	0	1	1	0	0	1	2	0	0	0	0	0	4	7	41	1	0	0	15	0	0	82
45	11	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	1	5	35	0	0	0	32	0	0	87
46	9	0	0	0	0	0	2	0	0	4	0	1	0	1	0	0	0	0	0	2	4	20	1	0	0	5	0	0	49

47	19	0	0	0	1	0	0	0	0	8	0	2	0	0	0	0	0	0	0	0	7	43	2	0	0	6	0	0	88
48	13	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	1	0	0	1	4	28	0	0	0	1	0	0	52
49	4	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	20	3	0	0	1	0	0	33
50	5	0	0	0	0	0	4	0	0	3	0	0	2	2	0	0	0	0	0	1	5	23	13	0	0	7	0	0	65
Site 3																													
Control																													
51	36	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	4	5	5	0	0	1	0	0	55
52	24	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	5	9	2	0	0	2	0	0	48
53	36	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0	2	6	3	1	0	0	4	0	0	57
54	45	0	0	0	0	0	0	1	0	0	0	3	1	5	0	0	1	0	0	1	2	10	0	0	0	3	0	0	72
55	32	0	0	0	0	0	0	1	0	2	0	2	0	7	0	0	2	0	0	1	3	13	1	0	0	0	0	0	64
56	30	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	8	1	0	0	4	7	0	0	0	4	0	0	58
57	18	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	24
58	35	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	2	0	0	0	3	8	0	0	0	1	0	0	53
59	17	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	1	2	0	3	3	16	0	0	0	1	0	0	49
60	17	0	0	0	0	0	0	0	0	1	0	5	0	1	0	0	0	0	0	0	9	9	0	0	0	1	0	0	43
Site 4																													
Stump-harvested																													
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	8
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
64	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
65	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
66	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
68	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	1	1	0	0	0	0	0	0	0	11
69	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Site 4																													
Control																													
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2

72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
73	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	1	0	0	5	0	0	1	0	0	0	0	0	16
74	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2	0	0	0	0	0	4
75	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	5	0	0	11	0	0	0	0	0	18
76	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	1	0	0	0	0	0	23	0	0	0	0	0	31
77	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3
78	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	4	0	0	9	2	0	3	0	0	0	0	0	21
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	0	0	0	8
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	3	1	0	0	0	0	0	0	0	10
Total	770	1	3	1	2	11	16	8	4	388	2	31	15	86	4	1	66	7	1	229	93	777	82	2	4	131	4	2	

Appendix 4: Abundance of species of Carabidae collected at each trap (Year 2)

trap no.	Carabus granulatus	Abax parallelepipedus	Pterostichus niger	Pterostichus madidus	Loricera pilicornis	Cychrus caraboides	Leistus terminatus	Trechus rubens	Pterostichus melanarius	Pterostichus rhaeticus	Carabus problematics	Nebria brevicollis	Pterostichus aethiops	Bembidion lampros	Notiophilus biguttatus	Total abundance
Site 1																
Stump-harvested																
1	7	3	9	0	0	0	0	0	0	0	0	1	0	0	0	20
2	6	8	9	0	0	0	0	0	0	0	0	11	0	0	0	34
3	5	12	21	1	0	0	0	0	0	0	0	3	0	0	0	42
4	7	8	4	2	1	0	1	0	0	0	0	5	0	0	0	28
5	6	9	12	2	1	1	0	0	0	0	0	1	0	0	0	32
6	1	7	13	1	0	0	0	0	0	0	0	0	0	0	0	22
7	9	5	7	1	0	0	1	1	0	0	0	4	0	0	0	28
8	2	10	2	2	0	0	0	0	0	0	0	3	0	0	0	19
9	6	13	11	1	0	0	0	0	0	0	0	9	0	0	0	40
10	6	16	2	0	0	0	0	0	0	0	0	4	0	0	0	28
Site 1																
Control																
11	6	9	6	2	0	0	0	0	0	0	0	0	0	0	0	23
12	7	20	17	1	0	0	0	0	0	0	0	1	0	0	0	46
13	7	16	25	0	0	0	0	0	0	0	0	10	0	0	0	58
14	5	11	14	2	0	0	0	0	0	0	0	1	0	0	0	33
15	2	10	7	2	0	1	0	0	0	0	0	12	0	0	0	34
16	2	2	4	0	0	0	0	0	0	0	0	8	0	0	0	16
17	5	11	8	0	0	0	0	0	0	0	0	5	0	0	0	29
18	3	10	7	1	0	0	0	0	0	0	0	0	0	0	0	21
19	6	23	24	5	0	0	0	0	0	0	0	1	0	0	0	59
20	7	8	11	1	0	0	0	0	0	0	0	3	0	0	0	30
Site 2																
Stump-harvested																
21	7	16	11	1	0	0	0	1	0	0	0	1	0	0	0	37
22	7	28	11	0	0	0	0	0	0	0	0	0	0	0	0	46
23	4	14	5	1	0	0	0	0	0	0	0	3	0	0	0	27
24	3	22	8	0	0	0	0	0	0	0	0	0	0	0	0	33
25	19	19	21	0	0	0	0	0	0	0	0	1	0	0	0	60
26	15	19	27	1	2	0	0	0	0	0	0	0	0	0	0	64
27	7	17	17	4	0	0	0	0	0	0	0	1	0	0	0	46
28	8	19	9	1	0	0	0	0	0	0	0	1	0	0	0	38
29	8	8	32	0	0	0	0	0	0	0	0	1	0	0	0	49
30	4	11	10	4	0	0	0	0	0	0	0	0	0	0	0	29
Site 2																
Control																
31	6	7	13	2	0	0	0	0	0	0	0	3	0	0	0	31
32	8	5	5	0	0	0	0	0	0	0	0	0	0	0	0	18
33	8	14	19	1	0	0	0	0	0	0	0	0	0	0	0	42
34	6	10	10	4	0	0	0	0	0	0	0	0	0	0	0	30
35	11	9	24	5	0	0	0	0	0	0	0	0	0	0	0	49

36	7	3	13	1	0	0	0	0	0	0	0	0	0	0	0	24
37	4	14	25	1	1	0	0	0	0	0	0	0	0	0	0	45
38	10	12	15	2	0	0	0	0	0	0	0	0	0	0	0	39
39	10	2	13	0	0	0	0	0	0	0	0	0	0	0	0	25
40	2	2	4	2	0	1	0	0	0	0	0	0	0	0	0	11
Site 3 Stump-harvested																
41	19	7	49	1	0	0	2	1	5	3	0	0	0	0	0	87
42	9	1	22	0	0	0	0	0	2	16	0	0	0	0	0	50
43	11	0	1	0	0	0	0	0	1	6	0	0	0	0	0	19
44	17	1	10	4	0	0	0	0	0	2	1	0	1	0	0	36
45	20	3	5	0	0	0	1	0	3	4	0	0	1	0	0	37
46	8	4	11	1	0	0	1	0	2	4	1	0	0	0	0	32
47	18	9	26	1	0	0	0	0	3	1	1	0	0	0	0	59
48	1	3	17	0	0	0	1	1	1	0	0	0	0	0	0	24
49	7	2	33	1	0	0	0	2	2	6	0	0	0	0	0	53
50	24	1	34	1	0	0	0	0	0	4	0	0	0	0	0	64
Site 3 Control																
51	9	5	28	0	0	0	0	1	1	0	1	0	0	0	0	45
52	32	1	25	0	0	0	0	0	0	1	0	0	0	0	0	59
53	7	2	9	0	0	0	0	0	1	0	2	0	0	0	0	21
54	24	6	27	0	0	0	0	2	0	0	1	0	0	0	0	60
55	3	1	17	0	0	0	0	0	0	1	2	0	0	0	0	24
56	13	7	26	0	0	0	0	3	0	2	5	0	0	0	0	56
57	5	1	8	0	0	0	1	1	0	1	1	1	0	0	0	19
58	22	6	21	0	0	0	0	1	1	0	7	0	0	0	0	58
59	8	0	16	0	0	0	0	0	0	0	1	0	0	1	0	26
60	17	6	8	0	0	0	0	0	1	0	3	0	0	0	0	35
Site 4 Stump-harvested																
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
64	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5
67	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
68	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
69	0	0	0	0	1	0	0	0	0	2	0	0	0	0	1	4
70	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Site 4 Control																
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
72	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
73	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
74	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	3
78	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
79	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0	15
80	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1

Appendix 5: Abundance of saproxylics collected at each trap (Year 1). Year 2 saproxylics are not shown because there was only one species (Hylobius abietis) and all six individuals were collected in control traps.

Trap no.	Agathidium marginatum	Barypithes araneiformis	Barypithes pellucidus	Dolopius marginatus	Helodes minuta	Hylastes ater	Hylobius abietis	Hylurgops palliatus	Liparus coronatus	Nargus wilkli	Otiorrhynchus singularis	Strophosomus melanogrammus	Totals
Site 1 Stump-harvested													
1	0	0	0	0	0	1	0	1	0	0	0	0	2
2	0	1	0	0	0	0	0	0	0	0	0	0	1
3	0	3	0	0	0	0	2	0	0	0	0	2	7
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	2	0	0	0	0	0	0	0	0	0	0	2
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	0	0	0	0	0	1
9	0	4	0	0	0	0	0	0	0	0	0	0	4
10	0	0	0	0	0	0	0	0	0	0	0	0	0
Site 1 Control													
11	0	1	0	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	5	0	0	0	0	0	0	0	0	0	2	7
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	6	0	0	0	0	0	0	0	0	0	0	6
16	0	1	0	0	0	0	0	0	0	0	0	0	1
17	0	1	0	0	0	0	0	0	0	0	0	0	1
18	0	2	0	0	0	0	0	0	0	0	0	0	2
19	0	3	0	0	0	0	0	0	0	0	0	1	4
20	0	4	0	0	0	0	0	0	0	0	0	0	4
Site 2 Stump-harvested													
21	0	3	0	0	0	1	0	1	0	0	0	0	5
22	0	4	0	0	0	1	0	0	0	0	0	0	5
23	0	7	0	0	0	0	1	0	0	0	0	1	9
24	0	2	0	0	0	0	1	0	0	0	0	0	3
25	0	4	0	0	0	0	1	0	0	0	0	0	5
26	0	2	0	0	0	0	0	0	0	0	0	0	2
27	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	3	0	0	0	0	0	0	0	0	0	0	3
29	0	2	0	0	0	0	1	0	0	0	1	0	4

30	0	2	0	0	0	1	0	0	0	0	0	0	3
Site 2 Control													
31	0	1	0	0	0	0	0	0	0	0	1	1	3
32	0	1	0	0	0	0	0	0	0	0	0	0	1
33	0	0	0	0	0	0	1	0	0	0	0	0	1
34	0	1	0	0	0	0	0	0	0	0	0	0	1
35	0	5	0	0	0	0	0	0	0	0	1	0	6
36	0	4	0	0	0	0	0	0	0	0	0	2	6
37	0	1	0	0	0	0	0	0	0	0	0	0	1
38	0	4	0	0	0	0	0	0	0	0	0	0	4
39	0	4	0	0	0	0	0	0	0	0	1	0	5
40	0	0	0	0	0	0	0	0	0	0	0	0	0
Site 3 Stump-harvested													
41	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	1	0	0	0	0	0	0	0	0	0	0	1
44	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	2	0	0	2
47	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	1	0	0	0	0	0	0	1
49	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	1	0	0	0	0	0	0	0	0	0	0	1
Site 3 Control													
51	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	1	0	0	0	0	0	1
54	0	1	0	0	0	0	0	0	0	0	0	0	1
55	0	0	1	0	0	0	0	0	0	0	0	0	1
56	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	1	0	0	0	0	0	1
58	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	1	0	0	0	0	1	0	0	0	2
60	0	0	0	0	0	0	0	0	0	0	0	0	0
Site 4 Stump-harvested													
61	0	0	0	0	1	0	0	0	0	0	0	0	1
62	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	1	0	0	0	0	1
66	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	1	0	0	0	0	0	0	0	1
Site 4 Control													
71	0	0	0	0	1	0	0	0	0	0	0	0	1
72	1	0	0	0	0	0	0	0	0	0	0	0	1

73	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	1	0	0	0	0	1
76	0	0	0	0	2	0	0	0	0	0	0	0	2
77	0	0	0	0	1	0	0	0	0	0	0	0	1
78	0	0	0	0	0	0	1	0	0	0	0	0	1
79	0	0	0	0	0	0	1	0	0	0	0	0	1
80	0	0	0	0	1	0	0	0	0	0	0	0	1