Transactions of the Illinois State Academy of Science
(1996), Volume 89, 1 and 2, pp. 25-36

Impact of Dormant Season Herbicide Treatment on the Alien Herb Garlic Mustard (*Alliaria petiolata* [Bieb.] Cavara and Grande) and Groundlayer Vegetation

Victoria A. Nuzzo
NATIVE LANDSCAPES
1947 Madron Road
Rockford IL 61107

ABSTRACT

Experimental control of *Alliaria petiolata* was conducted in three sites over two years, testing three herbicides at various concentrations, and monitoring response of both *A. petiolata* and groundlayer flora. Glyphosate (trade name Roundup) significantly reduced *A. petiolata* by >93% when applied at 1% and 2%, but not at 0.5%, concentrations. Glyphosate at all concentrations had little effect on herbaceous species, which were primarily dormant at the time of application, but at 0.5% concentration significantly reduced cover of sedges (*Carex jamesii* and *C. laxiflora*) from a pretreatment mean of 13.1% to a post-treatment mean of 2.2%. Bentazon (trade name Basagran) non-significantly reduced *A. petiolata* cover by >90% (compared to a 70% reduction in the control plots) when applied at 0.56 kg and 1.12 kg AI/ha. Bentazon did not affect cover of groundlayer species, nor species density. Acifluorfen (trade name Blazer) killed all *A. petiolata*, inhibited *A. petiolata* seedling germination, and significantly reduced cover of native herbs by >70%, and appeared to have a strong soil residual.

INTRODUCTION

Alien species threaten the integrity of natural areas (Drake et al. 1989, Wagner 1993), and are often implicated in the loss of native flora (Mack 1989, Mooney and Drake 1986). Attempts to reduce or eliminate alien species with herbicides poses risks to the natural community, as both target and non-target species may be damaged. The decision to use an herbicide is based on the real or potential threat posed by the alien species, anticipated reduction in the target alien species following treatment, and sensitivity of non-target native flora to the herbicide. In general, little is known about the response of native vegetation to various herbicides.

In the Midwest, the alien biennial herb garlic mustard (*Alliaria petiolata* [Bieb.] Cavara & Grande; hereafter referred to as *Alliaria*) is considered a severe threat in deciduous forests (Nuzzo 1994a, White et al. 1993). This cool-season herb overwinters as a basal rosette, and continues to grow on snow-free days when temperatures are above freezing (Cavers et al. 1979). Thus, control efforts are usually conducted in late fall and early spring, when *Alliaria* is physiologically active and most native species are dormant.

Research indicates that a 3% glyphosate spray is an effective dormant season control agent for *A. petiolata* (Nuzzo 1991). Fall treatment significantly reduced adult density the following June, while spring treatment significantly reduced both adult density and seedling frequency in June, as treatment was conducted during the period of germination. Impact on native herbs was not monitored, but spring treatment appeared to sharply reduce cover of native herbs (Nuzzo pers. obs.). Bentazon reduced *Alliaria* cover by 94%, and acifluorfen reduced *Alliaria* by 34-46%, when applied during the growing season (Nuzzo 1994b).

The impact of these three herbicides on community structure and species composition is unknown. Glyphosate (trade name Roundup) is a non-selective systemic herbicide that kills all vegetation green at the time of application. Bentazon (trade name Basagran) is a post-emergent contact herbicide that targets dicots and some species of sedges (*Cyperaceae*), but does not impact graminoid species. Acifluorfen (trade name Blazer), also a post-emergent contact herbicide, targets dicots and some grass species. Native sedges (*Carex* sp.), forbs that are evergreen or semi-evergreen, and early spring ephemereals that emerge at the same time *Alliaria* seedlings germinate, are potential targets of dormant season treatment with any of these herbicides.

This research was undertaken to 1) investigate the relative effectiveness of three herbicides (glyphosate, bentazon, and acifluorfen) as control agents for *Alliaria*, and 2) to assess the associated herbicide impact on groundlayer community structure.

METHODS

Study sites

Three study sites were selected that had low to moderate infestation of *Alliaria*, natural quality rank of B to C (lightly to moderately disturbed; White and Madany 1978), relatively intact, diverse herbaceous layer, and absence of state or federal endangered or threatened plant species.

Hall Memorial Woods is a 16.2 hectare Grade B dry-mesic and mesic upland forest on the southwest side of Rockford, Winnebago County, Illinois, in the Freeport Section of the Rock River Hill Country Natural Division. The overstory is dominated by slippery elm (*Ulmus rubra*), white oak (*Quercus alba*) and white ash (*Fraxinus americana*), and the sapling layer is dominated by yellowbud hickory (*Carya cordiformis*), basswood (*Tilia americana*) and slippery elm. The understory is moderately dense, and dominated by wild plum (*Prunus americana*). Plots were established in the mesic portion of the forest, in an area dominated by trilliums (*Trillium flexipes* and *T. recurvatum*) in spring, and wild geranium (*Geranium maculatum*) and false solomon seal (*Smilacina racemosa*) in summer.

Maple Grove Forest Preserve is a 20 hectare Grade B mesic upland forest in Downer's Grove Illinois, located in the Morainal Section of the Northeastern Morainal Natural Division. The overstory is dominated by sugar maple (*Acer saccharum*), white ash and white oak. The sapling layer is dominated by sugar maple, and the understory is open

with few shrubs. Groundlayer is composed of spring ephemereals and perennials, which produce moderate cover in spring, and low cover in August.

Pecatonica Bottoms Nature Preserve is a 17 hectare Grade B mesic floodplain forest 23 km northwest of Rockford on the north bank of the Pecatonica River, Winnebago County, Illinois, located within the Freeport Section of the Rock River Hill Country Natural Division. The overstory is dominated by black maple (*Acer nigrum*), basswood, and black walnut (*Juglans nigra*). The understory is very open with few saplings or shrubs, and the groundlayer is extremely rich, with high herbaceous cover throughout the growing season.

Data Collection

Permanent plots (4m x 4m) were established in early spring (after *Alliaria* seedling germination), in areas where *Alliaria* seedlings were fairly abundant and herbaceous flora was diverse. Twelve plots were established in Hall Woods and 12 in Maple Grove in 1990, and 26 in Pecatonica Bottoms in 1991. Four $1m^2$ quadrats were randomly chosen as permanent quadrats within each 16 m^2 plot. Plots were paired on the basis of initial *Alliaria* cover (low and high cover plots paired), and pairs were randomly assigned to receive treatment or control.

Data were collected in May and August the year prior to dormant season treatment, and again the year after treatment. Phenological indicators were recorded, and data were collected at the same phenological date each spring at each site. Collected data consisted of: *Alliaria* adult density, adult cover, and seedling cover, all recorded in May, and rosette cover recorded in August; and presence and percent cover by seven cover classes (<1%, 1-7%, >7-25%, >25-50%, >50-75%, >75-93%, and >93%) of all herbaceous and graminoid species, and all woody species <1m tall, rooted in the quadrat.

Data Analysis

May and August data for all species, excluding *Alliaria*, were combined by overlaying data sheets; the higher cover class assigned to each species within each quadrat was recorded on the master data sheet. Because the quadrats were located in the same positions in May and August, selection of the higher of the two values accurately reflected maximum growth of each species within that quadrat. Data were used to calculate total species density, and cover of all individual species, based on cover class midpoints. Cover values were then summed by life-form group (herbaceous, graminoid, and woody species) within each quadrat.

A single "percent change" value was obtained for each variable by dividing post-treatment data by pre-treatment data, within each quadrat. This method eliminated the problem of auto-correlation due to permanent quadrats, and also relativized among sites and years. Mean percent change within quadrats reflected actual change over time, and often varied from average change within treatments.

Change in *Alliaria* cover was assessed by dividing adult cover in spring by immature rosette cover the preceding summer. Under normal conditions, rosettes that survive the winter increase substantially in cover the following spring. Other measures of *Alliaria* abundance -- seedling cover and adult density -- were tested for significant differences using

spring (post-treatment) data. Seedling cover is highly variable depending on the seed bank, and differences in seedling cover among plots do not necessarily reflect impact of treatment.

Preliminary analysis of data from Hall Woods and Maple Grove indicated no differences between season of treatment, nor between plots within treatments. Data were subsequently combined and tested for significant differences (0.05 s.l.) by two-way ANOVA using site and treatment as grouping variables. No differences were detected between plots within treatments at Pecatonica Bottoms (1991/1992), and community data were combined and tested by two-way ANOVA using treatment and season as the grouping variables. *Alliaria* data (seedling, rosette and adult cover, and adult density) at Pecatonica Bottoms did not follow normal distributions, and were tested for significant differences by Kruskal-Wallis.

Treatments

Glyphosate (1% and 2% v:v concentrations) was applied in Maple Grove and Hall Woods in fall 1990/spring 1991. Based on the results of the 1990/91 applications, a 0.5% concentration of glyphosate was tested at Pecatonica Bottoms, along with acifluorfen at 1.12 kg AI/ha (1.0# AI/acre), and bentazon at 0.28, 0.56, and 1.12 kg/ha (0.25, 0.5 and 1.0 #AI/acre).

Herbicides were mixed with distilled water and 10 ml of water-soluble blue dye/l a few hours prior to application. Ten ml/l of crop oil concentrate was added to acifluorfen and bentazon. Herbicide was applied in overlapping bands with a two-nozzle (flat spray tip) boom attached to a CO^2 powered sprayer unit, calibrated to deliver 93.5 liters of water/ha (10 gallons/acre) at 19 psi, 35 m/min.

Herbicide was applied after the majority of native plants were dormant, on days with low wind and above-freezing temperatures. Applications were made 12 November 1990 and 3 March 1991 in Hall Woods, 13 November 1990 and 21 March 1991 in Maple Grove, and 13 November 1991 and 1 March 1992 in Pecatonica Bottoms. Spring treatments were made prior to *Alliaria* seedling germination and emergence of native ephemeral herbs.

RESULTS

1% and 2% Glyphosate (1990/1991)

Glyphosate significantly reduced adult *Alliaria* cover at both sites (Table 1), regardless of season of application or concentration. At Hall Woods, *Alliaria* cover more than doubled in control plots between fall 1990 and spring 1991, from 6.8% to 16.3%, but declined from 8.0-10.1% to <0.25% in treated plots (Table 2). Similar declines were recorded in Maple Grove, from pretreatment means of 23-28% cover to <2% cover after treatment (Table 2).

Reflecting the decrease in adult cover, adult density was significantly lower in treated plots than in controls at both sites (Tables 1 and 2). Density was higher at Maple Grove than Hall Woods, averaging 31.1/m^2 and 8.8/m^2, respectively, in untreated plots. In treated plots density ranged from a mean of 0.06-3.8/m^2 (Table 2).

Alliaria seedling cover was not affected by herbicide application, as treatment was made prior to germination. Seedling cover varied significantly between sites, but within sites was similar in all plots regardless of treatment (Tables 1 and 2).

Total herbaceous cover and woody vegetation cover were not significantly affected by glyphosate treatment. The two test sites differed significantly in groundlayer cover, but the response of vegetation to herbicide treatment was similar in both sites. At Hall Woods, herbaceous cover increased in all plots by 20-30% between years, ranging from 102-119% in 1991, and from 130-139% in 1992. At Maple Grove, herbaceous cover declined in all plots, from 80-99% in 1991 to 65-97% in 1992. At both sites, changes in treated plots were comparable to those recorded in control plots. While glyphosate did not reduce total herb cover, two herbaceous species appeared sensitive to this herbicide; the perennial semi-evergreen white avens (*Geum canadense*) and the annual bedstraw (*Galium aparine*). Woody cover increased and decreased similar to herbaceous cover at both sites. Species density (number of species/m^2) was similar in all plots before and after treatment at both sites.

0.5% Glyphosate, bentazon, and acifluorfen (1991/1992)

Alliaria underwent high natural mortality in the control plots, and seedling cover, adult density, adult cover, and percent change from 1991 rosette cover to 1992 adult cover, were similarly low in control, glyphosate, and bentazon treated plots (Table 4).

Bentazon at 0.56 kg and 1.12 kg AI/ha nonsignificantly reduced *Alliaria* cover within individual quadrats; within plots (4 quadrats/plot) *Alliaria* cover declined >90%, from pretreatment means of 31% and 55% cover, to post treatment means of 2% and 5% cover (Table 4). In the control plots, *Alliaria* cover declined 71%, from 22% to 6%. Glyphosate at 0.5% concentration, and bentazon at 0.28 kg AI/ha had no significant effect on *Alliaria* cover.

In contrast, acifluorfen at 1.12 kg/ha eliminated all adult *Alliaria*, and reduced seedling cover to <0.1% (Table 4), significantly lower than in the control plots (sl <0.001). Acifluorfen also eliminated most forb vegetation, including species dormant at the time of application. Average cover declined 72%, from 232% prior to treatment, to just 48% 6-9 months after treatment (Table 4). The majority of cover was produced by wood nettle (*Laportea canadensis*), with a minor contribution by *Viola* sp.. Other forbs had very low cover, and usually occurred as seedlings or as diminutive plants with few leaves. Acifluorfen did not affect cover of woody species, nor of cyperoid species (Tables 3 and 4). Species density declined significantly in the acifluorfen-treated plots (Table 3), from a mean of 13.6 to 10.0/m^2, reflecting the impact on herbaceous species (Table 4).

Glyphosate at 0.5% concentration did not affect *Alliaria* cover, but did significantly reduce cyperoid cover by 63%, from 13.1% cover pre-treatment to 2.2% cover post-treatment (Tables 3 and 4). Most abundant, and therefore most affected, species were the sedges *Carex jamesii* (declined from 5.4% to 0.8%), and *C. laxiflora* (7.2% to 0.4%). Glyphosate had no significant effect on cover of woody species (Table 3). Herbaceous cover was slightly and nonsignificantly lower in the glyphosate-treated plots, indicating that some species may have been impacted by this herbicide. Two annual species, *Chaerophyllum procumbens* and *Galium aparine*, had lower frequency and cover after

treatment. Woodland phlox (*Phlox divaricata*) and wild ginger (*Asarum canadense*), both perennial and semi-evergreen species, did not appear affected by treatment.

Native groundlayer vegetation was unaffected by an application of bentazon (Table 3). Cover of herbaceous, cyperoid and woody species, and mean species density, were comparable before and after treatment at all concentrations of Bentazon.

DISCUSSION

Cover of adult *Alliaria* was sharply reduced >93% by applications of both 1% and 2% glyphosate (but not 0.5%) to dormant rosettes, similar to the reduction obtained with a 3% solution (Nuzzo 1991). Because immature rosettes were killed, adult density was also significantly reduced by 95-99%, relative to the control. Glyphosate is equally effective when applied in late fall as in very early spring, as *Alliaria* rosettes remain semi-evergreen through the winter months. Seedlings germinated several weeks to several months after the herbicide was applied, and were therefore not affected, as glyphosate has virtually no soil residual. When glyphosate is applied during the germination period, seedlings are significantly reduced (Nuzzo 1991).

Use of glyphosate, particularly in spring, resulted in some species loss, as the herbicide is non-selective; herbaceous species that were green at the time of application were reduced or killed by the herbicide. Species most noticeably affected were sedges (*Carex jamesii* and *C. laxiflora*), and white avens (*Geum canadense*), a semi-evergreen early successional forb. Surprisingly, two other semi-evergreen herbs, phlox and wild ginger, did not appear affected by this herbicide. The annual bedstraw *Galium aparine* appeared to decline with glyphosate treatment. *G. aparine* is a winter annual that germinates in early fall and overwinters as a small plant, and may have been physiologically active at the time of herbicide application.

Dormant season application of bentazon at 0.56 kg and 1.12 kg AI/ha produced a nonsignificant reduction in *Alliaria* cover in this study. When applied during the growing season, bentazon significantly reduced *Alliaria* cover, comparable to glyphosate (Nuzzo 1994). While it is possible that bentazon is primarily effective as a growing season treatment, it is also possible that dormant season treatment impact was obscured by natural over-winter *Alliaria* mortality, which can exceed 78% (Nuzzo 1993). Additional study is needed to determine if this herbicide can effectively reduce *Alliaria* presence when applied during the dormant season.

Acifluorfen removed all *Alliaria* and most herbaceous vegetation. Although listed as a post-emergent herbicide, acifluorfen had a long-lasting soil residual that prevented *Alliaria* germination, and killed numerous herbaceous species that were completely dormant at the time of treatment.

Seedlings were not affected by either glyphosate or bentazon, because herbicides were applied prior to seedling germination.

RECOMMENDATIONS

Application of 1% or 2% glyphosate applied during the dormant season at above-freezing temperatures effectively kills *Alliaria* rosettes, but also damages other species that are green at the time of application, particularly sedges. Glyphosate is a suitable management tool for small *Alliaria* populations, and the problem of non-target species loss may be balanced against the benefit of removing *Alliaria*.

Where sensitive species are present in the groundlayer, application of bentazon at 0.56 kg/ha may be an acceptable substitute for glyphosate. Bentazon has none of the drawbacks of glyphosate, but may be less effective than glyphosate in controlling *Alliaria*. Neither herbicide affected seedling germination, and depending on the seedbank, repeated dormant season applications may be needed to control *A.petiolata*.

ACKNOWLEDGEMENTS

This research was supported by a grant from the Illinois Department of Energy and Natural Resources. I would like to thank the Rockford Park District, the Winnebago County Forest Preserve District, and the DuPage County Forest Preserve District for permission to use their facilities. John Alesandrini, Scott Kobal, Michael Jones, Wayne Lampa, and Matt Paulson provided valuable field assistance.

LITERATURE CITED

Cavers, P.B., M.I. Heagy and R.F. Kokron. 1979. The biology of Canadian weeds. 35. *Alliaria petiolata* (M. Bieb.) Cavara and Grande. Canadian Journal of Plant Science 59:217:229.

Drake, J.A., H.A. Mooney, F. di Castri, R.H. Groves, F.J. Kruger, M. Rejmanek, and M. Williamson (eds.). 1989. Biological invasions: a global perspective. John Wiley and Sons. NY. 525 p.

Mack, R.N. 1989. Temperate grasslands vulnerable to plant invasions: characteristics and consequences. pp 155-179 *in* Drake, J.A., H.A. Mooney, F. di Castri, R.H. Groves, F.J. Kruger, M. Rejm¨nek, and M. Williamson (eds.). 1989. Biological invasions: a global perspective. John Wiley and Sons. NY. 525 p.

Mooney, H.A. and J.A. Drake (eds.). 1986. Ecology of biological invasions on North America and Hawaii. Springer-Verlag. NY 321 p.

Nuzzo, V.A. 1991. Experimental control of garlic mustard [*Alliaria petiolata* (Bieb.) Cavara & Grande] in northern Illinois using fire, herbicide and cutting. Natural Areas Journal 11:158-167.

Nuzzo, V.A. 1993. Natural mortality of garlic mustard (*Alliaria petiolata* (Bieb.) Cavara & Grande) rosettes. Natural Areas Journal 13:132-133.

Nuzzo, V.A. 1994a. Element stewardship abstract for *Alliaria petiolata* (*Alliaria officinalis*) garlic mustard. The Nature Conservancy. Arlington VA. 20 p.

Nuzzo, V.A. 1994b. Response of garlic mustard (*Alliaria petiolata* Bieb [Cavara and Grande]) to summer herbicide treatment. Natural Areas Journal 14:309-310.

Wagner, W.H., Jr. 1993. Problems with biotic invasions: a biologist's viewpoint. pp 1-8 *in* McKnight, B.N. (ed.) Biological pollution: the control and impact of invasive exotic species. Indiana Academy of Science. Indianapolis, IN. 261 p.

White, D.J., E. Haber, and C. Keddy. 1993. Invasive plants of natural habitats in Canada. Canadian Museum of Nature. Ottawa, Canada. 121 p.

White, J. and M.H. Madany. 1978. Classification of natural communities in Illinois. pp 309-405 *in* Illinois natural areas inventory technical report, volume 1: Survey methods and results. Illinois Natural Areas Inventory. Urbana IL. 426 pp.

Table 1. Summary tables of two-way ANOVA for percent change in cover of herbaceous and woody vegetation, and species density, at Hall Woods and Maple Grove, 1990 - 1991.

Source of Variation	df	SS	MS	F	P
***Alliaria* Cover, 1991/1990**					
Site	1	56.01	56.01	2.837	0.096
Treatment	2	331.64	165.82	8.397	<0.001
Site X Treatment	2	115.45	57.73	2.923	0.059
Error	87	1717.92	19.75		
Adult Density 1991					
Site	1	2016.67	2016.67	10.116	0.002
Treatment	2	7321.58	3660.79	18.362	<0.001
Site X Treatment	2	2070.08	1035.04	5.192	0.007
Error	90	17942.63	199.36		
Seedling Cover 1991					
Site	1	4320.17	4320.17	7.090	0.009
Treatment	2	1515.77	757.89	1.244	0.293
Site X Treatment	2	3355.90	1677.95	2.754	0.069
Error	90	54841.16	609.35		
Herbaceous Cover 1991/1990					
Site	1	2.146	2.146	10.043	0.002
Treatment	2	0.322	0.161	0.754	0.473
Site X Treatment	2	0.494	0.247	1.155	0.320
Error	90	19.235	0.214		
Woody Cover 1991/1990					
Site	1	13.626	13.626	4.853	0.030
Treatment	2	10.790	5.395	1.921	0.153
Site X Treatment	2	7.624	3.812	1.357	0.263
Error	88	247.115	2.808		
Species Density 1991/1990					
Site	1	0.028	0.028	0.280	0.598
Treatment	2	0.373	0.186	1.882	0.158
Site X Treatment	2	0.584	0.292	2.945	0.058
Error	90	8.918	0.099		

Table 2. Mean cover of *Alliaria petiolata*, herbaceous species (excluding *Alliaria*), and woody species, and mean species density, before (1990) and after (1991) herbicide treatment at Hall Woods and Maple Grove.

		HALL WOODS			MAPLE GROVE		
		Control	Glyphosate 1%	Glyphosate 2%	Control	Glyphosate 1%	Glyphosate 2%
ALLIARIA							
Rosette Cover	(1990)	6.81	8.00	10.09	22.75	28.22	23.53
Adult Cover	(1991)	16.03	0.06	0.25	26.84	1.91	1.38
Seedling Cover	(1991)	54.25	52.69	36.41	26.00	40.00	37.09
Adult Density	(1991)	8.81	0.19	0.06	31.06	3.81	1.69
COMMUNITY							
Herb Cover	(1990)	101.63	118.84	105.41	79.47	81.78	98.81
	(1991)	130.72	139.34	130.66	64.84	74.53	97.13
Woody Cover	(1990)	36.41	13.53	17.19	7.09	6.25	6.63
	(1991)	32.06	17.44	17.53	3.38	3.88	5.31
Species/m^2	(1990)	7.38	8.13	8.50	7.88	8.69	9.44
	(1991)	7.63	7.31	7.19	7.13	6.56	8.50

Table 3. Summary tables of two-way ANOVA for percent change in cover of herbaceous, cyperoid, and woody vegetation, and species density, at Pecatonica Bottoms, 1991 - 1992.

Source of Variation	df	SS	MS	F	P
Herbaceous Cover, 1992/1991					
Treatment	5	1.723	0.345	9.176	<0.001
Season	1	0.132	0.132	3.526	0.064
Treatment X Season	5	0.325	0.065	1.730	0.137
Error	84	3.154	0.038		
Cyperoid Cover, 1992/1991					
Treatment	5	60.920	12.184	1.190	0.357
Season	1	22.764	22.764	2.090	0.152
Treatment X Season	5	42.563	8.513	0.782	0.566
Error	84	914.563	10.891		
Woody Cover, 1992/1991					
Treatment	5	298.192	59.638	1.835	0.117
Season	1	9.433	9.433	0.290	0.592
Treatment X Season	5	481.429	96.286	2.963	0.017
Error	72	2339.828	32.498		
Species Density 1992/1991					
Treatment	5	1.271	0.254	8.615	<0.001
Season	1	0.009	0.009	0.307	0.581
Treatment X Season	5	0.292	0.058	1.980	0.090
Error	84	2.479	0.030		

Table 4. Mean cover of *Alliaria petiolata*, herbaceous species (excluding *Alliaria*), cyperoid species, and woody species, and mean species density, before (1991) and after (1992) herbicide treatment at Pecatonica Bottoms.

		Control	Glyphosate	Bentazon			Acifluorfen
			0.5%	0.28kg	0.56 kg	1.12 kg	1.12 kg
ALLIARIA							
Rosette Cover	(1991)	21.81	21.22	36.34	31.44	55.47	23.97
Adult Cover	(1992)	6.34	6.19	13.53	2.44	5.22	0.00
Seedling Cover	(1992)	5.13	15.16	6.88	9.13	15.44	0.09
Adult Density	(1992)	8.88	7.88	11.13	3.81	8.25	0.00
COMMUNITY							
Herb Cover	(1991)	205.34	120.38	169.69	185.06	135.69	221.78
	(1992)	138.34	66.34	102.88	103.31	83.78	63.91
Cyperoid Cover	(1991)	18.78	13.06	12.00	17.66	15.44	10.09
	(1992)	23.75	2.21	13.16	16.59	17.91	11.66
Woody Cover	(1991)	2.63	4.19	5.41	1.56	2.31	2.25
	(1992)	4.06	3.34	6.31	3.78	3.34	7.66
Species/m^2	(1991)	13.81	12.63	13.31	14.63	13.06	13.67
	(1992)	13.56	13.44	14.44	13.88	12.88	10.00