Survey and analysis of woodland vegetation within Langley Wood NNR

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1. Introduction and survey method

In the spring of 2000 a grid of points was established across Langley Wood NNR using differential GPS. These points were used to sample woodland structure (Jonathan Cox Associates, June 2000). In the autumn of 2000 this grid of points was used to sample the woodland vegetation using standard National Vegetation Classification (NVC) quadrat sampling techniques. Quadrat data was collected over a period of 6 days in September 2000. At each sample point a 50x50m quadrat was used to gather data on canopy and shrub layer species composition and cover. Within the 50m quadrat, a smaller 10x10m quadrat was used to sample woodland ground flora. In most instances, the location of the 50x50m quadrats was to the south east of each sample point so that the sample point forms the north west corner of the quadrat. At 23 sample points the quadrat was placed as close to the sample point as possible to obtain a sample of homogenous vegetation. The location of all quadrats was mapped as accurately as possible in the field. The location of all sample quadrats is shown on map 2. Cover of all species was assessed using the Domin scale.

The time of year of the survey made it difficult to record some of the vernal dominants such as *Anemone nemorosa* and *Hyacinthoides non-scripta*. It may be that further sampling during spring would be useful in verifying the results of this September survey. Particular care was taken to record bryophyte species as at this time of year they provide one of the best indicators of woodland type.

The data collected from the field survey was collated into spreadsheets and analysed using TWINSPAN. This assisted in splitting the data into potential sub-communities although a considerable amount of time was needed to equate the groups of quadrats identified by TWINSPAN to appropriate NVC sub-communities.

A further days field survey was undertaken in December 2000 to attempt to confirm the range of NVC sub-communities present and their distribution and where possible relate these to the distribution of stand types mapped by George Peterken.

2. Results

The quadrat data from the survey is presented in Appendix 1.

Details of the TWINSPAN output for the oak woodland and alder woodland samples are presented in Appendix 2.

TWINSPAN Dendrograms of samples produced for oak woodland and alder woodland samples are presented in Appendix 3.

Map 2 shows the distribution of NVC sub-communities defined at the different quadrat locations throughout Langley Wood. A simplified map of Peterken stand types is presented in Map 1. This provides a useful comparison with the distribution of NVC communities shown in Map 2.

3. Analysis

The data gathered from the quadrat survey did not provide any conclusive indication of the degree of variation in the vegetation types present within Langley Wood. Most of the woodland has been mapped by George Peterken as falling within stand type 6, described as oak woodland. Three oak stand types have been identified 6Db Lowland birch pedunculate oakwoods, 6Dc Lowland hazel pedunculate oakwoods and 6Cb Lowland hazel sessile oakwoods. In terms of the NVC all three of these stand types can fall within W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* woodland. However, W10 is divided into five sub-communities and it was not apparent from the results of the quadrat survey, which of these were present in Langley Wood and to what extent they occur.

In addition to the dominant oak woodland stand types, areas of 3A acid pedunculate oak – ash - hazel woodland occurs, in particular along the north western edge of the wood. This stand type is also subsumed within W10 although again it was unclear if this formed a distinct sub-community or should be accepted as natural variation within other W10 sub-communities.

Some other minor stand types were also mapped by George Peterken, in particular the lime woods 5A and 5B and the birch woods 12A and 12B. The presence of lime and dominance of birch in some areas of the woodland again do not distinguish these woodland types from W10 and hence there was a need to determine to which of the W10 sub-communities these stand types should be assigned.

Lastly, there are some well defined and well developed alder woodlands along the stream and river valleys that cross Langley Wood. Most of these have been accurately mapped by George Peterken and classified as Valley alder woods 7Aa and 7Ab and Wet valley alder woods 7B.

To assist in separating the samples into different NVC communities and sub-communities, TWINSPAN analysis has been used. To simplify the analysis the quadrat data was divided into those samples clearly falling within W10 (Stand types 3A, 5, 6 and 12) and those within the alder woodland (stand type 7). Small areas of 2A ash maple woodland were also mapped by George Peterken but no samples of this stand type were included in the quadrats.

TWINSPAN was used to provide dendrograms by sample of the two data sets (oak woodland and alder woodland). Details of the TWINSPAN analysis and for the most important quadrat divisions are presented in Appendix 3.

4. Results of TWINSPAN analysis

4.1 Analysis of oak woodland

At the first division, TWINSPAN splits the oak woodland samples into two groups. The smallest group comprises 6 quadrats (1, 2, 6, 31, A7 and A10). These are distinguished from the other samples by an absence of hazel *Corylus avellana* and *Oxalis acetosella* and the presence of *Carex remota* and *Dicranella heteromalla*. Species biased towards this small group include several species indicative of acid and rather wet woodlands including *Athyrium felix-femina, Holcus mollis, Hypericum pulchrum* and *Blechnum spicant*. This small group of

quadrat sample sites are clustered in the central southern part of the wood with quadrat 31 being rather anomalous situated in the east of the wood. The distribution of these quadrats equates quite well with the distribution of the more acid oak woodland stand types mapped by George Peterken as shown in Map 1.

The larger group containing 48 quadrats is distinguished by the presence of hazel and *Oxalis* and absence of *Dicranella heteromalla* and *Carex remota*. Species preferring these quadrats include *Acer pseudoplatanus, Brachypodium sylvaticum, Crataegus monogyna, Dryopteris felix-mas, Euphorbia amygdaloides* and *Fraxinus excelsior*.

The second division splits the group of 48 quadrats into a smaller group comprising 9 quadrats (3, 4, 5, 15, 16, 17, 33, A1, A8) and a larger group of 39 quadrats. Species preferring the smaller group of quadrats include *Acer pseudoplatanus, Ajuga reptans, Galium palustre, Hyperichum pulchrum, Castanea sativa* and the mosses *Dicranella heteromalla, Dicranum scorparium* and *Fissidens* sp. This smaller group of quadrats are distributed along the south eastern edge of the wood and appear to occur in areas mapped as both 6Dc pedunculate oak – hazel woodland and 3A acid pedunculate oak – ash – hazel woodland.

Species biased towards the larger group include *Acer campestre, Rubus fruticosus, Hypericum androsaemum, Agrostis capillaris, Brachypodium sylvaticum, Digitalis purpurea, Dryopteris felix mas, Lamiastrum galeobdelon, Rubus fruticosus* and *Scutellaria minor*. This is a mix of species from both slightly base enriched and slightly acidic wet woodland. It is split by TWINSPAN into two further groups based on the presence of *Pteridium aquilinum* and *Polytrichum formosum* and the absence of *Mnium hornum*. This creates a smaller group comprising of 16 quadrats and a larger group of 23 quadrats. The smaller group is negative towards *Pteridium* and *Polytrichum formosum*. Species preferring this group include *Acer campestre, Betula pubescens, Brachythecium rutabulum, Crataegus monogyna, Euphorbia amygdaloides, Hypericm adrosaemum, Juncus acutiflorus, Prunus* sp., *Rubus fruticosus, Sanicula europea, Thuidium tamariscinum*. This is therefore a slightly more base enriched woodland type. The distribution of these quadrats follows the north western edge of the wood and equates quite well with the distribution of 3A acid pedunculate oak – ash – hazel woodland mapped by George Peterken.

The larger group of 23 quadrats is positive towards *Pteridium* and *Polytrichum* and negative for *Mnium hornum*. Species biased towards this larger group of quadrats include *Blechnum spicant, Fagus sylvatica, Geranium robertianum, Hedera helix, Ilex aquifolium, Polytrichum formosum* and *Salix* spp. (including *Salix cinerea*). Quadrats equating to this slightly more acid oak woodland occur throughout the central area of the wood and equate well with the distribution of 6Dc pedunculate oak – hazel woodland.

On the basis of this analysis it seems that there are 4 groups of oak woodland as summarised in table 1.

Table 1. TWINSPAN Analysis of Oak woodland stand type data

Indicators	Quadrat numbers
Negative for *Corylus avellana* and *Oxalis acetosella* Positive for *Dicranella heteromalla* and *Carex remota*	1, 2, 6, 32, A7, A10
Negative for *Thuidium tamariscinum* Positive for *Dryopteris felix mas, Acer pseaudoplatanus* and *Ribes* sp.	3, 4, 5, 15, 16, 17, 33, A1, A8
Negative for *Pteridium aquilinum* and *Polytrichum formosum* Positive for *Mnium hornum*	9, 10, 24, 37, 40, 41, 26, 31, 34, 38, 39, 45, 46, A3, A5, A6
Positive for *Pteridium aquilinum* and *Polytrichum formosum* Negative for *Mnium hornum*	7, 8, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 25, 27, 28, 30, 35, 36, 42, 43, 44, A4, A9

4.2 Analysis of alder woodland

Only 6 quadrats were located in alder woodland. These all appear to conform to W7 *Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland. There are 3 sub-communities of W7 described by the NVC. TWINSPAN analysis was used to assist in deciding if more than one of these sub-communities is present in Langley Wood.

TWINSPAN splits the 6 quadrats in alder woodland using *Athyrium felix-femina* as the first indicator. Four quadrats are negative for this species and 2 positive. Species preferring the negative group of quadrats include *Carex remota, Anemone nemorosa, Atrichum undulatum, Cardamine* sp., *Carex sylvatica, Circaea lutetiana* and *Chrysosplenium oppisitifolium.*

Species biased towards the positive group of 2 quadrats include *Acer pseudoplatanus, Acer campestre, Betula pendula, Mercurialis perennis, Urtica dioica, Veronica montana, Geum urbanum* and *Glechoma hederacea.*

This is possibly the basis for the division of the samples into two sub-communities within W7.

5. NVC Analysis

5.1 W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* woodland

W10 woodland dominates Langley Wood almost to the exclusion of all other NVC communities. Separation of this extensive community into sub-communities has proved problematical. The NVC identifies 5 sub-communities of W10.

The TWINSPAN analysis initially splits a small group of quadrats from the main group. These are clustered in the southern part of the wood and are characterised by the absence of *Corylus avellana* and *Oxalis acetosella* and the presence of *Dicranella heteromalla.* This group of quadrats conforms most closely with the Typcial sub-community (W10a). The lack of hazel and presence of sessile oak and oak hybrids, *Calluna vulgaris, Erica tetralix* and other calcifuge species in these quadrats suggests a tendency towards W16 *Quercus – Betula – Deschampsia flexuosa* woodland. However, the absence of *Deschampsia flexuosa* and high frequency of *Rubus fruticosus, Lonicera* and *Pteridium* keep this group of quadrats within W10. This area of acid woodland has been mapped by George Peterken as a mosaic of pedunculate oak - birch woodland (6Db), sessile oak woodland (6Cb(c)) and lime woodland (5a and 5b).

In the second TWINSPAN division, another small group of quadrats is identified as being negative for *Thuidium tamariscinum* and positive for *Dryopteris felix mas, Acer pseaudoplatanus* and *Ribes* sp. These quadrats are clustered along the south eastern edge of the wood. The frequency of *Acer pseudoplatanus* (33% or III) and *Oxalis acetosella* (78% or IV) suggests this group might be most closely defined as W10e the *Acer pseudoplatanus – Oxalis acetosella* sub-community. No comparable stand type was mapped by George Peterken to coincide with this group of quadrats which overlap with areas of 6Dc oak – hazel woodland and small patches of 3A acid pedunculate oak – hazel – ash woodland.

This leaves the consideration of the main group of 39 quadrats separated at the second TWINSPAN division. TWINSPAN splits this group of quadrats at the 5th division on the basis of *Pteridium aqulinum, Polytrichum formosum* and *Mnium hornum*. The negative group for *Pteridium* and *Polytrichum* also has a high frequency of *Oxalis acetosella* (75% or IV), *Acer campestre* (56% or III) and *Fraxinus excelsior* (63% or III). This tends to place this group of quadrats within the W10e sub-community. The preference for mosses *Mnium hornum, Brachythecium rutabulum* and *Thuidium tamariscinum* for this group of quadrats further reinforces this classification. This group of quadrats is distributed along the north western edge of the wood and follows quite closely the distribution of 3A acid pedunculate oak – hazel – ash woodland mapped by George Peterken. There is some indication of a tendency towards W8 *Fraxinus excelsior – Acer campestre – Mercurialis perennis* woodland in this area of the wood, however, the absence of *Mercurialis* and very restricted distribution of *Acer campestre* keep this community within W10.

The remaining group of quadrats which is positive for *Pteridium* and *Polytrichum formosum* also has high frequency of *Quercus robur, Q. petraea* and *Corylus avellana*; occassional *Tilia cordata, Veronica montana* and *Dryopteris felix-mas*. *Hyacinthoides non-scripta* is also common in these quadrats, although the time of survey was not good for identifying this species. This combination of species suggests these quadrats conform most closely to the Typical sub-community W10a. Their distribution equates quite strongly with the ubiquitous oak hazel woodland (6Dc) mapped by George Peterken throughout the central core of the wood. However, it also includes some areas mapped as 6Db oak - birch woodland. The lack of hazel in these areas of the wood may be an artefact of past management or woodland succession rather than any change in soil or other edaphic conditions.

Table 2 summarises the proposed division of W10 quadrats by sub-community.

Table 2.

Quadrat numbers	TWINSPAN Indicators	W10 Sub-community
1, 2, 6, 32, A7, A10	Negative for *Corylus avellana* and *Oxalis acetosella* Positive for *Dicranella heteromalla* and *Carex remota*	Typical W10a
3, 4, 5, 15, 16, 17, 33, A1, A8	Negative for *Thuidium tamariscinum* Positive for *Dryopteris felix mas, Acer pseaudoplatanus* and *Ribes* sp.	*Acer pseudoplatanus – Oxalis acetosella* W10e
9, 10, 24, 37, 40, 41, 26, 31, 34, 38, 39, 45, 46, A3, A5, A6	Negative for *Pteridium aquilinum* and *Polytrichum formosum* Positive for *Mnium hornum*	*Acer pseudoplatanus – Oxalis acetosella* W10e
7, 8, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 25, 27, 28, 30, 35, 36, 42, 43, 44, A4, A9	Positive for *Pteridium aquilinum* and *Polytrichum formosum* Negative for *Mnium hornum*	Typical W10a

5.2 W7 *Alnus glutinosa – Fraxinus excelsior – Lysmachia nemorum* woodland

The stream valleys that cross the wood support some well developed alder woodland. This all conforms quite well the W7 *Alnus glutinosa – Fraxinus excelsior – Lysmachia nemorum* community. TWINSPAN is helpful in splitting the 6 alder wood quadrats into two groups but this is on the basis of the presence or absence of *Athyrium felix-femina*. This species is equally frequent in all the 3 of the W7 sub-communities so this feature is not in itself helpful. However, closer scrutiny of the preferential species associated with the two groups suggests the split made by TWINSPAN is helpful in defining sub-communities. The larger group comprising 4 quadrats has constant and abundant *Carex remota* together with species such as *Anemone nemorosa, Atrichum undulatum, Cardamine* sp., *Carex sylvatica, Circaea lutetiana, Chrysosplenium oppositifolium* and *Filipendula ulmaria*. *Urtica dioica* is present at a low level in one quadrat. On this basis, these 4 quadrats have been placed within the W7b *Carex remota – Cirsium palustre* sub-community although they do not appear to conform particulalry well to the sub-community described in the NVC, possibly because the samples of this sub-community used in the NVC were taken mainly from northern and western Britain. W7b is the most widespread W7 community present in the Langley Wood, being recorded in quadrats along central stream valley into Bottom Pond Copse and the eastern end of Moor Copse. It also occurs along the stream valley on the northern edge of Glazier's Copse. The remaining two quadrats do not really provide sufficient samples to assess their sub-community, but the abundance of *Urtica dioica* in the western end of Moor Copse suggests these quadrats should be places within the W7a *Urtica dioica* sub-community.

The split of quadrats by sub-community type is summarised in Table 3.

Table 3.

Quadrat numbers	TWINSPAN Indicators	W7 Sub-community
47, 48	Negative for Athyrium felix-femina	W7a Urtica dioica sub-community
29, 49, A2 and A11	Positive for Athyrium felix-femina	W7b Carex remota – Cirsium palustre sub-community

6. Discussion

The use of TWINSPAN has been essential in untangling the data produced from a total of 60 quadrats within Langley Wood. The initially rather homogenous W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* community can be divided into at least 4 distinct oak woodland types in Langley Wood. These conform to two sub-communities of W10. There is some correlation between the distribution of these sub-communities and the stand types mapped by George Peterken. In particular there is good correlation between the areas mapped as 3A acid pedunculate oak-ash-hazel woodland and the W10e *Acer pseudoplatanus – Oxalis acetosella* sub-community. There is less good correlation between the distribution of W10e and Peterken stand types along the south eastern edge of the wood. The remaining two oak woodland types identified by TWINSPAN conform to the W10a typical sub-community. These show some good correlation with stand type mapping with one group being associated with the more acidic oak – birch, sessile oak and lime woodland stand types in the south of Langley Wood and the other with the more ubiquitous oak – hazel woodland that dominates most of Langley Wood.

Further quadrat sampling is recommended of the alder woodlands as these appear to be well developed throughout Langley Wood but have only be included within 6 quadrats. This limited amount of sampling suggests the presence of two W7 sub-communities. The most ubiquitous appears to conform best to the W7b *Carex remota – Cirsium palustre* sub-community although the examples within Langley Wood are perhaps not typical of the sub-community described by the NVC.

Detailed mapping of sub-communities has not been possible in the time available for this survey. Now that there is a clearer understanding of the species associated with the various sub-communities it might now be possible to develop more detailed NVC maps of the wood. This would be best done during spring or early summer with the assistance of differential GPS. At this time of year leaf cover will not be complete allowing more accurate use of GPS whilst woodland ground flora should be in a good condition to survey. In particular there is a need to establish the extent of W10e sub-community along the south eastern edge of the wood as this does not appear to conform well with any of the previously mapped stand types.

Appendix 1. Langley Wood quadrat data

Quadrat number	1	2	6	32	A7	A10	7	8	11	12	13	14	18	19	20	21	22	23	25	27	28	30	35	36	42	43	44	A4	A9
	W10a Typical sub-community						W10a Typical sub-community																						
Acer campestre																	2												
Acer pseudoplatanus								1	2			1					1												
Agrostis capillaris	7	3	3	1	3							3		3			2		2		1	2		1		4			
Agrostis stolonifera		3								5																			
Ajuga reptans																													
Alnus glutinosa			1												2														
Anemone nemorosa									1															1					1
Anthoxanthum odoratum	1																					2							
Arctium sp.																													
Athyrium filix-femina		1				1				2				2	1														
Atrichum undulatum		3	3	2	3		2	1	4	4		3			3	5	2	1			1			2	3	1	3	4	3
Betula pendula	1	2	6		6	2	1	5		2		4			5	1		1	3	5	2		2	1		2		1	2
Betula pubescens		3	5		6	2	4	2	2	5	1	4	3	4	5	6	1	3	1	1	3		2		1	2	2	3	6
Betula sp. seedling		2																											
Blechnum spicant		2	5			5	4		3	2					1	2							4						3
Brachythecium rutabulum																									1				
Brachypodium sylvaticum			4		2		4	1	2	1		5			2		3	5	2			2			2			2	4
Calluna vulgaris		1																											
Campylopus introflexus		1																											
Cardamine sp.																													
Carex remota	2	2		1	2	1	1			3	1				1						2			1		1		1	
Carex sylvatica		2	2		1										1														
Castanea sativa		1					5		1	2		3																	
Carpinus betulus																													
Carpinus betulus seedling																													
Circaea lutetiana																													
Cirriphyllum cuspidatum																													
Cirsium arvense																													
Chrysosplenium oppositifolium																													
Cornus sanguinea										1							2												
Corylus avellana			1	3	1	1	6	1	5	7	8	9	8	8	8	8	7	7	7	2	7	8	8	7	8	8	8	7	6
Crataegus monogyna									1	2	1	1		1		2	1	3	2				1	1	1			1	1
Crataegus monogyna seedling																		1						1					

Quadrat number	1	2	6	32	A7	A10	7	8	11	12	13	14	18	19	20	21	22	23	25	27	28	30	35	36	42	43	44	A4	A9
	W10a Typical sub-community						W10a Typical sub-community																						
Deschampsia cespitosa							1											1										1	
Dicranella heteromalla	1	3		1		1															1				1				
Dicranum scoparium											2			1			1				1								
Digitalis purpurea					3																							1	
Diplophyllum albicans		2																											
Dryopteris dilatata																													
Dryopteris filix-mas				1					2					1	1													1	
Dryopteris sp.			1						2			1		1					1										
Erica tetralix		4																											
Euonymus europaeus																													
Euphorbia amagdaloides									3	1				1	3	2	3	2				2					2		3
Eurhynichium praelongum		3	3	1	3	1	2	1		1	3	3	2	3	4			1	1		1		1				2		
Eurhynichium striatum							2		1		3	2			1	1	1	1				1		1	2	1	2	1	1
Fagus sylvatica									1	2		3	2	1	1	1	3		3				2	1	2			2	
Fagus sylvatica seedling																													
Festuca gigantea																													
Festuca rubra																					1								
Filipendula ulmaria																													
Fissidens sp.																		1											
Frangula alnus																													
Fraxinus excelsior						2			4			1	1	1		1		3	1				3	1	3	2		1	1
Fraxinus excelsior seedling			2		1							2	1						3				2		2	2			
Galium palustre										1		1		3															
Geranium robertianum																													
Geum urbanum																													
Glechoma hederacea																													
Hedera helix	1			3	3	2	1	3	2	1	3	3	3	3	3		3		2	3	3	1		2	2	2			
Holcus mollis			4		3	3	6	1			4	3	4		3					3				3					
Hyacinthoides non-scripta				3	3										2					2								2
Hypericum androsaemum								1							1														
Hypericum pulchrum		2	2		2																								
Hypnum cupressiforme		1																											
Ilex aquifolium				2								1																	

Quadrat number	1	2	6	32	A7	A10	7	8	11	12	13	14	18	19	20	21	22	23	25	27	28	30	35	36	42	43	44	A4	A9
	W10a Typical sub-community						W10a Typical sub-community																						
Ilex aquifolium 'seedling'	1			1			1				2				1					1					1				1
Impatiens glandulifera																													
Isothecium myosuroides																							1	1	1				
Juncus acutiflorus		2																											
Juncus conglomeratus	2																												
Juncus effusus	2	7	3				2			1	1				1	1		1			1			1		2			
Lamiastrum galeobdolon																													
Leucobryum glaucum		2																											
Lonicera periclymenum		2	3	1		2	3	3			3	3	2					1		2				1		1			1
Lophocolea cuspidata	1																								1				
Luzula multiflora	1																												
Luzula sp. (? L. pilosa)		2		1		1							1	2	2							1		1			1		
Lycopus europaeus																													
Lysimachia nemorum			2		1		2			1																			1
Malus sylvestris																													
Melica uniflora																													
Mentha aquatica																													
Mercurialis perennis																													
Mnium hornum	1	3	4	2					1					2											2				
Oxalis acetosella							4		3	3			3	3	4	3		3	3		2	2	3		3	3	3	4	4
Pellia sp.										1																			
Pinus sp.																													
Plagiomnium undulatum																													
Polytrichum formosum	4	4	5	2	3	2	2		1	1	3	3		3	3	3		1	3		1	3	1	3	2	3	1	3	
Populus tremula																							3				3		
Populus sp.																													
Potentilla erecta																					1			1		1			
Potentilla sterilis															1			1											1
Prunus spinosa																													
Prunus sp.																													
Pseudoscleropodium purum					3											1			3		1			3				2	1
Pteridium aquilinum			6	8	9	3	5	9	5	3	5	2	4	4	4	2	5	5	3	8	8		4	5	4	2	3	4	7
Quercus petraea				9			7	6	8		1					6		2	4				2						
Quercus robur	6	8	7			2	7	6		8	9	3	9	9	8	4	9	9	7	7	9	9	7	9	9	9	9	9	7
Quercus sp. hybrids	6					9																						2	

Quadrat number	1	2	6	32	A7	A10	7	8	11	12	13	14	18	19	20	21	22	23	25	27	28	30	35	36	42	43	44	A4	A9
	W10a Typical sub-community						W10a Typical sub-community																						
Quercus sp. seedling		2													1		1			1	1								
Ranunculus repens																													
Rhododendron ponticum	2	1	2		1							2																	
Rhytidiadelphus loreus																			1										
Rhytidiadelphus triquetrus																			2										
Ribes sp.																													
Rosa sp.																													
Rubus fruticosus agg.	1	2	3	2	2	3	3			1	1	3	2	1	2		1			2	2		1		1			1	1
Rumex sanguineus																													
Ruscus aculeatus				1																									
Salix spp. (incl. S. cinerea)																													
Sanicula europaea																													
Scrophularia nodosa																													
Scutellaria minor			3		1					1				2												1			
Sorbus aucuparia												2			1														
Sorbus aucuparia seedling					1							2																	
Stachys sylvatica																													
Stellaria alsine																													
Stellaria holostea													2																
Taxus baccata																													
Taxus baccata seedling															1														
Teucrium scorodonia					2			1													1	1			2		1		
Thuidium tamariscinum			3						1	1	4	4	3	3	2	2	4	4	6		1	5	5	3	3	4	1	5	4
Tilia cordata						3		6	1																				1
Urtica dioica																													
Veronica montana																						1				1			
Viola sp.			3		2		1		1			4		3	2	1	2	1				1		3		2			3
Leaf litter	5	7	4	9		8	1	8	8	8	7	7	9	9	7	9		4	8	8	9	8	7	8	9	9	9	7	
Bare ground																													

Appendix 2. Oak woodland TWINSPAN output

QUADRAT DIVISION 1 Number of quadrates in cluster = 54
eigenvalue = 0.19 number of iterations = 4
Indicators and their sign
Corylus avellana [-];
Oxalis acetosella [-];
Dicranella heteromalla [+];
Carex remota [+];
The maximum indicator score for the negative group = 0
The minimum indicator score for the positive group = 1
Negative group: 2 Number of objects = 48 comprising:

Q3, Q4, Q5, Q7, Q8, Q9, Q10, 11, 12, 13, 16, 24, 33, 37, 40, 41, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 34, 35, 36, 38, 39, 42, 43, 44, 45, 46, A1, A3, A4, A5, A6, A8, A9,

The borderline negative group: Number of objects = 2 comprising:

27, 28,

The positive group: 3 Number of objects = 6 comprising:

Q1, Q2, Q6, 32, A7, A10,

The misclassified positive:Number of objects = 1 comprising:

Q6,

Species preferring the negative group of quadrats

Acer campestre 1 (10, 0) *Acer pseudoplatanus* 1 (14, 0) *Brachypodium sylvaticum* 1 (32, 2) *Crataegus monogyna* 1 (24, 0) *Crataegus monogyna* seedling 1 (10, 0) *Dryopteris filix-mas* 1 (18, 1) *Euphorbia amagdaloides* 1 (21, 0) *Eurhynichium striatum* 1 (25, 0) *Fagus sylvatica* 1 (18, 0) *Fraxinus excelsior* 1 (29, 1) *Oxalis acetosella* 1 (36, 0) *Thuidium tamariscinum* 1 (31, 1) *Acer campestre* 2 (10, 0) *Acer pseudoplatanus* 2 (14, 0) *Brachypodium sylvaticum* 2 (32, 2) *Crataegus monogyna* 2 (24, 0) *Crataegus monogyna* seedling 2 (10, 0) *Dryopteris filix-mas* 2 (18, 1) *Euphorbia amagdaloides* 2 (21, 0) *Eurhynichium striatum* 2 (25, 0) *Fagus sylvatica* 2 (18, 0) *Fraxinus excelsior* 2 (29, 1) *Oxalis acetosella* 2 (36, 0) *Thuidium tamariscinum* 2 (31, 1) *Corylus avellana* 3 (43, 0) *Thuidium tamariscinum* 3 (14, 0) *Corylus avellana* 4 (43, 0) *Thuidium tamariscinum* 4 (14, 0) *Corylus avellana* 5 (42, 0)

Species biased towards the positive group of quadrats

Agrostis capillaris 1 (14, 5) *Athyrium filix-femina* 1 (5, 2) *Blechnum spicant* 1 (12, 3) *Carex remota* 1 (10, 5) *Carex sylvatica* 1 (8, 3) *Dicranella heteromalla* 1 (2, 4) *Holcus mollis* 1 (9, 3) *Hypericum pulchrum* 1 (0, 3) *Lonicera periclymenum* 1 (15, 4) *Luzula* sp. (? L. *pilosa*) 1 (8, 3) *Lysimachia nemorum* 1 (8, 2) *Mnium hornum* 1 (14, 4) *Polytrichum formosum* 1 (22, 6) *Quercus* sp. hybrids 1 (1, 2) *Rhododendron ponticum* 1 (3, 4) *Scutellaria minor* 1 (6, 2) *Agrostis capillaris* 2 (14, 5) *Athyrium filix-femina* 2 (5, 2) *Blechnum spicant* 2 (12, 3) *Carex remota* 2 (10, 5) *Carex sylvatica* 2 (8, 3) *Dicranella heteromalla* 2 (2, 4) *Holcus mollis* 2 (9, 3) *Hypericum pulchrum* 2 (0, 3) *Lonicera periclymenum* 2 (15, 4) *Luzula* sp. (? L. *pilosa*) 2 (8, 3) *Lysimachia nemorum* 2 (8, 2) *Mnium hornum* 2 (14, 4) *Polytrichum formosum* 2 (22, 6) *Quercus* sp. hybrids 2 (1, 2) *Rhododendron ponticum* 2 (3, 4) *Scutellaria minor* 2 (6, 2) *Blechnum spicant* 3 (2, 2) *Polytrichum formosum* 3 (0, 3) *Quercus* sp. hybrids 3 (0, 2) *Blechnum spicant* 4 (2, 2) *Polytrichum formosum* 4 (0, 3) *Quercus* sp. hybrids 4 (0, 2) *Betula pendula* 5 (6, 2) *Betula pubescens* 5 (5, 2) *Blechnum spicant* 5 (0, 2) *Pteridium aquilinum* 5 (12, 3) *Quercus* sp. hybrids 5 (0, 2)

Species with no quadrat preference

Atrichum undulatum 1 (34, 4) *Betula pendula* 1 (31, 5) *Betula pubescens* 1 (41, 4) *Corylus avellana* 1 (48, 4) *Eurhynichium praelongum* 1 (27, 5) *Fraxinus excelsior* seedling 1 (20, 2) *Hedera helix* 1 (38, 4) *Hyacinthoides*

non-scripta 1 (19, 2) *Ilex aquifolium* 'seedling' 1 (17, 2) *Juncus effusus* 1 (15, 3) *Pteridium aquilinum* 1 (40, 4) *Quercus petraea* 1 (12, 1) *Quercus robur* 1 (46, 4) *Rubus fruticosus* agg. 1 (26, 6) *Viola* sp. 1 (26, 2) *Atrichum undulatum* 2 (34, 4) *Betula pendula* 2 (31, 5) *Betula pubescens* 2 (41, 4) *Corylus avellana* 2 (48, 4) *Eurhynichium praelongum* 2 (27, 5) *Fraxinus excelsior* seedling 2 (20, 2) *Hedera helix* 2 (38, 4) *Hyacinthoides* non-scripta 2 (19, 2) *Ilex aquifolium* 'seedling' 2 (17, 2) *Juncus effusus* 2 (15, 3) *Pteridium aquilinum* 2 (40, 4) *Quercus petraea* 2 (12, 1) *Quercus robur* 2 (46, 4) *Rubus fruticosus* agg. 2 (26, 6) *Viola* sp. 2 (26, 2) *Betula pendula* 3 (11, 2) *Betula pubescens* 3 (14, 2) *Brachypodium sylvaticum* 3 (12, 1) *Pteridium aquilinum* 3 (21, 3) *Quercus robur* 3 (42, 3) *Betula pendula* 4 (11, 2) *Betula pubescens* 4 (14, 2) *Brachypodium sylvaticum* 4 (12, 1) *Pteridium aquilinum* 4 (21, 3) *Quercus robur* 4 (42, 3) *Quercus robur* 5 (39, 3)

END OF LEVEL 1

TWINSPAN QUADRAT CLASSIFICATION LEVEL 1

QUADRAT DIVISION 2 Number of quadrates in cluster = 48
eigenvalue = 0.1627 number of iterations = 6
Indicators and their sign
Thuidium tamariscinum [+];
Dryopteris filix-mas [-];
Acer pseudoplatanus [-];
Ribes sp. [-];
The maximum indicator score for the negative group = -2
The minimum indicator score for the positive group = -1
Negative group: 4 Number of objects = 9 comprising:

Q3, Q4, Q5, 16, 33, 15, 17, A1, A8,

The misclassified negatives: Number of objects = 3 comprising:

Q5, 33, 15,

The positive group: 5 Number of objects = 39 comprising:

Q7, Q8, Q9, Q10, 11, 12, 13, 24, 37, 40, 41, 14, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 34, 35, 36, 38, 39, 42, 43, 44, 45, 46, A3, A4, A5, A6, A9,

The borderline positive group: Number of objects = 6 comprising:

Q9, 40, 14, 27, 45, A6,

Species preferring the negative group of quadrats

Acer pseudoplatanus 1 (6, 8) *Ajuga reptans* 1 (2, 0) *Campylopus introflexus* 1 (3, 5) *Castanea sativa* 1 (4, 1) *Dicranella heteromalla* 1 (3, 2) *Dicranum scoparium* 1 (7, 11) *Fissidens* sp. 1 (3, 0) *Frangula alnus* 1 (3, 0) *Galium palustre* 1 (6, 13) *Hedera helix* 1 (3, 3) *Hypericum pulchrum* 1 (3, 3) *Isothecium myosuroides* 1 (3, 5) *Potentilla erecta* 1 (2, 1) *Prunus* sp. 1 (4, 0) *Quercus robur* 1 (2, 2) *Quercus* sp. seedling 1 (3, 2) *Rhytidiadelphus triquetrus* 1 (2, 1) *Sorbus aucuparia* 2 (6, 8) *Stellaria holostea* 2 (2, 0) *Anthoxanthum odoratum* 2 (3, 5) *Atrichum undulatum* 2 (4, 1) *Carex sylvatica* 2 (3, 2) *Castanea sativa* 2 (7, 11) *Dryopteris dilatata* 2 (3, 0) *Dryopteris filix-mas* 2 (3, 0) *Euphorbia amagdaloides* 2 (6, 13) *Fagus sylvatica* 2 (3, 3) *Fissidens* sp. 2 (3, 3) *Galium palustre* 2 (3, 5) *Lysimachia nemorum* 2 (2, 1) *Mercurialis perennis* 2 (4, 0) *Pinus* sp. 2 (2, 2) *Polytrichum formosum* 2 (3, 2) *Potentilla sterilis* 2 (2, 1) *Quercus* sp. hybrids 3 (2, 1) *Rhytidiadelphus loreus* 3 (2, 4) *Rhytidiadelphus triquetrus* 3 (4, 7) *Salix* spp. (incl. S. *cinerea*) 3 (2, 1) *Tilia cordata* 3 (2, 0) *Agrostis capillaris* 3 (4, 1) *Agrostis stolonifera* 3 (2, 2) *Betula pendula* 3 (3, 4) *Carex sylvatica* 3 (2, 0) *Deschampsia cespitosa* 4 (2, 1) *Erica tetralix* 4 (2, 4) *Euphorbia amagdaloides* 4 (4, 7) *Glechoma hederacea* 4 (2, 1) *Quercus petraea* 4 (2, 0) *Stellaria holostea* 4 (4, 1) *Thuidium tamariscinum* 4 (2, 2) *Viola* sp. 4 (3, 4) *Atrichum undulatum* 4 (2, 0) *Carex sylvatica* 5 (2, 1) *Corylus avellana* 5 (3, 3) *Dryopteris dilatata* 5 (2, 1) *Hyacinthoides non-scripta* 5 (2, 0)

Species biased towards the positive group of quadrats

Acer campestre 1 (0, 10) *Agrostis capillaris* 1 (1, 13) *Betula* sp. seedling 1 (1, 11) *Brachypodium sylvaticum* 1 (0, 10) *Digitalis purpurea* 1 (0, 8) *Dryopteris filix-mas* 1 (2, 23) *Ilex aquifolium* 'seedling' 1 (0, 8) *Lamiastrum galeobdolon* 1 (1, 13) *Luzula* sp. (? *L. pilosa*) 1 (1, 21) *Pinus* sp. 1 (0, 12) *Rubus fruticosus* agg. 1 (2, 29) *Scutellaria minor* 2 (0, 10) *Sorbus aucuparia* seedling 2 (1, 13) *Agrostis capillaris* 2 (1, 11) *Alnus glutinosa* 2 (0, 10) *Carpinus betulus* 2 (0, 8) *Cirsium arvense* 2 (2, 23) *Fraxinus excelsior* seedling 2 (0, 8) *Holcus mollis* 2 (1, 13) *Ilex aquifolium* 2 (1, 21) *Lonicera periclymenum* 2 (0, 12) *Pseudoscleropodium purum* 2 (2, 29) *Betula pubescens* 3 (2, 19) *Blechnum spicant* 3 (0, 8) *Carpinus betulus* 3 (0, 14) *Acer pseudoplatanus* 4 (2, 19) *Agrostis capillaris* 4 (0, 8) *Betula pubescens* 4 (0, 14)

Species with no quadrat preference

Atrichum undulatum 1 (7, 27) *Betula pendula* 1 (7, 24) *Betula pubescens* 1 (7, 34) *Brachythecium rutabulum* 1 (6, 26) *Circaea lutetiana* 1 (9, 39) *Cirsium arvense* 1 (4, 20) *Cornus sanguinea* 1 (2, 8) *Diplophyllum albicans* 1 (3, 18) *Dryopteris dilatata* 1 (5, 22) *Dryopteris* sp. 1 (2, 16) *Fagus sylvatica* seedling 1 (5, 24) *Festuca gigantea*

1 (3, 17) *Fraxinus excelsior* 1 (8, 30) *Fraxinus excelsior* seedling 1 (1, 8) *Holcus mollis* 1 (4, 13) *Hypericum androsaemum* 1 (2, 13) *Hypnum cupressiforme* 1 (2, 13) *Leucobryum glaucum* 1 (7, 29) *Melica* uniflora 1 (1, 8) *Pellia* sp. 1 (5, 35) *Plagiomnium undulatum* 1 (8, 38) *Pteridium aquilinum* 1 (6, 20) *Sanicula europaea* 1 (5, 21) *Viola* sp. 2 (7, 27) *Acer campestre* 2 (7, 24) *Acer pseudoplatanus* 2 (7, 34) *Ajuga reptans* 2 (6, 26) *Betula* sp. seedling 2 (9, 39) *Blechnum spicant* 2 (4, 20) *Brachythecium rutabulum* 2 (2, 8) *Carpinus betulus* seedling 2 (3, 18) *Circaea lutetiana* 2 (5, 22) *Cornus sanguinea* 2 (2, 16) *Dicranum scoparium* 2 (5, 24) *Digitalis purpurea* 2 (3, 17) *Dryopteris* sp. 2 (8, 30) *Erica tetralix* 2 (1, 8) *Fagus sylvatica* seedling 2 (4, 13) *Festuca rubra* 2 (2, 13) *Frangula alnus* 2 (2, 13) *Hyacinthoides* non-scripta 2 (7, 29) *Juncus acutiflorus* 2 (1, 8) *Leucobryum glaucum* 2 (5, 35) *Lophocolea cuspidata* 2 (8, 38) *Oxalis acetosella* 2 (6, 20) *Quercus robur* 2 (5, 21) *Ribes* sp. 3 (3, 11) *Rubus fruticosus* agg. 3 (3, 9) *Scutellaria minor* 3 (6, 37) *Brachypodium sylvaticum* 3 (5, 37) *Eurhynichium praelongum* 4 (3, 11) *Fagus sylvatica* 4 (3, 9) *Hyacinthoides non-scripta* 4 (6, 37) *Agrostis stolonifera* 4 (5, 37) *Deschampsia cespitosa* 5 (2, 6) *Dryopteris filix-mas* 5 (5, 37) *Fraxinus excelsior* 5 (2, 10) *Holcus mollis* 5 (5, 34)

QUADRAT DIVISION 5 Number of quadrates in cluster = 39
eigenvalue = 0.1505 number of iterations = 6
Indicators and their sign
Mnium hornum [-];
Pteridium aquilinum [+];
Polytrichum formosum [+];
The maximum indicator score for the negative group = 0
The minimum indicator score for the positive group = 1
Negative group: 10 Number of objects = 16 comprising:

Q9, Q10, 24, 37, 40, 41, 26, 31, 34, 38, 39, 45, 46, A3, A5, A6,

The borderline negative group: Number of objects = 1 comprising:

46,

The misclassified negatives: Number of objects = 2 comprising:

34, A3,

The positive group: 11 Number of objects = 23 comprising:

Q7, Q8, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 25, 27, 28, 30, 35, 36, 42, 43, 44, A4, A9,

The borderline positive group: Number of objects = 6 comprising:

11, 14, 19, 23, 25, 42,

Species preferring the negative group of quadrats

Acer campestre 1 (9, 1) *Betula pubescens* 1 (4, 1) *Brachythecium rutabulum* 1 (6, 1) *Carpinus betulus* seedling 1 (6, 2) *Crataegus monogyna* seedling 1 (7, 4) *Euphorbia amagdaloides* 1 (11, 6) *Fagus sylvatica* seedling 1 (10, 3) *Hypericum androsaemum* 1 (10, 3) *Juncus acutiflorus* 1 (5, 3) *Prunus* sp. 2 (9, 1) *Rubus fruticosus* agg. 2 (4, 1) *Sanicula europaea* 2 (6, 1) *Thuidium tamariscinum* 2 (6, 2) *Agrostis capillaris* 2 (7, 4) *Betula pubescens* 2 (11, 6) *Brachypodium sylvaticum* 2 (10, 3) *Crataegus monogyna* seedling 2 (10, 3) *Dryopteris dilatata* 2 (5, 3) *Oxalis acetosella* 3 (6, 1) *Stellaria holostea* 4 (6, 1) *Castanea sativa* 5 (4, 2) *Crataegus monogyna* 5 (4, 0)

Species biased towards the positive group of quadrats

Blechnum spicant 1 (2, 8) *Diplophyllum albicans* 1 (3, 13) *Fagus sylvatica* 1 (0, 8) *Geranium robertianum* 1 (3, 10) *Hedera helix* 1 (2, 6) *Ilex aquifolium* 1 (3, 18) *Juncus conglomeratus* 1 (0, 6) *Polytrichum formosum* 1 (1, 5) *Salix* spp. (incl. *S. cinerea*) 2 (2, 8) *Anthoxanthum odoratum* 2 (3, 13) *Brachythecium rutabulum* 2 (0, 8) *Circaea lutetiana* 2 (3, 10) *Cornus sanguinea* 2 (2, 6) *Dicranum scoparium* 2 (3, 18) *Dryopteris filix-mas* 2 (0, 6) *Hedera helix* 2 (1, 5) *Populus tremula* 3 (3, 16) *Veronica montana* 4 (3, 16) *Dryopteris filix-mas* 5 (0, 10)

Species with no quadrat preference

Acer pseudoplatanus 1 (4, 4) *Agrostis capillaris* 1 (5, 8) *Arctium* sp. 1 (11, 16) *Athyrium filix-femina* 1 (9, 15) *Atrichum undulatum* 1 (13, 21) *Betula pendula* 1 (4, 7) *Betula* sp. seedling 1 (13, 13) *Castanea sativa* 1 (16, 23) *Carpinus betulus* 1 (6, 14) *Deschampsia cespitosa* 1 (4, 4) *Dicranella heteromalla* 1 (8, 10) *Dicranum scoparium* 1 (9, 13) *Digitalis purpurea* 1 (8, 15) *Erica tetralix* 1 (11, 13) *Eurhynichium striatum* 1 (13, 17) *Frangula alnus* 1 (7, 6) *Fraxinus excelsior* seedling 1 (4, 9) *Hypericum pulchrum* 1 (12, 17) *Juncus effusus* 1 (13, 22) *Lamiastrum galeobdolon* 1 (4, 8) *Leucobryum glaucum* 1 (16, 22) *Melica uniflora* 1 (6, 14) *Populus tremula* 1 (9, 20) *Prunus spinosa* 1 (9, 12) *Pseudoscleropodium purum* 2 (4, 4) *Pteridium aquilinum* 2 (5, 8) *Rhytidiadelphus loreus* 2 (11, 16) *Rhytidiadelphus triquetrus* 2 (9, 15) *Ribes* sp. 2 (13, 21) *Rosa* sp. 2 (4, 7) *Ruscus aculeatus* 2 (13, 13) *Taxus baccata* seedling 2 (16, 23) *Teucrium scorodonia* 2 (6, 14) *Agrostis stolonifera* 2 (4, 4) *Ajuga reptans* 2 (8, 10) *Alnus glutinosa* 2 (9, 13) *Anemone nemorosa* 2 (8, 15) *Betula pendula* 2 (11, 13) *Blechnum spicant* 2 (13, 17) *Carex sylvatica* 2 (7, 6) *Carpinus betulus* 2 (4, 9) *Deschampsia cespitosa* 2 (12, 17) *Dryopteris* sp. 2 (13, 22) *Erica tetralix* 2 (4, 8) *Euphorbia amagdaloides* 2 (16, 22) *Fissidens* sp. 2 (6, 14) *Holcus mollis* 2 (9, 20) *Hypericum pulchrum* 2 (9, 12) *Juncus conglomeratus* 3 (4, 7)

Lamiastrum galeobdolon 3 (5, 4) *Luzula multiflora* 3 (16, 21*) Potentilla erecta* 3 (3, 5) *Potentilla sterilis* 3 (16, 21) *Prunus spinosa* 3 (4, 10) *Rhododendron ponticum* 4 (4, 7) *Rhytidiadelphus triquetrus* 4 (5, 4) *Ruscus aculeatus* 4 (16, 21) *Viola* sp. 4 (3, 5) *Acer pseudoplatanus* 4 (16, 21) *Agrostis capillaris* 4 (4, 10*) Corylus avellana* 5 (16, 21) *Euphorbia amagdaloides* 5 (14, 20)

Appendix 2. Alder woodland TWINSPAN Output

QUADRAT DIVISION 1 Number of quadrates in cluster = 6
eigenvalue = 0.3746 number of iterations = 2
Indicators and their sign
Athyrium filix-femina [+];
The maximum indicator score for the negative group = 0
The minimum indicator score for the positive group = 1
Negative group: 2 Number of objects = 4 comprising:

29, 49, A2, A11,

The positive group: 3 Number of objects = 2 comprising:

47, 48,

Species preferring the negative group of quadrats

Agrostis capillaris 1 (1, 0) *Anemone nemorosa* 1 (2, 0) *Atrichum undulatum* 1 (2, 0) *Cardamine* sp. 1 (1, 0) *Carex remota* 1 (4, 1) *Carex sylvatica* 1 (2, 0) *Circaea lutetiana* 1 (4, 1) *Chrysosplenium oppositifolium* 1 (3, 0) *Crataegus monogyna* 1 (1, 0) *Deschampsia cespitosa* 1 (1, 0) *Fagus sylvatica* 1 (2, 0) *Filipendula ulmaria* 1 (2, 0) *Fissidens* sp. 1 (1, 0) *Galium palustre* 1 (3, 0) *Ilex aquifolium* 1 (1, 0) *Isothecium myosuroides* 1 (1, 0) *Mnium hornum* 1 (1, 0) *Pellia* sp. 1 (1, 0) *Populus* sp. 1 (1, 0) *Potentilla sterilis* 1 (1, 0) *Ranunculus repens* 1 (1, 0) *Agrostis capillaris* 2 (1, 0) *Anemone nemorosa* 2 (2, 0) *Atrichum undulatum* 2 (2, 0) *Cardamine* sp. 2 (1, 0) *Carex remota* 2 (4, 1) *Carex sylvatica* 2 (2, 0) *Circaea lutetiana* 2 (4, 1) *Chrysosplenium oppositifolium* 2 (3, 0) *Crataegus monogyna* 2 (1, 0) *Deschampsia cespitosa* 2 (1, 0) *Fagus sylvatica* 2 (2, 0) *Filipendula ulmaria* 2 (2, 0) *Fissidens* sp. 2 (1, 0) *Galium palustre* 2 (3, 0) *Ilex aquifolium* 2 (1, 0) *Isothecium myosuroides* 2 (1, 0) *Mnium hornum* 2 (1, 0) *Pellia* sp. 2 (1, 0) *Populus* sp. 2 (1, 0) *Potentilla sterilis* 2 (1, 0) *Ranunculus repens* 2 (1, 0) *Acer pseudoplatanus* 3 (1, 0) *Atrichum undulatum* 3 (1, 0) *Carex remota* 3 (3, 0) *Chrysosplenium oppositifolium* 3 (1, 0) *Corylus avellana* 3 (2, 0) *Ilex aquifolium* 3 (1, 0) *Mentha aquatica* 3 (2, 0) *Quercus robur* 3 (1, 0) *Ranunculus repens* 3 (1, 0) *Ribes* sp. 3 (1, 0) *Acer pseudoplatanus* 4 (1, 0) *Atrichum undulatum* 4 (1, 0) *Carex remota* 4 (3, 0) *Chrysosplenium oppositifolium* 4 (1, 0) *Corylus avellana* 4 (2, 0) *Ilex aquifolium* 4 (1, 0) *Mentha aquatica* 4 (2, 0) *Quercus robur* 4 (1, 0) *Ranunculus repens* 4 (1, 0) *Ribes* sp. 4 (1, 0) *Acer pseudoplatanus* 5 (1, 0) *Carex remota* 5 (3, 0) *Chrysosplenium oppositifolium* 5 (1, 0) *Corylus avellana* 5 (2, 0) *Quercus robur* 5 (1, 0)

Species biased towards the positive group of quadrats

Acer campestre 1 (1, 1) *Acer pseudoplatanus* 1 (1, 2) *Ajuga reptans* 1 (1, 1) *Athyrium filix-femina* 1 (0, 2) *Betula pendula* 1 (0, 1) *Cirriphyllum cuspidatum* 1 (0, 1) *Digitalis purpurea* 1 (0, 1) *Dryopteris dilatata* 1 (1, 1) *Dryopteris* sp. 1 (1, 1) *Euonymus europaeus* 1 (0, 1) *Eurhynichium striatum* 1 (0, 1) *Fraxinus excelsior* seedling 1 (1, 2) *Geranium robertianum* 1 (2, 2) *Geum urbanum* 1 (2, 2) *Glechoma hederacea* 1 (0, 2) *Holcus mollis* 1 (0, 1) *Hyacinthoides non-scripta* 1 (1, 1) *Impatiens glandulifera* 1 (0, 1) *Juncus effusus* 1 (1, 1) *Lonicera periclymenum* 1 (0, 1) *Lycopus europaeus* 1 (0, 1) *Malus sylvestris* 1 (0, 1) *Mercurialis perennis* 1 (2, 2) *Oxalis acetosella* 1 (2, 2) *Plagiomnium undulatum* 1 (2, 2) *Prunus* sp. 1 (0, 1) *Pteridium aquilinum* 1 (0, 1) *Quercus robur* 1 (2, 2) *Quercus* sp. seedling 1 (0, 1) *Rhytidiadelphus triquetrus* 1 (0, 1) *Ribes* sp. 1 (2, 2) *Rumex sanguineus* 1 (1, 1) *Salix* spp. (incl. *S. cinerea*) 1 (0, 2) *Sanicula europaea* 1 (1, 1) *Scrophularia nodosa* 1 (0, 1) *Sorbus aucuparia* 1 (0, 1) *Stellaria alsine* 1 (0, 1) *Taxus baccata* 1 (0, 1) *Teucrium scorodonia* 1 (0, 1) *Thuidium tamariscinum* 1 (1, 2) *Urtica dioica* 1 (1, 2) *Veronica montana* 1 (1, 2) *Acer campestre* 2 (1, 1) *Acer pseudoplatanus* 2 (1, 2) *Ajuga reptans* 2 (1, 1) *Athyrium filix-femina* 2 (0, 2) *Betula pendula* 2 (0, 1) *Cirriphyllum cuspidatum* 2 (0, 1) *Digitalis purpurea* 2 (0, 1) *Dryopteris dilatata* 2 (1, 1) *Dryopteris* sp. 2 (1, 1) *Euonymus europaeus* 2 (0, 1) *Eurhynichium striatum* 2 (0, 1) *Fraxinus excelsior* seedling 2 (1, 2) *Geranium robertianum* 2 (2, 2) *Geum urbanum* 2 (2, 2) *Glechoma hederacea* 2 (0, 2) *Holcus mollis* 2 (0, 1) *Hyacinthoides non-scripta* 2 (1, 1) *Impatiens glandulifera* 2 (0, 1) *Juncus effusus* 2 (1, 1) *Lonicera periclymenum* 2 (0, 1) *Lycopus europaeus* 2 (0, 1) *Malus sylvestris* 2 (0, 1) *Mercurialis perennis* 2 (2, 2) *Oxalis acetosella* 2 (2, 2) *Plagiomnium undulatum* 2 (2, 2) *Prunus* sp. 2 (0, 1) *Pteridium aquilinum* 2 (0, 1) *Quercus robur* 2 (2, 2) *Quercus* sp. seedling 2 (0, 1) *Rhytidiadelphus triquetrus* 2 (0, 1) *Ribes* sp. 2 (2, 2) *Rumex sanguineus* 2 (1, 1) *Salix* spp. (incl. *S. cinerea*) 2 (0, 2) *Sanicula europaea* 2 (1, 1) *Scrophularia nodosa* 2 (0, 1) *Sorbus aucuparia* 2 (0, 1) *Stellaria alsine* 2 (0, 1) *Taxus baccata* 2 (0, 1) *Teucrium scorodonia* 2 (0, 1) *Thuidium tamariscinum* 2 (1,

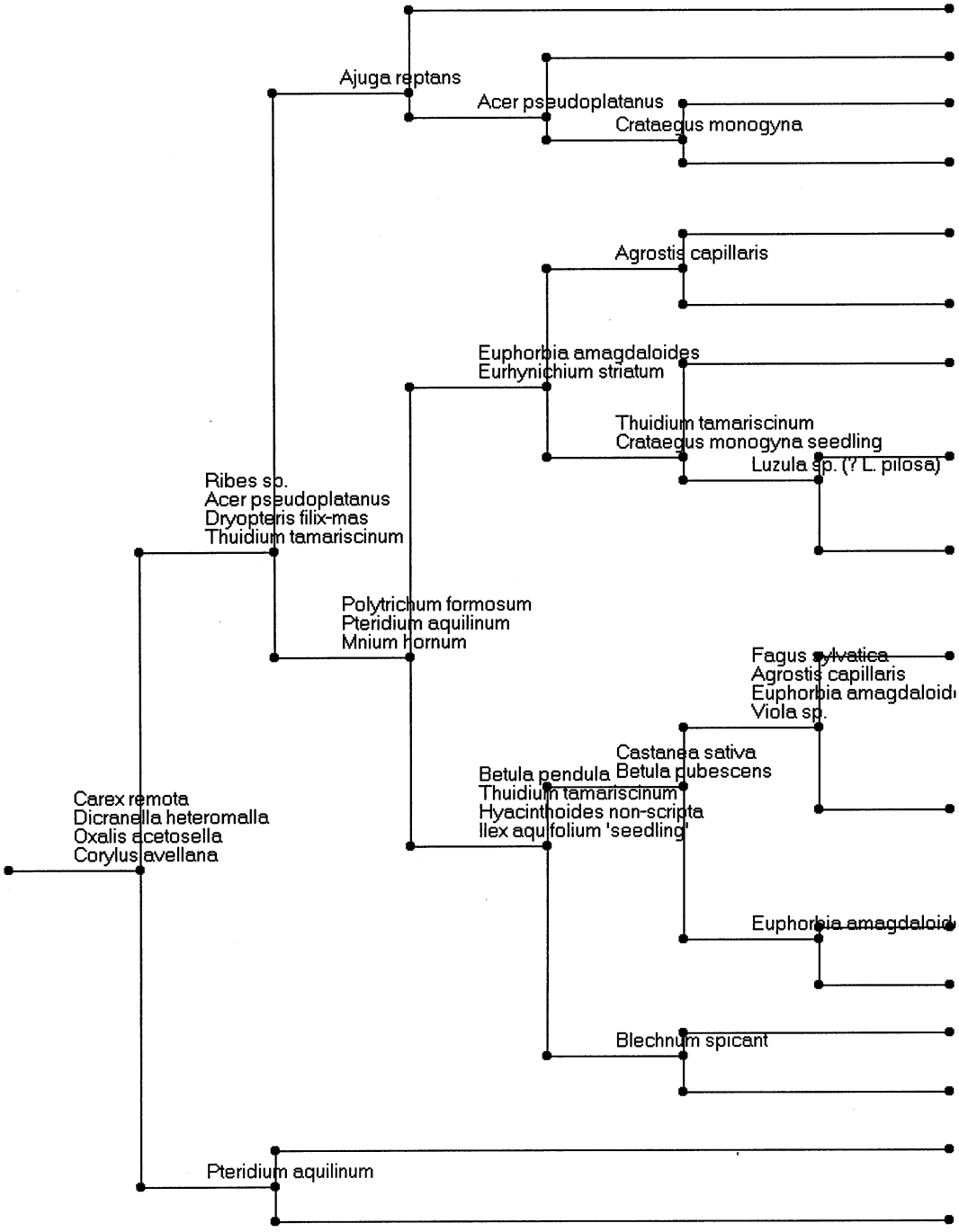
2) *Urtica dioica* 2 (1, 2) *Veronica montana* 2 (1, 2) *Betula pubescens* 3 (0, 1) *Brachypodium sylvaticum* 3 (2, 2) *Eurhynichium praelongum* 3 (0, 1) *Geranium robertianum* 3 (0, 1) *Glechoma hederacea* 3 (0, 1) *Holcus mollis* 3 (0, 1) *Mercurialis perennis* 3 (1, 2) *Plagiomnium undulatum* 3 (1, 1) *Thuidium tamariscinum* 3 (0, 2) *Betula pubescens* 4 (0, 1) *Brachypodium sylvaticum* 4 (2, 2) *Eurhynichium praelongum* 4 (0, 1) *Geranium robertianum* 4 (0, 1) *Glechoma hederacea* 4 (0, 1) *Holcus mollis* 4 (0, 1) *Mercurialis perennis* 4 (1, 2) *Plagiomnium undulatum* 4 (1, 1) *Thuidium tamariscinum* 4 (0, 2) *Brachypodium sylvaticum* 5 (2, 2) *Mercurialis perennis* 5 (1, 1)

Species with no quadrat preference

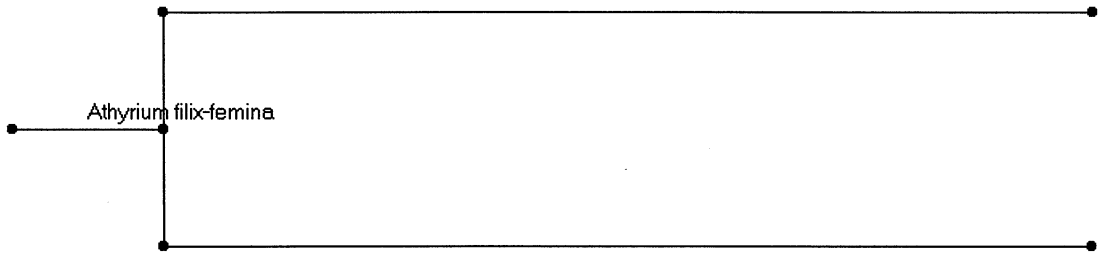
Alnus glutinosa 1 (4, 2) *Betula pubescens* 1 (4, 2) *Brachypodium sylvaticum* 1 (3, 2) *Corylus avellana* 1 (4, 2) *Dryopteris filix-mas* 1 (2, 1) *Euphorbia amagdaloides* 1 (2, 1) *Eurhynichium praelongum* 1 (3, 2) *Fraxinus excelsior* 1 (4, 2) *Hedera helix* 1 (3, 1) *Lamiastrum galeobdolon* 1 (2, 1) *Lysimachia nemorum* 1 (4, 2) *Mentha aquatica* 1 (3, 2) *Rubus fruticosus* agg. 1 (2, 1) *Viola* sp. 1 (3, 2) *Alnus glutinosa* 2 (4, 2) *Betula pubescens* 2 (4, 2) *Brachypodium sylvaticum* 2 (3, 2) *Corylus avellana* 2 (4, 2) *Dryopteris filix-mas* 2 (2, 1) *Euphorbia amagdaloides* 2 (2, 1) *Eurhynichium praelongum* 2 (3, 2) *Fraxinus excelsior* 2 (4, 2) *Hedera helix* 2 (3, 1) *Lamiastrum galeobdolon* 2 (2, 1) *Lysimachia nemorum* 2 (4, 2) *Mentha aquatica* 2 (3, 2) *Rubus fruticosus* agg. 2 (2, 1) *Viola* sp. 2 (3, 2) *Alnus glutinosa* 3 (4, 2) *Fraxinus excelsior* 3 (3, 1) *Alnus glutinosa* 4 (4, 2) *Fraxinus excelsior* 4 (3, 1) *Alnus glutinosa* 5 (4, 2) *Fraxinus excelsior* 5 (3, 1)

END OF LEVEL 1

Appendix 3. Oak Woodland TWINSPAN Dendrogram (samples)



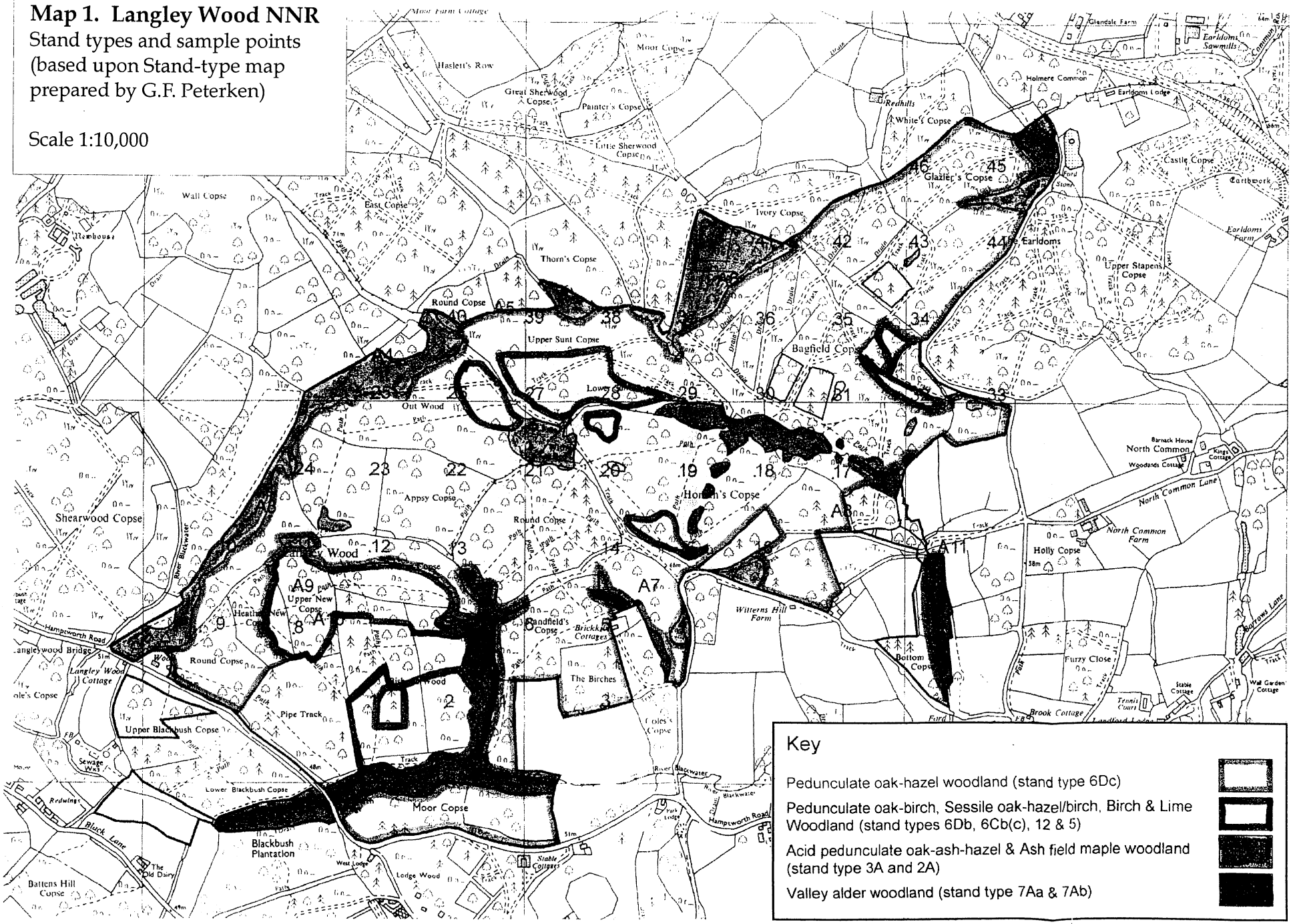
Appendix 4. Alder Woodland TWINSPAN Dendrogram (samples)



Map 1. Stand types and sample points

Map 1. Langley Wood NNR
Stand types and sample points (based upon Stand-type map prepared by G.F. Peterken)

Scale 1:10,000

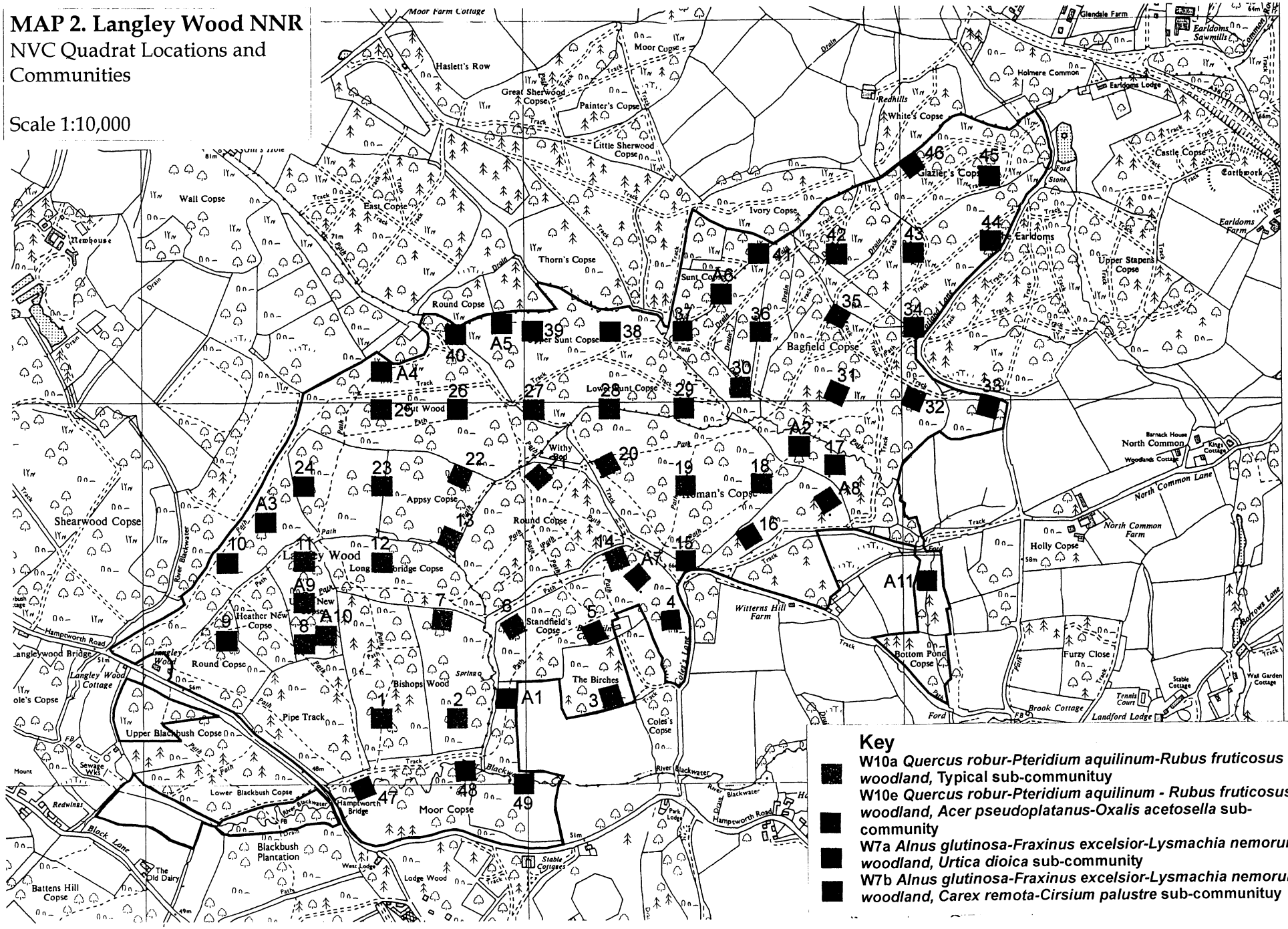


Map 2. Quadrat locations

MAP 2. Langley Wood NNR

NVC Quadrat Locations and Communities

Scale 1:10,000



Key

- W10a *Quercus robur-Pteridium aquilinum-Rubus fruticosus woodland*, Typical sub-communituy
- W10e *Quercus robur-Pteridium aquilinum - Rubus fruticosus woodland, Acer pseudoplatanus-Oxalis acetosella* sub-community
- W7a *Alnus glutinosa-Fraxinus excelsior-Lysmachia nemorum woodland, Urtica dioica* sub-community
- W7b *Alnus glutinosa-Fraxinus excelsior-Lysmachia nemorum woodland, Carex remota-Cirsium palustre* sub-communituy