RESEARCH ON THE IMPACT OF AMERICAN SKUNK CABBAGE *LYSICHITON AMERICANUS* ON NATIVE VEGETATION

January 2013
N A Sanderson BSc MSc
for Hampshire and Isle of Wight Wildlife Trust

NEIL SANDERSON
Botanical Survey
and
Assessment

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Report commissioned by Hampshire & Isle of Wight Wildlife Trust on behalf of The New Forest Non-Native Plants Project

Hampshire & Isle of Wight Wildlife Trust
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NATURAL ENGLAND
NEW FOREST NATIONAL PARK
Forestry Commission England
Environment Agency

NEW FOREST NON–NATIVE PLANTS PROJECT

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Cover Picture: Harcourt Wood, riverine woodland developing on the base of a former millpond, showing an area heavily invaded by Skunk Cabbage.

NEW FOREST NON–NATIVE PLANTS PROJECT RESEARCH ON THE IMPACT OF SKUNK CABBAGE ***LYSICHITON AMERICANUS*** ON NATIVE VEGETATION

1.0 INTRODUCTION

1.1 Background

1.1.1 The New Forest Non-Native Plants Project

The New Forest Non-Native Plants Project is hosted by Hampshire and Isle of Wight Wildlife Trust (HIWWT). The Project was set up in 2009 and is jointly funded by a partnership of local and national organisations including HIWWT, Environment Agency, Defra, Natural England, Forestry Commission and the New Forest National Park Authority. The Project aims to stop the spread of invasive non-native plants in the New Forest area, particularly along watercourses and in other wetland habitats.

Species currently being tackled by the Project include Himalayan Balsam, Giant Hogweed, Japanese Knotweed, American Skunk Cabbage, Parrot's Feather, Creeping Water Primrose and Bog Arum. The Project is undertaking trials to assess the effectiveness of methods to control New Zealand Pygmyweed.

The New Forest Non-Native Plants Project recognises the need for ecologically important habitats to be safeguarded from potential invasion from non-native species and recognises the need to restore formerly diverse habitats that have been degraded through invasion by non-native species.

1.12 The Invasive Non-Native Species Framework Strategy for Great Britain

The New Forest Non-Native Plants Project helps to implement, at the local level, The Invasive Non-Native Species Framework Strategy for Great Britain published by Defra in 2008. The Strategy recognises (paragraph 11.2) that "Research is a key area in relation to invasive non-native species. It is vital that we underpin policy with a strong evidence base and research outcomes will often be a key component helping to inform risk assessment, surveillance, detection, monitoring, control and eradication strategies".

1.1.3 Need for Research on the Impact of Invasive Non-natives on Native Vegetation

The New Forest Non-Native Plants Project has recognised the need for research to be undertaken (and disseminated) to assess the impact of invasive non-native plant species on native vegetation. The New Forest is characterised by high quality habitats, many of which are recognised as being of national or international importance through statutory designation.

1.2 Brief

1.2.1 Priority species for research during 2012, American Skunk cabbage

The New Forest Non-Native Plants Project has identified American Skunk Cabbage ***Lysichiton americanus*** as the next highest priority species for research to be undertaken in the New Forest area during 2012 after Himalayan Balsam ***Impatiens glandulifera***. The problems caused by the spread of American skunk cabbage have only recently been recognised at a national level. During 2010 the Centre for Ecology

and Hydrology started to gather information relating to the distribution and impacts of Skunk Cabbage as the Government was aware there was a lack of information about its economic, social, habitat and biodiversity impacts. The New Forest Non-Native Plants Project contributed information to CEH regarding the distribution of Skunk Cabbage and recognised the need for detailed research to be undertaken to assess the impact of this species on native vegetation in the New Forest area.

1.2.2 Aim of the research

To describe the characteristics of the native vegetation susceptible to invasion by American skunk cabbage in the New Forest area and to indicate the relative ecological value of these habitats in a national context.

1.2.3 Methodology

The research will involve vegetation surveys within random quadrats or along random transects at a number of 'plots' susceptible to invasion by American skunk cabbage. The research will describe the habitats using National Vegetation Classification (NVC) terminology, with notes on species of particular interest.

In liaison with the Project Officer, research plots relating to invasion by American skunk cabbage will be identified within:

- Harcourt Wood near Minstead
- HIWWT nature reserve at Ampress in the Lymington River Reedbeds Site of Special Scientific Interest (SSSI).

2.0 METHODS

2.1 Vegetation Survey

2.1.1 Sites

Two sites were studied, one in riverine woodland on the floodplain of the Fleet Water at Harcourt Wood, north of Lyndhurst, at the head of the Bartley Water. This is a privately-owned woodland but leased to the Forestry Commission. Here two separate areas were sampled, Area 1 an area of riverine Alder wood on the site of a former mill pond and Area 2 an area of Alder and Ash – Hazel riverine woodland upstream of this (Map 1). The second was in swamp woodland by the Lymington River by Ampress Camp, Lymington, which is part of Hampshire and Isle of Wight Wildlife Trust's Lymington Reedbeds Nature Reserve and in the Lymington River Reedbeds Site of Special Scientific Interest (SSSI). At the first site no control measures had been carried out, providing ideal conditions to determine the impact of Skunk Cabbage ***Lysichiton americanus*** on native vegetation. At the second site control of Skunk Cabbage ***Lysichiton americanus*** had started in 2010 but the impact of large patches of Skunk Cabbage was still very evident.

2.1.2 Timing

The field survey at Harcourt Wood was carried out on 16th May 2012. The site included Ash – Hazel riverine woodland on better drained alluvium rich in spring ephemerals, requiring an early season survey. The survey of the Alder swamp at Ampress was carried out on the 26th July 2012. This habitat lacked spring ephemerals, allowing scheduling of this survey latter in the year.

2.1.3 Landscape History

The landscape history of the sites was briefly assessed using freely available map sources. These were:

- Thomas Milne's 1" map of Hampshire, 1791. A detailed county map of Hampshire. Available at the website "Old Hampshire Mapped". A detailed county maps surveyed independently of the Old Series Ordnance Survey.
- Surveyors Drawings for the first series 1" OS Map for the area can be found on the British Library website "British Library, Online Gallery, Ordnance Survey Drawings". The sites are covered by the 1807 2" Salisbury (OSD 76) and 1797 3" Christchurch Ordnance Surveyors Drawing (OSD 75 pt.1).
- Various historic 25" Ordnance Survey plans and 6" maps presented on the "old Maps" website, starting from 1868.
- The Land Utilisation Survey of Great Britain of the 1930s is available on the website "A Vision of Britain through Time". This shows areas that were then woodland, rough pasture, enclosed pasture, arable, housing and industry. The areas are covered by the 1933 Isle of Wight Sheet 14 and the 1933 Ringwood Sheet 131.

2.1.4 Vegetation

The vegetation was described with reference to the National Vegetation Classification (NVC) (Rodwell, 1991). Sample quadrats were taken using the sample

methods as the NVC, with 4 x 4m quadrats to sample the ground flora. The cover of the ground flora species was recorded using the Domin as described in Rodwell (1991). The canopy was recorded in a 50 x 50m area but cover was not estimated. In constrained communities of limited area representative areas were chosen by eye. Where large areas of more uniform vegetation occurred, less subjective methods of quadrat placement along transects were used described in Section 2.1.5. Quadrats were photographed (all photos can be seen in web galley Harcourt & Ampress Gallery).

Species list were made for the habitats studied, recording both vascular plants and bryophytes. Frequency was recorded using the DAFOR scale (D= Dominant, A = Abundant, F = Frequent, O = Occasional & R = Rare). Notes were made on the interest of the lichen and bryophyte epiphytic vegetation but systematic lists were not made.

2.1.5 Sampling

The route taken was recorded on a Garmin GPSmap 62s GPS receiver, on which the quadrat locations and target notes were recorded as waypoints. This data was imported to both Google Earth and MacGPS Pro to place the data on air photographs and OS base maps respectively.

In large areas of uniform vegetation with Skunk Cabbage ***Lysichiton americanus*** present quadrats were recorded along transects. At Harcourt Wood Area 1 a transect was started from at SU29294 09886 (HCQ01a) and followed a bearing of 260º. The transect was a bit difficult to follow. The first quadrat pairs were placed at the start. After the start point, quadrats were placed using random numbers between 1 to 50 generated in Excel 2008 for Mac and taken as meters. Ten pairs of quadrats were placed with paced at distances 10m, 5m, 9m, 43m, 48m, 49m, 18m, 42m, 30m and 23m. At each point two quadrats were placed, one in the nearest area of high Skunk Cabbage cover and a second in the nearest area of low Skunk Cabbage cover. The two quadrats were both placed in similar patches of higher ground to avoid flood channels.

In Ampress a transect was taken from SZ32249 96912 (LA1a) to SZ32290 96816 (LA5a) following a bearing of approximately 155º. The terrain was very difficult to get through due to wetness. The former Skunk Cabbage patches, treated in 2010 and 2011, were much less frequent than in Harcourt Wood, so five quadrat pairs were placed where ever a large patch of Skunk Cabbage had occurred. At these one quadrat was placed within the areas treated and one adjacent on similar ground in vegetation with little or no Skunk Cabbage.

2.2 Data

2.2.1 Nomenclature

The nomenclature follows Stace (2010) for vascular plants and Hill et al (2008) for bryophytes. The lichen nomenclature follows Smith et al (2009) for lichens.

The new vascular plant flora (Stace, 2010) introduces some significant changes to familiar names. The synonyms for vascular plants recorded in this survey for those changed since Stace (1997) are listed below:

New name	Old Name
Asplenium scolopendrium	Phyllitis scolopendrium
Betonica officinalis	Stachys officinalis
Callitriche brutia ssp hamulata	Callitriche hamulata
Ficaria verna	Ranunculus ficaria
Hedera helix	Hedera helix ssp helix
Schedonorus gigantea	Festuca gigantea

For bryophytes recent changes are:

New name	Old Name
Calliergonella cuspidata	Calliergon cuspidatum
Kindbergia praelongum	Eurhynchium praelongum
Oxyrrhynchium hians	Eurhynchium swartzii

2.2.2 Indicator Lists

Two lists indicative of habitat quality were regarded of relevance to this site:

- Ancient Woodland Vascular Plants (AWVP) (Rose, 1999): a list of 100 species characteristic of botanically rich woodland in southern England. Species rich woodlands would normally be expected to have over 20 species with only exceptional woods or large complexes with over 40. Full surveys are only possible with spring surveys.

- Ancient Woodland Indicator Lichens (NIEC): indicator list can be used to assess the diversity and conservation value of woodland epiphytic lichen floras (Rose, 1992 & Coppins & Coppins, 2002). The indicator species are associated with late succession stands with veteran trees (old growth stands i.e. stands more than 200 years old) (Alexander et al, 2002), especially those stands with a past continuity of old trees. Woods that have been clear felled, but regenerated, within the last 200 years (young growth stands) are therefore likely to be poorer in lichen indicator species than less disturbed stands. The NIEC ancient woodland index has a maximum score of 70. Hodgetts (1992) regards sites scoring 20 on this index as being of SSSI quality for their lichen flora. Sites scoring more than 30 on this index are likely to be of international significance. Such woods are likely to be old growth stands with a strong continuity of veteran trees. Below this, as a rough guide, woods with 10 to 19 could be regarded as of county importance and those with 5 to 9 are of high local significance for their woodland lichen flora.

2.2.3 Rarity & Threat

For vascular plants, Nationally Rare (NR) and Nationally Scarce (NS) are derived from the New Atlas of the British and Irish Flora (Preston et al, 2002), with Red Data Book status following (Cheffings & Farrell, 2005). For bryophytes, the definitions of Nationally Rare and Nationally Scarce species follows Preston (2006) and Red Data Book status is as revised in Hodgetts (2011). For lichens the definitions of Red Data Book status, Nationally Rare and Nationally Scarce and International Responsibility Species follows Woods & Coppins (2012).

2.2.4 National Vegetation Classification

Where five or more quadrats could be collected from a distinctive vegetation type, constancy tables were constructed and compared by eye to the NVC tables. The author has found that by using past ecological experience this method produces more meaningful results than comparing data using computer applications. The latter tend to lack any phytosociological discrimination and are prone to throwing unlikely results.

2.2.5 Statistical Analysis

At Harcourt Wood no treatment had been carried out yet, allowing the cover of Skunk Cabbage ***Lysichiton americanus*** to be compared statistically with data on the numbers and cover of other species in the quadrat data. In addition at both Harcourt Wood and Ampress it was possible to compare the number of species and cover of species other than Skunk Cabbage between the paired quadrats sets with and without Skunk Cabbage.

To allow the Domin cover values to be used statically, these were converted to mean percentage cover values using the 'Domin 2.6' conversion method (Currall, 1987). For species other than Sunk Cabbage, combined cover was produced by adding the mean percentage cover values of all these species.

With the transect data from Harcourt Wood the mean percentage cover of Skunk Cabbage was plotted against either numbers of other species and combined cover of other species in Excel 2008 for Mac, with a tend line added. In addition the Pearson correlation coefficient function in Excel 2008 for Mac was used to calculate r. The significance of r was ascertained using the website "Significance of a Correlation Coefficient".

With the data from the paired quadrats in both transects the numbers of species and the combined cover of other species were compared for quadrats with or without high cover of Skunk Cabbage using the TTest function in Excel 2008 for Mac. The TTest function returns the probability associated with a Student's t-Test to determine whether two samples are likely to have come from the same two underlying populations that have the same mean. The paired or "dependent" T test with one tail (directional) was used.

3.0 HARCOURT WOOD

3.1 Landscape History

3.1.1 Geology

Both areas sampled consist of alluvium over the Barton Clay Formation (Website: Geology of Britain Viewer).

3.1.2 19th Century Maps

The landscape setting shown on the 1807 2" Salisbury Ordnance Surveyors Drawing (OSD 76) (Website: "British Library, Online Gallery, Ordnance Survey Drawings") was very different from today. The first area sampled (Area 1) was then part of a much larger millpond, which extended as far as the south west of the wood, where the river turns sharply east. The millpond was set in unenclosed common land of Minstead Manor, with rough grazing to the south and pasture woodland on the slopes to the north with heathland on the higher ground. The second area sampled (Area 2), was on the eastern edge of the landscape park around Minstead Manor, with treed ground depicted in the general area of the floodplain.

The latter, but much more accurate, 1869 25" Ordnance Survey Plan (Website: Old Maps) shows the common land as enclosed, with Area 1 then largely wooded, but with the eastern section still part of the pond. Area 2 was an unenclosed wooded fringe to the park to the north and with Harcourt Wood to the south.

3.1.3 Early 20th Century

The Land Utilisation Survey of Great Britain "A Vision of Britain through Time" shows the parkland as still open in Area 2, with the rest of the woodland. 1946 RAF photographs (digital versions held by the Forestry Commission) show the woodland as still predominantly broadleaved woodland. The downstream end of Area 1 looks to have still been open wetland along the stream.

3.1.4 Current Landscape

The bulk of the wood is replanted with conifers (Map 2) and is recorded as an ancient replanted woodland (Website: Magic) although part of the recorded ancient woodland is actually former heathland. The bulk of the base of the drained section of old millpond is semi-natural woodland, but the upper most sections are replanted with Poplar. This plantation extends into the south of Area 2. The north of Area 2 is now fenced off from the parkland but is mainly semi-natural woodland with a few exotic tree species.

The Skunk Cabbage ***Lysichiton americanus*** population is very large, dominating large areas of Area 1 (Map 1) and densest towards the surviving millpond to the east. Upstream of Area 1 the population thins out, with scattered plants extending into the north of Area 2. The northern most plant was at waymark HC07 (Map 3). The distribution suggests that the species was first planted on the millpond edge and has been colonising upstream for a considerable time.

3.2 Vegetation

3.2.1 Vegetation Area 1

The area sampled in Area 1 is dominated by wet woodland on fertile alluvium deposited on a former millpond base, drained in the 19th century. The canopy is largely dominated by Alder, with willows more frequent to the east, where the wood is younger, with scattered young Ash. Some of the Alder appears to have been coppiced but not systematically or for long. The area is largely dominated by Skunk Cabbage ***Lysichiton americanus*** with the more open patches supporting vegetation typical of fertile flushed alluvium in floodplains. Nettle is widely dominant but with mat of ***Chrysosplenium oppositifolium*** below and other constants including ***Poa trivialis***, ***Circaea lutetiana***, ***Ficaria verna***, ***Veronica montana***, ***Oenanthe crocata*** and ***Rumex sanguineus***. In terms of the NVC it is close to Alnus glutinosa – Urtica dioica Woodland (W6), a community of disturbed wet ground and heavily nutrient enriched wet soils, but is too herb rich. It fits better into the fertile end of Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland, Urtica dioica sub-community (W7a), the typical community of wet mineral alluvium or thin flushed peat in floodplains (Map 4).

With Area 1 a total of 63 species were recorded within the floodplain, including four bryophytes and 59 vascular plants (Species List 1). None of these were nationally or locally rare but an Ancient Woodland Vascular Plant (AWVP) score of 15 was made. The epiphytic lichen flora was looked at briefly; it was mostly composed of common species but a few of the largest Alder trunks supported the fairly mobile old woodland lichens ***Loxospora elatina*** and ***Thelotrema lepadinum***. An Oak trunk fallen in from the slope above had the similarly mobile old woodland lichen ***Cladonia parasitica***.

3.2.2 Vegetation Area 2

The north of the area includes Ash – Hazel floodplain woodland with Silver Birch, Hawthorn, Alder and rare Maple on well drained alluvium. There is some Large Leaved Lime, which is presumably a planted parkland tree. The ground flora is rich, with ***Brachypodium sylvaticum*** dominant, with a mixture of frequent to abundant ***Anemone nemorosa***, ***Hyacinthoides non-scripta***, ***Ajuga reptans***, ***Alliaria petiolata***, ***Carex sylvatica***, ***Circaea lutetiana***, ***Geum urbanum***, ***Ficaria verna***, ***Narcissus pseudonarcissus*** and ***Veronica montana***. The woodland is referable to Fraxinus excelsior – Acer campestris – Mercurialis perennis Woodland, Anemone nemorosa sub-community (W8b) (Map 4), a very typical community of ancient riverine woodland on better drained alluvium. Up slope, on dry ground, the woodland graded into more acid Quercus robur – Pteridium aquilinum – Rubus fruticosus Woodland, Anemone nemorosa sub-community (W10b). Locally on the west side of the floodplain spring fed seepages intermittently produce shallow peaty areas. These support less fertile versions of Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland, Urtica dioica sub-community (W7a) than Area 1, with lower Nettle ***Urtica dioica*** cover, higher sedge cover, especially ***Carex remota*** but still with mats of ***Chrysosplenium oppositifolium*** (Map 4). These form wet back swamp communities along the western edge of the floodplain.

The riverine woodland in Area 2 is a well developed example, with characteristic features such as back swamps where ground water springs rise at the floodplain edge and flood channels cut through the W8b woodland on the drier alluvium. The

Skunk Cabbage ***Lysichiton americanus*** population is sparser in this area and is scattered through the wetter habitat in the site.

Within Area 2 a total of 70 species were recorded within the floodplain, including one bryophyte and 69 vascular plants (Species List 3). None of these were nationally or locally rare but an Ancient Woodland Vascular Plant (AWVP) score of 18 was made. The fairly mobile old woodland lichen ***Phaeographis inusta*** was recorded on Alder. It is common in the New Forest area but is Nationally Scarce and an International Responsibility species.

3.2.3 Flora of the Wider Area

The area of floodplain between the two areas looked at in detail added the local ***Valeriana dioica*** in a swampy stand of W7a fed by a tributary stream (SU2889 0983) and the under recorded Nationally Scarce lichen ***Usnea wasmuthii*** on Sallow (SU2897 0983). The Ancient Woodland Vascular Plant (AWVP) score from the whole floodplain was 25, with a total of 90 vascular plants and 6 bryophytes recorded. The replanted ancient woodland of Harcourt Wood above the floodplain added nine AWVP indicators (***Betonica officinalis***, ***Blechnum spicant***, ***Dryopteris carthusiana***, ***Euphorbia amygdaloides***, ***Holcus mollis***, ***Hypericum pulchrum***, ***Melica uniflora***, ***Rosa arvensis*** & ***Ruscus aculeatus***), bringing the site score to 34. Relict old Hollies survived rarely from the pasture woodland and added the old woodland species ***Mycoporum antecellens*** and ***Stenocybe septata*** in SU2909. The best area of old Holly was to the far east on the north bank of the surviving millpond about SU2948 1004, with the Near Threatened ***Mycoporum lactea*** (also Nationally Scarce and an International Responsibility species) noted on one old Holly. This is the first record outside the Open Forest woods in Hampshire for the Holly specialist. Also noted were the lichens ***Mycoporum antecellens***, ***Pertusaria multipuncta***, ***Phaeographis dendritica***, ***Porina borreri*** (Nationally Scarce), ***Stenocybe septata*** and ***Thelotrema lepadinum*** on Holly and ***Arthonia vinosa*** and ***Megalaria pulverea*** on Oak. The area had a NIEC ancient woodland lichen index score of eight.

The area includes high quality semi-natural ancient floodplain woodland showing the full range from softwood floodplain woodland (W7) to hardwood floodplain woodland (W8) and characteristic physical features such as back swamps, natural levees and flood channels. This is a good example of the Annex 1 Priority Habitat 91E0 * Alluvial forests with ***Alnus glutinosa*** and ***Fraxinus excelsior*** (***Alno-Padion***, ***Alnion incanae***, ***Salicion albae***). This is best developed in Area 2 but occurs as developing or disturbed stands downstream. This example is within a catchment which is within the New Forest SAC just downstream of the millpond. As the New Forest SAC includes 91E0 * Alluvial forests as a notified feature, this example would have considerable significance and probably should be included within the SAC. The higher land is a replanted pasture woodland and heathland site with some relic old Holly with some epiphytic lichen interest. The whole site has a rich surviving ancient vascular plant flora. It has high potential for restoration.

3.3 Impact of Skunk Cabbage

3.3.1 Impact of Skunk Cabbage in Area 1

The dominance of the large bulky perennial Skunk Cabbage ***Lysichiton americanus*** has a clear and obvious negative impact on the vegetation (Species List 2). Most of the native species are displaced, or reduced considerably in cover. Nettle cover is

greatly reduced but it manages to maintain its constancy. Other species such as ***Circaea lutetiana***, ***Ficaria verna***, ***Poa trivialis***, ***Veronica montana***, ***Oenanthe crocata***, ***Rumex sanguineus***, ***Filipendula ulmaria*** and ***Galium aparine*** are greatly reduced. The small annual ***Cardamine flexuosa***, is the only widespread native species to maintain its frequency. The only species that was a little more frequent in the sampled high cover quadrats was seedlings of the non-native ***Impatiens*** cf ***capensis***.

The result is a species poor vegetation, which is no clearly longer referable to Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland, Urtica dioica sub-community (W7a). The areas with high cover of Skunk Cabbage are closer to Alnus glutinosa – Urtica dioica Woodland (W6) (Constancy Table 1 & Species List 1).

The Skunk Cabbage here is capable of total dominance. The largest plants are found in the wettest areas but the species is obviously capable of achieving a high cover over all the ground within Area 1.

With the Harcourt Wood Skunk Cabbage ***Lysichiton americanus*** population not yet treated, it was also possible to plot the cover of Skunk Cabbage against the number of other species recorded per quadrat (Plot 1) and combined cover of all other species per quadrat (Plot 2).

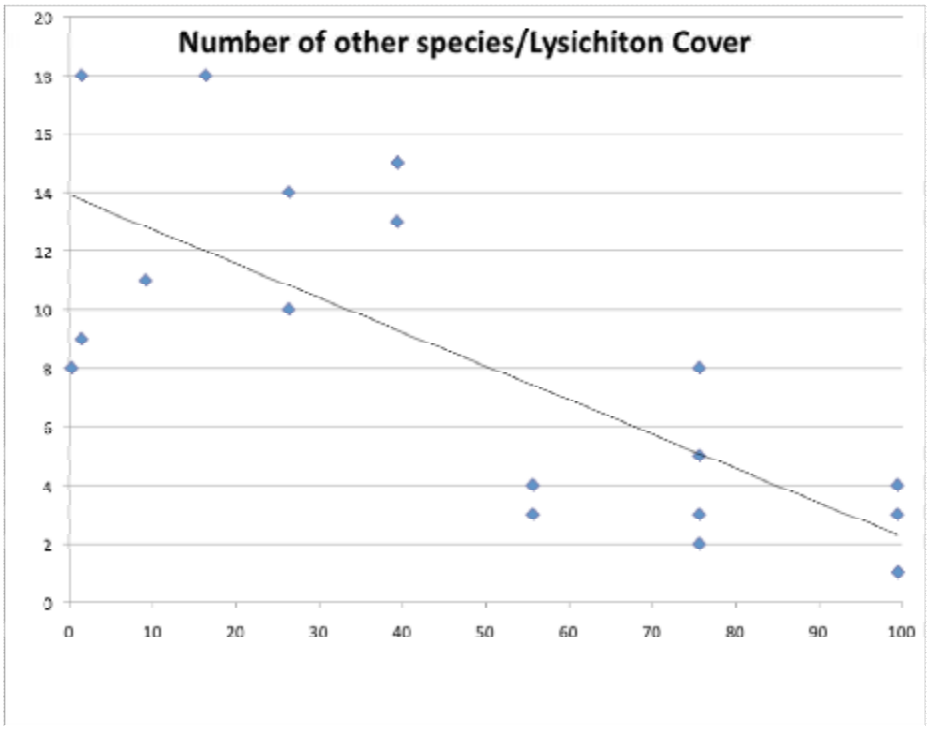
Both show strong and highly significant negative relationships between Skunk Cabbage cover and the diversity and cover of other species. In addition, significance of the differences between the number of other species and the combined cover of other species in the paired high and low cover Skunk Cabbage quadrats was tested using a Paired Student's T-Test. Again these were, not surprisingly, highly significant.

CONSTANCY TABLE 1
Comparisons Between Ground Vegetation with Low and High Cover of Skunk Cabbage
Lysichiton americanus

Species	Low Cover	High Cover	All
Lysichiton americanus	V	V	V
Circaea lutetiana	V	II	V
Ficaria verna	V		III
Poa trivialis	V	I	III
Urtica dioica	V	V	V
Veronica montana	V	I	III
Chrysosplenium oppositifolium	IV	III	III
Oenanthe crocata	IV	I	II
Rumex sanguineus	IV	I	III
Filipendula ulmaria	III		II
Galium aparine	III		II
Athyrium filix-femina	II	I	II
Cardamine flexuosa	II	II	II
Carex remota	II	I	II
Ranunculus repens	II		I
Schedonorus gigantea	II		I
Veronica chamaedrys	II		I
Ajuga reptans	I		I

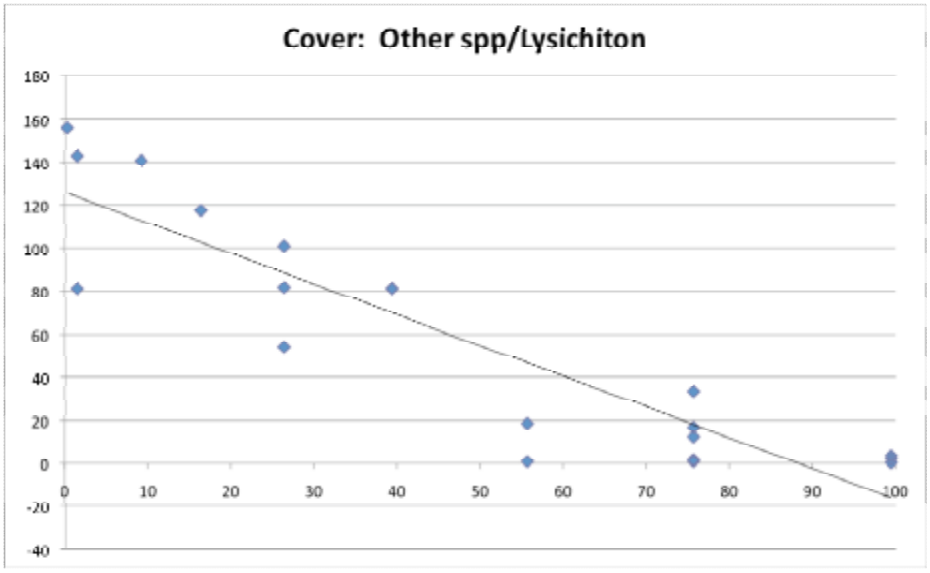
Brachypodium sylvaticum	I		I
Brachythecium rutabulum	I		I
Deschampsia cespitosa	I		I
Fissidens viridulus	I		I
Fraxinus excelsior	I		I
Geum urbanum	I		I
Impatiens capensis	I	II	II
Kindbergia praelongum	I		I
Lysimachia nemorum	I		I
Lysimachia nummularia	I		I
Mentha aquatica	I		I
Mercurialis perennis	I	I	I
Myosotis sp	I	I	I
Plagiomnium undulatum	I		I
Ribes nigrum	I	I	I
Sanicula europaea	I		I
Stachys sylvatica	I		I
Viburnum opulus	I		I

PLOT 1
The Number of Other Species per Quadrat Plotted Against the Cover of Skunk Cabbage



Correlation Coefficient r = -0.76, Significance <0.0001

PLOT 2
The Combined cover of Other Species per Quadrat Plotted Against the Cover of Skunk Cabbage



Correlation Coefficient r = -0.90, Significance <0.0001

Probabilities lower than 0.05 are significant.

Paired Student's T-Tests

One sided Paired Student's T-Test of numbers of species other than Skunk Cabbage in paired quadrats with high Skunk Cabbage cover verses quadrats with low cover. Probabilities lower than 0.05 are significant.

Data

Quadrat Pairs	Skunk Cabbage Cover High	Low
Q1	2	11
Q2	3	10
Q3	3	14
Q4	5	18
Q5	5	13
Q6	1	10
Q7	3	15
Q8	4	9
Q9	8	8
Q10	4	18

Probability = 0.000045

One sided Paired Student's T-Test of combined cover of species other than Skunk Cabbage in paired quadrats with high Skunk Cabbage cover verses quadrats with low cover. Probabilities lower than 0.05 are significant.

Data

Quadrat Pairs	Skunk Cabbage Cover High	Low
Q1	1.8	140.7
Q2	0.9	54.2
Q3	0.9	100.8
Q4	33.4	117.6
Q5	16.8	81.1
Q6	0.3	81.8
Q7	2.1	81.4
Q8	18.5	81.2
Q9	12.5	156.0
Q10	3.6	142.8

Probability = 0.0000053

3.3.2 Impact of Skunk Cabbage in Area 2

In Area 2, the cover of Skunk Cabbage ***Lysichiton americanus*** is much lower than in Area 1. This seems most likely to be due to ongoing colonisation from the main colony further downstream, rather than any obvious limit on the growth of the species within the areas it has colonised. The location of Skunk Cabbage plants is shown on Map 3. Currently the plants are found in the wet flushed back swamp communities and in flood channels in drier alluvium. The back swamps are occupied by less nutrient enriched versions of Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland, Urtica dioica sub-community (W7a), than found downstream in Area 1 (Quadrat HCQ11), with lower Nettle cover. The Skunk Cabbage is locally frequent but not yet dominant enough to suppress the native vegetation. In the drier alluvium of the levees nearer the river the Skunk Cabbage is confined to flood channels in vegetation transitional between W7a and Fraxinus

excelsior – Acer campestris – Mercurialis perennis Woodland, Anemone nemorosa sub-community (W8b) (Quadrat HCQ12).

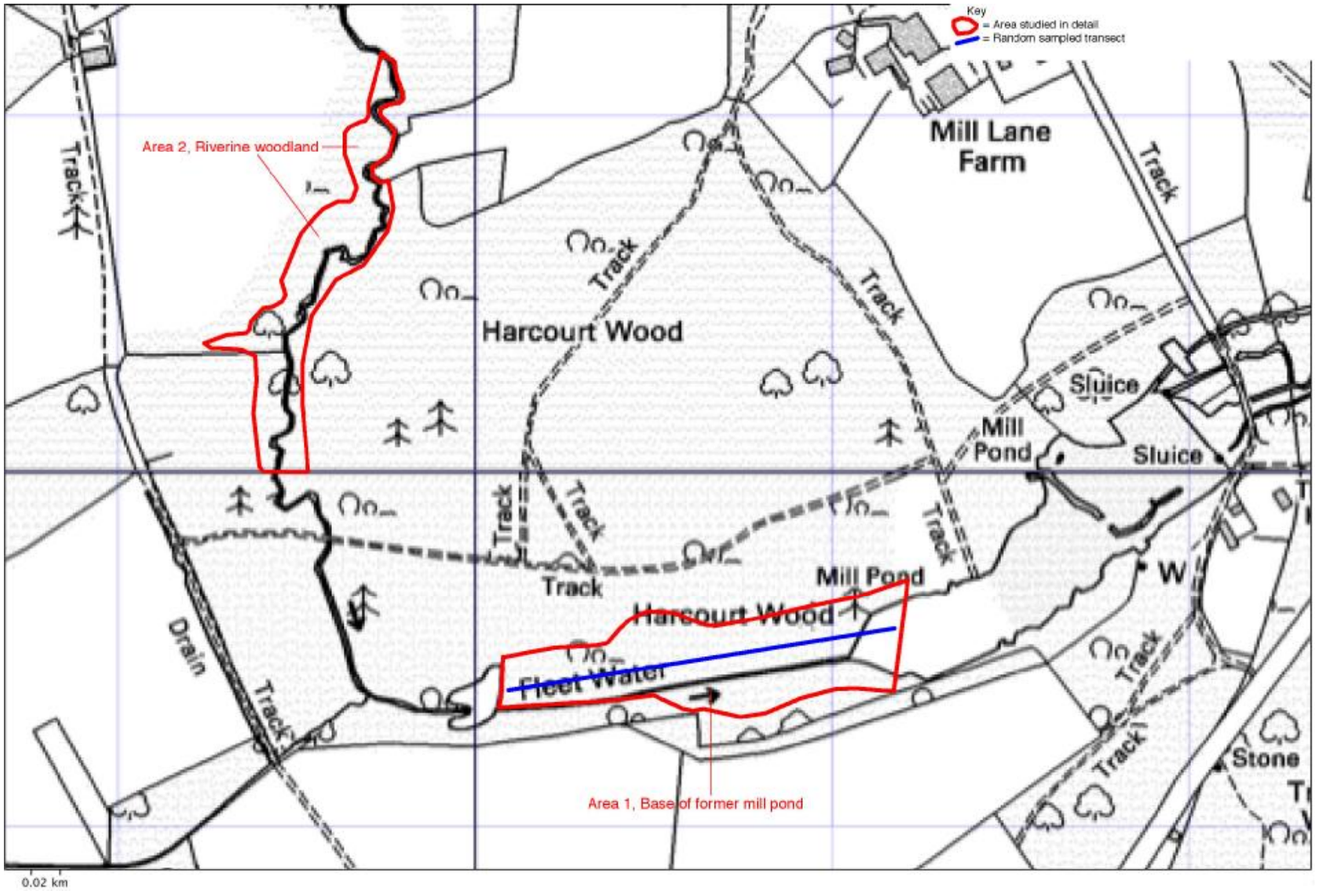
Assuming colonisation is on going here, the Skunk Cabbage looks to be capable of colonising all of the wet woodland (W7a). Observations at similar sites in Sussex suggest that it is unlikely to penetrate far into the W8b vegetation and that its colonisation will be limited by soil wetness.

3.4 Maps

Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

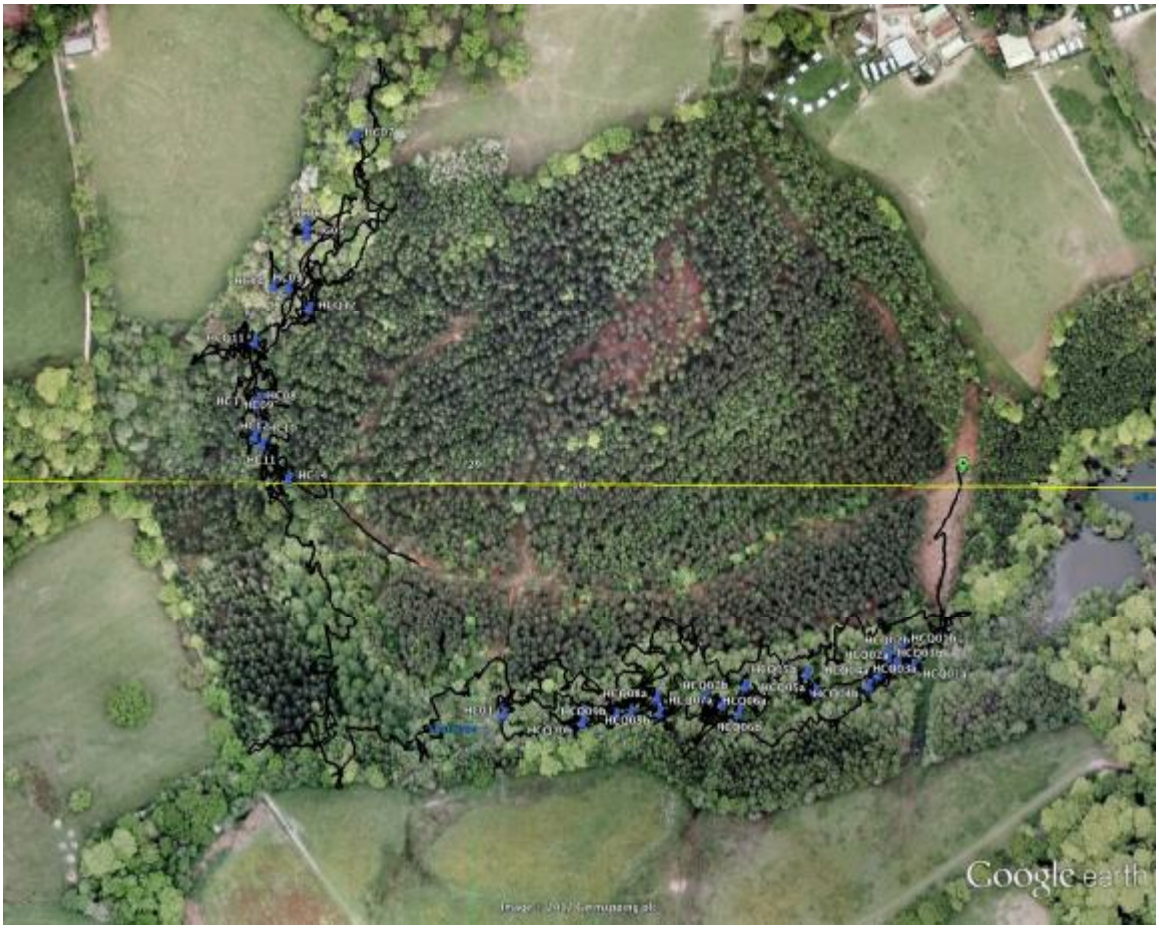
Study Areas Harcourt Wood Map 1



Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

Survey Harcourt Wood Map 2



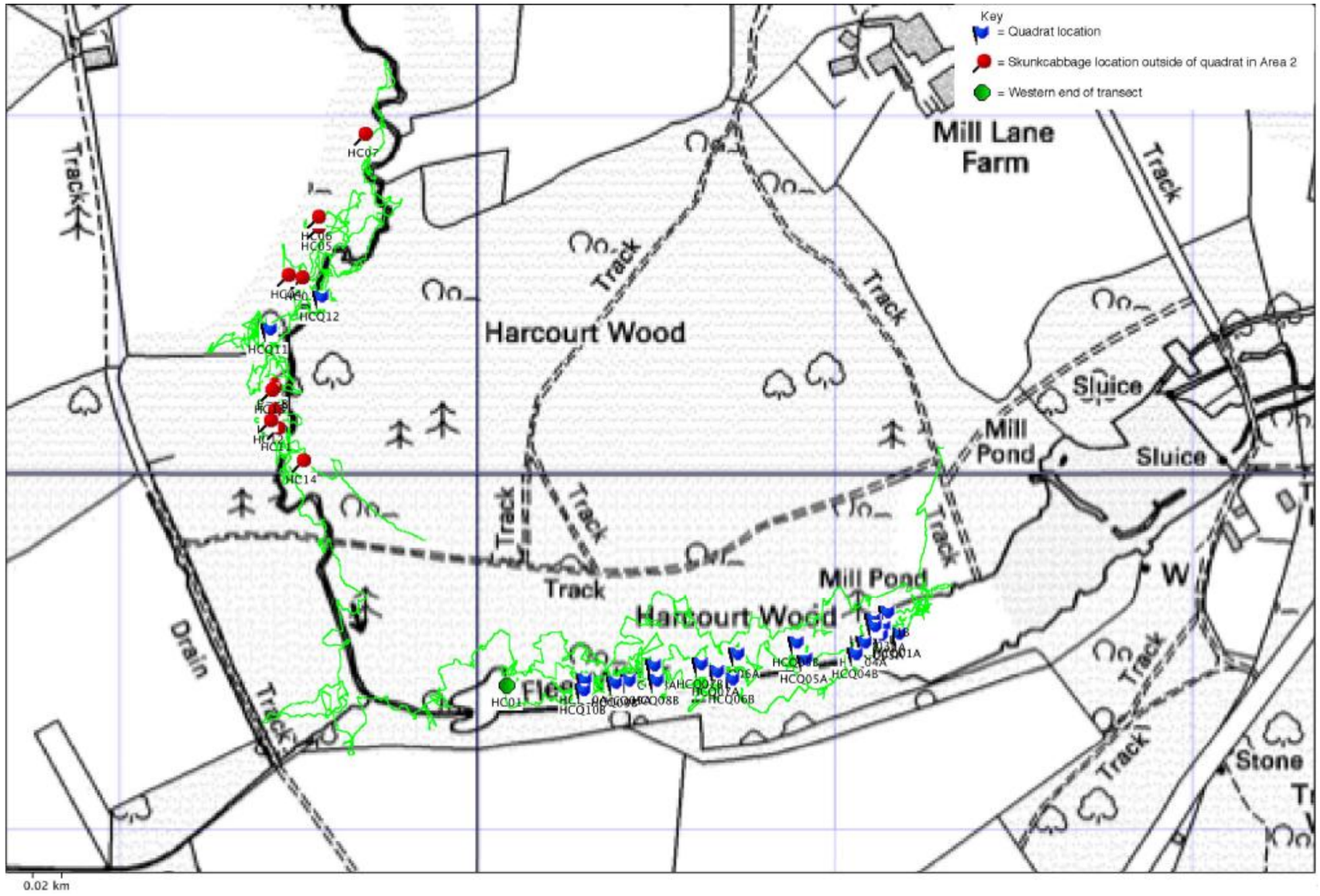
Route and waymarks in Google Earth, waypoint data given in Table 1

Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

Survey Harcourt Wood Map 3

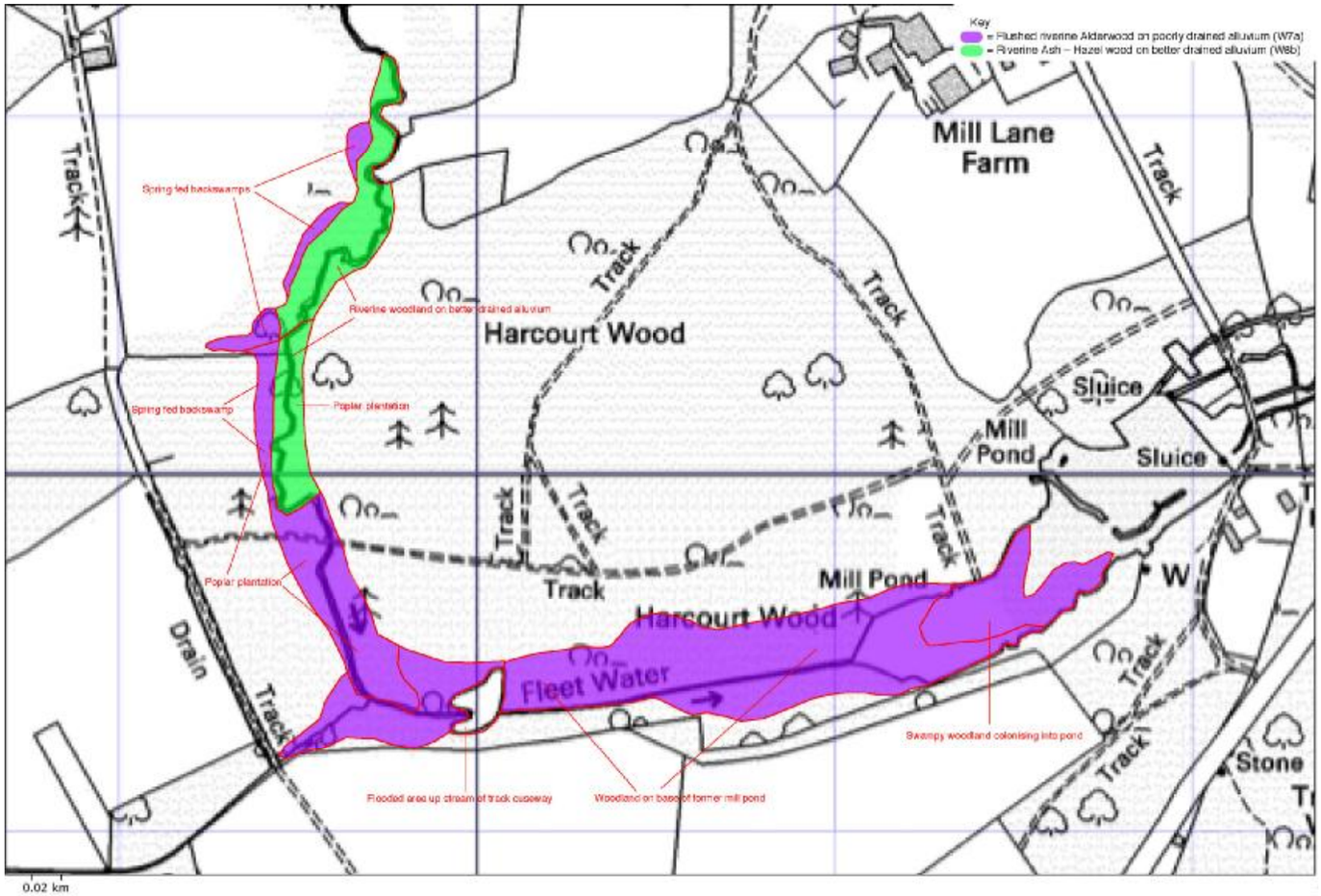
Route and waymarks on OS base map, waypoint data given in Table 1



Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

Vegetation Harcourt Wood Map 4



3.5 Data

SPECIES LIST 1
Harcourt Wood, Area 1, Species List and Domin Quadrat Data

Species	Area 1	Constancy All	Constancy High Cover	Constancy Low Cover	Q1a	Q1b	Q2a	Q2b	Q3a	Q3b	Q4a	Q4b	Q5a	Q5b	Q6a	Q6b	Q7a	Q7b	Q8a	Q8b	Q9a	Q9b	Q10a	Q10b	AW
TREES & TALL SHRUBS																									
Alnus glutinosa	A, LD	V	V	V	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
Betula pubescens ssp pubescens	R																								
Corylus avellana	R	I	I	I							C	C													
Crataegus monogyna	R	I	I	I			C	C	C	C															
Fraxinus excelsior	F	IV	III	IV						1	C	C	C	C	C	C	C	C	C	C			C	C	
Ilex aquifolium	R																								1
Rhododendron ponticum	O																								
Salix cinerea ssp oleifolia	A	IV	IV	IV	C	C	C	C	C	C	C	C	C	C	C	C	C	C					C	C	
Salix fragilis	F	II	II	II	C	C									C	C	C	C	C	C					
Viburnum opulus	O	I	I	I											C	C							C	2	1
UNDER SHRUBS																									
Ribes nigrum	O	I	I	I							4	1													
GRASSES																									
Agrostis stolonifera	R																								
Brachypodium sylvaticum	O	I		I						1														4	
Deschampsia cespitosa	O	I		I		1						1													
Glyceria fluitans	R																								
Poa trivialis	A	III	I	V		3		3		5		5		3		5		4		4	1	3		7	
Schedonorus gigantea	F	I		II		4				2		2		3											1
OTHER VASCULAR PLANTS																									
Ajuga reptans	O	I		I								3												1	
Alliaria petiolata	R																								
Anthriscus sylvestris	R																								
Apium nodiflorum	R																								
Asplenium scolopendrium	R																								
Athyrium filix-femina	O	II	I	II			1	2						1				4					1	1	
Callitriche brutia ssp hamulata	R																								
Callitriche platycarpa	O																								
Cardamine flexuosa	F	II	II	II				2	1				3	3	1	2					1	1			
Carex pendula	–																								1
Carex remota	F	II	I	II				4	1	4	2							2						2	1
Chrysosplenium oppositifolium	A	III	III	IV			1	4		2	4		2	6		5				6	2	7	1	5	1
Circaea lutetiana	F	V	II	V		4	1	3		3		4		4		4	1	4	1	4		4	2	6	
Dryopteris affinis	O																								1
Ficaria verna	F	III		V		3		3		3		3				2		3		2		4		2	
Filipendula ulmaria	O	II		III						2		3						2		2				1	
Galium aparine	F	II		III								1				2		2		1		2			
Geum urbanum	F	I		I		5						2													
Hedera helix	O																								
Heracleum sphondylium	R																								
Hyacinthoides non-scripta	R																								1
Impatiens glandulifera	O	II	II	I									1	1					1	1	1				
Lysichiton americanus	A, LD	V	V	V	9	4	9	6	8	6	9	5	9	7	10	6	10	7	8	2	9	1	10	2	
Lysimachia nemorum	F	I		I				4		4															1
Lysimachia nummularia	R	I		I																				3	
Mentha aquatica	O	I		I								1													
Mercurialis perennis	O	I	I	I									2											4	

Species	Area 1	Constancy All	Constancy High Cover	Constancy Low Cover	Q1a	Q1b	Q2a	Q2b	Q3a	Q3b	Q4a	Q4b	Q5a	Q5b	Q6a	Q6b	Q7a	Q7b	Q8a	Q8b	Q9a	Q9b	Q10a	Q10b	AW
Myosotis sp	O	I	I	I										2							1				
Oenanthe crocata	F	II	I	IV	1	1				1		2				1		2						1	
Oxalis acetosella	R																								1
Polypodium interjectum	R (e)																								1
Pteridium aquilinum	R																								
Ranunculus repens	O	I		II								2						2						3	
Rumex sanguineus	F	III	I	IV		5		2		5		4		3			1	4			1			4	
Sanicula europaea	R	I		I										1				1							1
Scrophularia nodosa	R																								
Solanum dulcamara	R																								
Stachys sylvatica	R	I		I										1											
Urtica dioica	A, LD	V	V	V	2	9		4	1	6	4	8	4	5		5	2	6	5	5	4	9	2	4	
Valeriana officinalis	R																								
Veronica chamaedrys	O	I		II		3												3						1	
Veronica montana	A	III	I	V		1				4		4		4		5		2	2	5	1	5		4	1
MOSSES																									
Brachythecium rutabulum	O	I		I								1													
Fissidens viridulus	R	I		I														1							
Kindbergia praelongum	O	I		I								2				2									
Plagiomnium undulatum	R	I		I								1													
Mud					5	3	5	7	6	6	3	4	4	5	4	6	4	5	4	7	4	4	4	5	

Key
Q1a = Quadrat placed on area of high cover of Skunk Cabbage ***Lysichiton americanus***
Q1b = Quadrat placed on area of low cover of Skunk Cabbage ***Lysichiton americanus***
C = Canopy species

AW = Ancient Woodland Vascular Plants
LD = Locally dominant
(e) = Epiphyte

SPECIES LIST 2
Harcourt Wood, Area 1 Quadrat Data, with Domin Cover Values Converted to Mean Percentage Cover Values

Species	Q1a	Q1b	Q2a	Q2b	Q3a	Q3b	Q4a	Q4b	Q5a	Q5b	Q6a	Q6b	Q7a	Q7b	Q8a	Q8b	Q9a	Q9b	Q10a	Q10b
Fraxinus excelsior						0.3														
Viburnum opulus																				1.5
Ribes nigrum							9.2	0.3												
Brachypodium sylvaticum						0.3														9.2
Deschampsia cespitosa		0.3						0.3												
Poa trivialis		4.3		4.3		16.4		16.4		4.3		16.4		9.2		9.2	0.3	4.3		39.4
Schedonorus gigantea		9.2				1.5		1.5		4.3										
Ajuga reptans							4.3													0.3
Athyrium filix-femina			0.3	1.5						0.3				9.2					0.3	0.3
Cardamine flexuosa				1.5	0.3				4.3	4.3	0.3	1.5					0.3	0.3		
Carex remota				9.2	0.3	9.2	1.5							1.5						1.5
Chrysosplenium oppositifolium			0.3	9.2		1.5	9.2		1.5	26.4		16.4				26.4	1.5	39.4	0.3	16.4
Circaea lutetiana		9.2	0.3	4.3		4.3		9.2		9.2		9.2	0.3	9.2	0.3	9.2		9.2	1.5	26.4
Ficaria verna		4.3		4.3		4.3		4.3				1.5		4.3		1.5		9.2		1.5
Filipendula ulmaria						1.5		4.3						1.5		1.5				0.3
Galium aparine								0.3				1.5		1.5		0.3		1.5		
Geum urbanum		16.4						1.5												
Impatiens glandulifera									0.3	0.3					0.3	0.3	0.3			
Lysichiton americanus	75.7	9.2	75.7	26.4	55.7	26.4	75.7	16.4	75.7	39.4	99.5	26.4	99.5	39.4	55.7	1.5	75.7	0.3	99.5	1.5
Lysimachia nemorum				9.2		9.2														
Lysimachia nummularia																				4.3
Mentha aquatica								0.3												
Mercurialis perennis									1.5											9.2
Myosotis sp										1.5							0.3			
Oenanthe crocata	0.3	0.3				0.3		1.5				1		1.5						0.3
Ranunculus repens								1.5						1.5						4.3
Rumex sanguineus		16.4		1.5		16.4		9.2		4.3			0.3	9.2			0.3			9.2
Sanicula europaea										0.3				0.3						
Stachys sylvatica										0.3										
Urtica dioica	1.5	75.7		9.2	0.3	26.4	9.2	55.7	9.2	16.4		16.4	1.5	26.4	16.4	16.4	9.2	75.7	1.5	9.2
Veronica chamaedrys		4.3												4.3						0.3
Veronica montana		0.3				9.2		9.2		9.2		16.4		1.5	1.5	16.4	0.3	16.4		9.2
Brachythecium rutabulum								0.3												
Fissidens viridulus														0.3						
Kindbergia praelongum								1.5				1.5								
Plagiomnium undulatum								0.3												

SPECIES LIST 3
Harcourt Wood, Area 2, Species List and Domin Quadrat Data

Species	Area 2	Q11	Q12	AW
TREES & TALL SHRUBS				
Acer campestre	R			1
Alnus glutinosa	F			
Betula pendula	O		C	
Betula x aurata	R			
Corylus avellana	A	C	C	
Crataegus monogyna	O			
Fagus sylvatica	R			
Fraxinus excelsior	D	C	C	
Populus cultivar	A			
Prunus spinosa	O			
Rhododendron ponticum	O			
Tilia platyphyllos	R			
UNDER SHRUBS				
Ribes rubrum	O			1
GRASSES				
Brachypodium sylvaticum	A	6	8	
Deschampsia cespitosa	O			
Glyceria fluitans	R	3		
OTHER VASCULAR PLANTS				
Ajuga reptans	F			
Alliaria petiolata	F		5	
Anemone nemorosa	F LA			1
Anthriscus sylvestris	R			
Apium nodiflorum	R			
Arum maculatum	R		2	
Barbarea intermedia	R			
Callitriche stagnalis	O			
Cardamine flexuosa	O	2		
Cardamine pratensis	R			
Carex pendula	O	2	1	1
Carex remota	F	4	3	1
Carex sylvatica	F			1
Chrysosplenium oppositifolium	F LA	7	2	1
Circaea lutetiana	A	3	4	
Conopodium majus	O			1
Dactylorhiza fuchsii	R			
Dryopteris affinis	O			1
Ficaria verna	A	4	4	
Galium aparine	O	2		
Galium palustre	O		2	
Geranium robertianum	O	1	1	
Geum urbanum	F	4	2	
Hyacinthoides non-scripta	F		1	1
Hypericum androsaemum	R			1
Lysichiton americanus	O	5	5	

Species	Area 2	Q11	Q12	AW
Lysimachia nemorum	F			1
Lysimachia nummularia	R			
Mercurialis perennis	O			
Narcissus pseudonarcissus	F			
Oenanthe crocata	O			
Polystichum setiferum	R			1
Primula vulgaris	O			
Ranunculus acris	R			
Ranunculus flammula	O			
Ranunculus repens	O			
Rubus fruticosus	R			
Rumex sanguineus	O	2		
Sanicula europaea	O			1
Scrophularia nodosa	R		1	
Solanum dulcamara	R			
Stachys sylvatica	O		1	
Stellaria holostea	O			
Urtica dioica	F	5	4	
Valeriana officinalis	O		2	
Veronica beccabunga	R			
Veronica chamaedrys	O			
Veronica hederifolia	O		3	
Veronica montana	A	5	5	1
Veronica serpyllifolia	O			
Viola reichenbachiana	O			1
Viola riviniana	O			
MOSSES				
Mnium hornum	O			
LIVERWORTS	+			
Conocephalum conicum	O			
Mud		4	4	

Key
C = Canopy species
AW = Ancient Woodland Vascular Plants

TABLE 1
Harcourt Wood Waypoint Data

Name	Zone	Easting	Northing	Comment
HC01	SU	29021	9852	End of Harcourt transect at ford
HC03	SU	28876	10136	Skunk Cabbage colonising flood channel
HC04	SU	28866	10138	Skunk Cabbage in back swamp
HC05	SU	28888	10171	Skunk Cabbage in back swamp
HC06	SU	28888	10179	Skunk Cabbage in back swamp
HC07	SU	28920	10237	Upper most Skunk Cabbage in spring fed back swamp
HC08	SU	28856	10061	Scattered Skunk Cabbage in flood channel
HC09	SU	28857	10059	Skunk Cabbage in damp W8b riverine woodland
HC10	SU	28856	10043	Skunk Cabbage in damp W8b riverine woodland
HC11	SU	28859	10031	Skunk Cabbage in damp W8b riverine woodland
HC12	SU	28854	10036	Skunk Cabbage on flood channel edge
HC13	SU	28855	10057	Several plants of Skunk Cabbage in W7a back swamp
HC14	SU	28877	10008	Skunk Cabbage in flood channel in W8b riverine woodland
HCQ01a	SU	29294	09886	High cover of Skunk Cabbage, under dense canopy of Sallow & Crack Willow
HCQ01b	SU	29286	09902	Low cover of Skunk Cabbage, under Alder, more open
HCQ02a	SU	29284	09891	High cover of Skunk Cabbage, under dense canopy of Sallow
HCQ02b	SU	29276	09896	Low cover of Skunk Cabbage, under dense canopy of Alder with Hawthorn
HCQ03a	SU	29281	09885	High cover of Skunk Cabbage, under dense canopy of Sallow with some Hawthorn
HCQ03b	SU	29277	09892	Low cover of Skunk Cabbage, under partial canopy of Alder & Sallow
HCQ04a	SU	29270	09880	High cover of Skunk Cabbage, in open area with Ash, Alder & Sallow
HCQ04b	SU	29264	09873	Low cover of Skunk Cabbage, in open area with Ash & Alder
HCQ05a	SU	29228	09869	High cover of Skunk Cabbage, in partially open area with Ash, Alder & Sallow
HCQ05b	SU	29222	09881	Low cover of Skunk Cabbage, in partially open area with Ash, Alder & Sallow
HCQ06a	SU	29181	09872	High cover of Skunk Cabbage, in open Alder & Crack Willow
HCQ06b	SU	29178	09855	Low cover of Skunk Cabbage, in open Alder & Ash
HCQ07a	SU	29167	09860	High cover of Skunk Cabbage, in partly open Ash & Sallow
HCQ07b	SU	29155	09865	Low cover of Skunk Cabbage, in partly open Ash & Sallow
HCQ08a	SU	29123	09864	High cover of Skunk Cabbage, in partly open Alder & Crack Willow
HCQ08b	SU	29125	09854	Low cover of Skunk Cabbage, in partly open Alder & Ash
HCQ09a	SU	29106	09853	High cover of Skunk Cabbage, in open Alder
HCQ09b	SU	29096	09852	Low cover of Skunk Cabbage, in partly open Alder
HCQ10a	SU	29074	09854	"High cover of Skunk Cabbage, in part open Sallow
HCQ10b	SU	29073	09847	High cover of Skunk Cabbage, in part open Alder & Ash

HCQ11	SU	28854	10099	Skunk Cabbage in back swamp in W7a
HCQ12	SU	28890	10122	Skunk Cabbage in flood channel in W7a / W8b transition

3.6 Photos

All photographs taken on site are shown in a web gallery Harcourt & Ampress Gallery. Selected photographs are shown here.

Photo 1. Harcourt Wood Area 1. W7a softwood floodplain woodland developing on the base of a former millpond, in an area not yet heavily invaded by Skunk Cabbage showing developing riverine woodland features including debris dam and a flood channel.

Photo 2. Harcourt Wood Area 1. W7a softwood floodplain woodland developing on the base of a former millpond, in an area heavily invaded by Skunk Cabbage.

Photo 3. Harcourt Wood Area 1. Quadrat HCQ08b in fertile W7a softwood floodplain woodland developing on the base of a former millpond. Area being invaded by Skunk Cabbage

Photo 4. Harcourt Wood Area 1. Quadrat HCQ08a in fertile W7a softwood floodplain woodland developing on the base of a former millpond. Area close to the above picture, which is fully invaded by Skunk Cabbage

Photo 5. Harcourt Wood Area 2. Quadrat HCQ11 in less fertile W7a softwood floodplain woodland in back swamp in ancient floodplain woodland. A pioneer invading Skunk Cabbage plant

Photo 6. Harcourt Wood Area 2. Pioneer Skunk Cabbage in a flood channel in W8a hardwood floodplain woodland. In this drier floodplain woodland the Skunk Cabbage is so far confined to the bases of flood channels.

Photo 7. Harcourt Wood Area 2. HCQ12 Pioneer Skunk Cabbage in flood channel in transition to W8a hardwood floodplain woodland. In this drier floodplain woodland the Skunk Cabbage is so far confined to the bases of flood channels.

Photo 8. Harcourt Wood Area 2. Fully developed W8a hardwood floodplain woodland with Bluebell and Wood Anemone. Skunk Cabbage is very unlikely to colonise this habitat.

4.0 AMPRESS

4.1 Landscape History

4.1.1 Geology

The area sampled was deep alluvium over the Becton and Chama Sand (Website: "Geology of Britain Viewer"). The top layers of the alluvium were peat.

4.1.2 1807 Ordnance Surveyors Drawing

The 1797 3" Christchurch Ordnance Surveyors Drawing (OSD 75 pt.1) (Website: "British Library, Online Gallery, Ordnance Survey Drawings") shows the area sampled to be estuarine habitat, as does the 1791 Milne Hampshire map (Website: Old Hampshire Mapped).

4.1.3 19th and 20th Ordnance Survey Plans

The later, but much more accurate, 1868 25" Ordnance Survey Plan (Website: Old Maps) shows the site as rough grazing, with the estuary above the Lymington Bridge silted up. The 1897 25" Ordnance Survey Plan is similar but on the 1909 25" Ordnance Survey Plan a patch of scrub was marked within the sampled area. The 1933 Land Utilisation Survey of Great Britain map "A Vision of Britain through Time", however, still shows the area as rough grazing. On the 1964 – 1972 1: 2500 plan the wet woodland was shown as well established.

4.1.4 Current Landscape

The higher land to the east has long been developed and is now an industrial estate and a hospital. The original boundary between the marsh and the now developed fields to the east survives, and is marked by ancient Oaks with a rich lichen flora on dry bark habitats (Sanderson, 2000). There is a narrow intermittent band of species poor dry secondary woodland along the landward edge. Beyond this is the wide band of wet woodland, which was being invaded by Skunk Cabbage ***Lysichiton americanus***. This is very wet and over deep peat, with spring fed seepages running through the wood. This passes into open reedbeds towards the river (Maps 5 & 7).

4.2 Vegetation

The wet woodland is dominated by Alder with some Sallow, Young Ash and Sycamore and Guelder-rose. The ground flora is very rich with tall sedges and reeds prominent but not dominant. These include constant Tussock Sedge ***Carex paniculata*** and Reed Canarygrass ***Phalaris arundinacea*** and locally abundant ***Carex acutiformis***. Constant herbs, small sedges and ferns include ***Athyrium filix-femina***, ***Caltha palustris***, ***Carex remota***, ***Filipendula ulmaria***, ***Veronica montana***, ***Galium palustre***, ***Scutellaria galericulata*** and the declining ***Valeriana dioica***. In wet flushed areas Golden Saxifrage ***Chrysosplenium oppositifolium*** forms dense mats. More localised species include ***Lysimachia vulgaris*** and ***Osmunda regalis***. In dense vegetation the bryophyte flora is poor, with ***Kindbergia praelongum*** constant and ***Oxyrrhynchium hians*** widespread. Where the vegetation is more open, especially where disturbed by Skunk Cabbage ***Lysichiton americanus*** control, a much more diverse bryophyte flora occurs with ***Rhizomnium punctatum***, ***Calliergonella cuspidata***, ***Pellia epiphylla***, the oceanic ***Hookeria lucens***, ***Riccardia chamedryfolia*** and the local ***Calliergon cordifolium*** (Species List 3).

In terms of the NVC the wet woodland is clearly referable to NVC community Alnus glutinosa – Carex paniculata Woodland (W5), typical of high quality swamp woodland developed on wet soft peat. This type of woodland is often a recent secondary development on formerly open peatland vegetation, as here. The stand here differs somewhat from the well developed fenny type found in the New Forest valley bogs (Alnus glutinosa – Carex paniculata Woodland, Lysimachia vulgaris sub-community, W5b). The presence of Golden Saxifrage ***Chrysosplenium oppositifolium*** in W5 woodland puts the community closer to the Alnus glutinosa – Carex paniculata Woodland, Chrysosplenium oppositifolium sub-community (W5c). This is a rare sub-community in south Hampshire and is much more typical of iron rich swamp woodlands in the Weald.

The Skunk Cabbage ***Lysichiton americanus***, had invaded patches of this wet woodland. The patches were densest to the north, suggesting that the colony originated from a single introduction or colonisation incident at the northern end of the area studied. These had recently been treated in the previous two seasons, producing bare and recolonising patches, with some Skunk Cabbage seedlings. There were also some surviving seedlings invading into intact vegetation at the edge of the dominance areas. The invasive exotic Himalayan Balsam ***Impatiens glandulifera*** was also present, mainly as week growths within the existing vegetation, but with locally stronger growth in the areas recently cleared of Skunk Cabbage. Both the surviving seedling Skunk Cabbage and the Himalayan Balsam were planned to be treated latter.

With the area studied a total of 70 species were recorded within the floodplain, including 13 bryophytes and 57 vascular plants (Species List 4). None of these were nationally or locally rare, although some such as ***Valeriana dioica*** and ***Calliergon cordifolium*** are infrequent species of high quality wetland habitat. A rather low Ancient Woodland Vascular Plant (AWVP) score of 10 was made; this is not unexpected for a recent woodland site.

The study area is a well developed example of a swamp woodland of a type rare in Hampshire (W5c) and is a rich example of this type of woodland.

4.3 Impact of Skunk Cabbage

The Skunk Cabbage ***Lysichiton americanus***, had clearly had a high impact on the native vegetation where it had become dominant (Species List 5). The site had already had its first treatment in 2010 & 2011, so the data collected from the areas previously dominated by Skunk Cabbage reflect both the shade impact of the Skunk Cabbage, any herbicide impacts on adjacent vascular plants and the first stages of recolonisation. Constancy Table 2 & Species List 4 compare data from quadrats from recovering former patches of Skunk Cabbage dominance with adjacent quadrats from vegetation not dominated by Skunk Cabbage. A striking feature is the high losses of the tall sedges, herbs and grasses, especially Tussock Sedge ***Carex paniculata***, but also ***Filipendula ulmaria*** and ***Phalaris arundinacea*** from the areas of former Skunk Cabbage dominance. As there were no recently dead remains of Tussock Sedge this appears to be an effect of Skunk Cabbage competition and not the treatment. This suggests that continued invasion by Skunk Cabbage would have removed the distinctiveness of the vegetation. The W5c affiliation of a Skunk

Cabbage dominated W5c stand would become less and less clear with increased Skunk Cabbage cover.

Declines are evident in the frequency of smaller herbs especially ***Caltha palustris***, ***Veronica montana***, ***Galium palustre***, ***Scutellaria galericulata*** and ***Valeriana dioica***. Some species are actually as frequent or more frequent in the treated areas. These include rapidly recolonising vascular plants such as ***Athyrium filix-femina***, ***Carex remota***, ***Impatiens glandulifera***, ***Circaea lutetiana*** and ***Lysimachia nummularia***. These have clearly increased since the removal of the Skunk Cabbage. There is also a marked increase in bryophyte cover and diversity in the recovering treated areas with increases in ***Chiloscyphus pallescens***, ***Oxyrrhynchium hians***, ***Rhizomnium punctatum***, ***Hookeria lucens*** and ***Riccardia chamedryfolia***. The mosses are clearly benefiting from the removal of the Skunk Cabbage but probably also increased in cover as the Skunk Cabbage suppressed the competing vascular plants.

Assuming the Himalayan Balsam ***Impatiens glandulifera*** is also controlled, there is no obvious reason why the vegetation should not fully recover on the treated areas.

CONSTANCY TABLE 2
Comparisons Between Ground Vegetation not Invaded by Skunk Cabbage ***Lysichiton americanus*** with Areas Formerly Dominated by Skunk Cabbage

Species	Not Invaded by Skunk Cabbage	Skunk Cabbage Removed	All
Lysichiton americanus	II	III	III
Athyrium filix-femina	V	IV	V
Caltha palustris	V	III	V
Carex paniculata	V	I	III
Carex remota	V	V	V
Filipendula ulmaria	V	II	IV
Veronica montana	V	III	IV
Galium palustre	IV	III	IV
Impatiens glandulifera	IV	IV	IV
Kindbergia praelongum	IV	III	IV
Phalaris arundinacea	IV		II
Scutellaria galericulata	IV	II	III
Valeriana dioica	IV	III	IV
Chiloscyphus pallescens	III	IV	IV
Chrysosplenium oppositifolium	III	II	III
Circaea lutetiana	III	IV	IV
Oxyrrhynchium hians	III	V	IV
Angelica sylvestris	II		I
Brachypodium sylvaticum	II		I
Calliergonella cuspidata	II	II	II
Dryopteris dilatata	II	I	II
Geum urbanum	II	I	II
Hedera helix	II		I
Lysimachia nemorum	II		I
Lysimachia nummularia	II	III	III
Lysimachia vulgaris	II	I	II
Pellia epiphylla	II	I	II
Rhizomnium punctatum	II	IV	III

Acer pseudoplatanus	I	II	I
Brachythecium rivulare	I	II	II
Cardamine flexuosa	I		I
Carex acutiformis	I		I
Crataegus monogyna	I	I	I
Dryopteris carthusiana	I		I
Homalia trichomanoides	I		I
Hookeria lucens	I	III	II
Iris pseudacorus	I		I
Juncus effusus	I		I
Mentha aquatica	I		I
Myosotis scorpioides	I	I	I
Ribes rubrum	I		I
Riccardia chamedryfolia	I	IV	III
Rubus fruticosus	I		I
Senecio jacobaea	I		I
Solanum dulcamara	I		I
Viburnum opulus	I		I
Calliergon cordifolium		I	I
Cardamine pratensis		I	I
Fissidens taxifolius		I	I
Lemna minor		I	I
Lycopus europaeus		I	I
Plagiothecium denticulatum		I	I
Rumex sanguineus		I	I
Valeriana officinalis		I	I

The removal of the Skunk Cabbage precludes plotting Skunk Cabbage cover against species numbers and combined cover of other species as at Harcourt Wood. However, significance of the differences between the number native species and the combined cover of native species in the paired Skunk Cabbage absent and Skunk Cabbage removed quadrats was tested using a Paired Student's T-Test.

With the numbers of species, all the species showed a just significant negative relationship with the former dominance of Skunk Cabbage and a much stronger significant negative relationship with the numbers of native vascular plants. The numbers of bryophytes were higher in areas recovering from Skunk Cabbage dominance but this was not significant.

For the combined cover of native species both all native species and native vascular plants show a highly significant negative relationship with the former dominance of Skunk Cabbage. The combined cover bryophyte, however, shows a significant positive relationship with the former dominance of Skunk Cabbage.

Paired Student's T-Tests
One sided Paired Student's T-Test of numbers of species other than Skunk Cabbage and Himalayan Balsam in paired quadrats with Skunk Cabbage absent verses quadrats with Skunk Cabbage removed. Probabilities lower than 0.05 are significant.

Data, All Native Species

Quadrat	Skunk Cabbage	
Pairs	Absent	Removed

Q1	20	18
Q2	15	16
Q3	25	19
Q4	22	10
Q5	18	12

Probability = 0.042

Data, All Native Vascular Plant Species

Quadrat Pairs	Skunk Cabbage Absent	Removed
Q1	16	11
Q2	13	9
Q3	19	11
Q4	17	8
Q5	15	5

Probability = 0.0017

Data, All Bryophyte Species

Quadrat Pairs	Skunk Cabbage Absent	Removed
Q1	4	7
Q2	2	7
Q3	6	8
Q4	5	2
Q5	3	7

Probability = 0.095

One sided Paired Student's T-Test of combined cover of species other than Skunk Cabbage and Himalayan Balsam in paired quadrats with Skunk Cabbage absent verses quadrats with Skunk Cabbage removed. Probabilities lower than 0.05 are significant.

Data, All Native Species

Quadrat Pairs	Skunk Cabbage Absent	Skunk Cabbage Removed
Q1	144	132.7
Q2	163.4	107.5
Q3	133.8	111.8
Q4	150.8	99
Q5	120.8	67.1

Probability = 0.0069

Data, All Native Vascular Plant Species

Quadrat Pairs	Skunk Cabbage Absent	Skunk Cabbage Removed
Q1	127.5	48.4
Q2	153.9	57.9
Q3	102.2	39
Q4	140.4	85.5
Q5	105.8	10.7

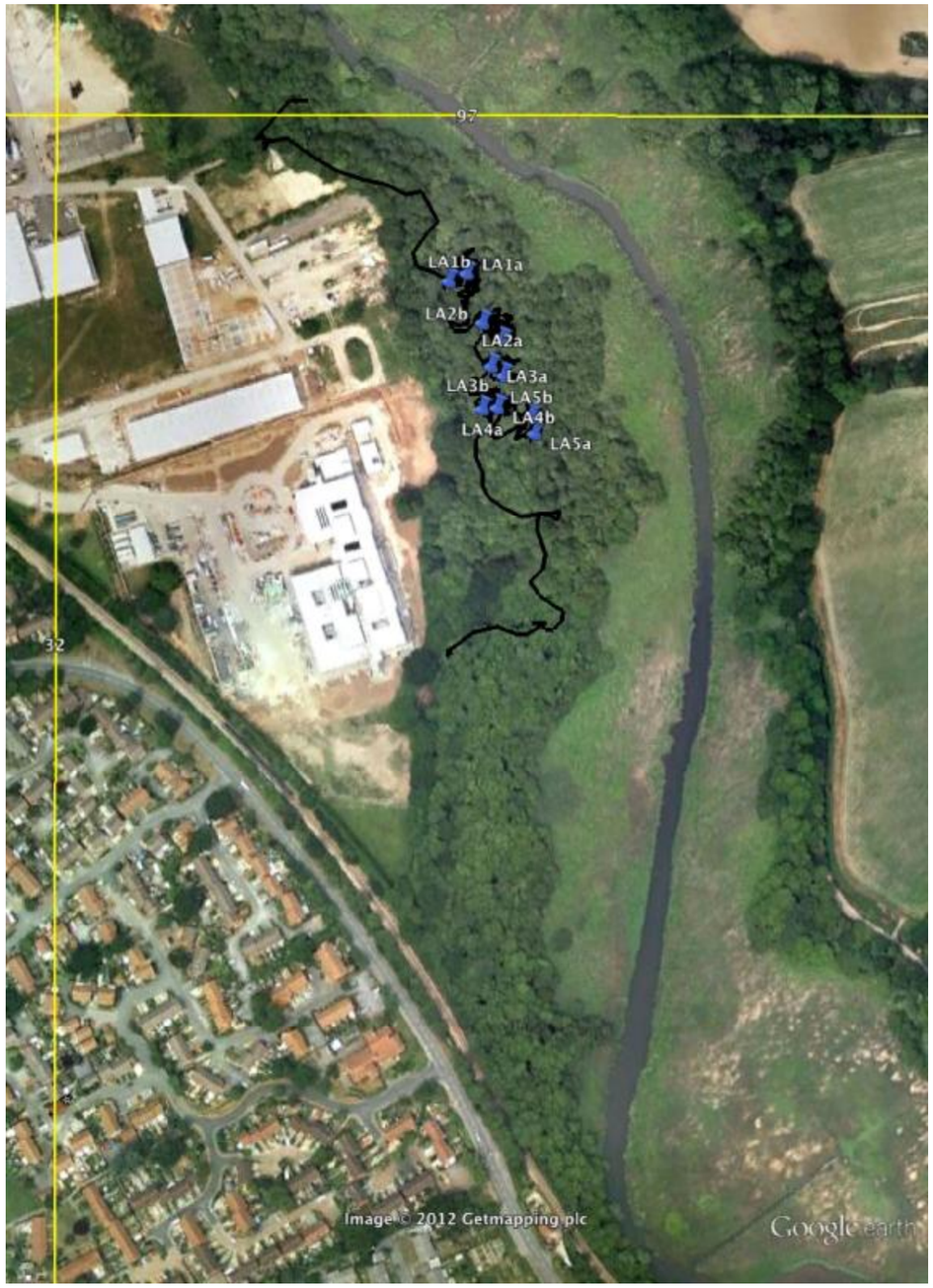
Probability = 0.00036

Data, All Bryophyte Species

Quadrat Pairs	Skunk Cabbage Absent	Skunk Cabbage Removed
Q1	16.5	84.3
Q2	9.5	49.6
Q3	31.6	72.8
Q4	10.4	13.5
Q5	15	56.4

Probability = 0.010

4.4 Maps



Route and waymarks in Google Earth, waypoint data given in Table 2

Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

Survey Ampress Map 5

Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

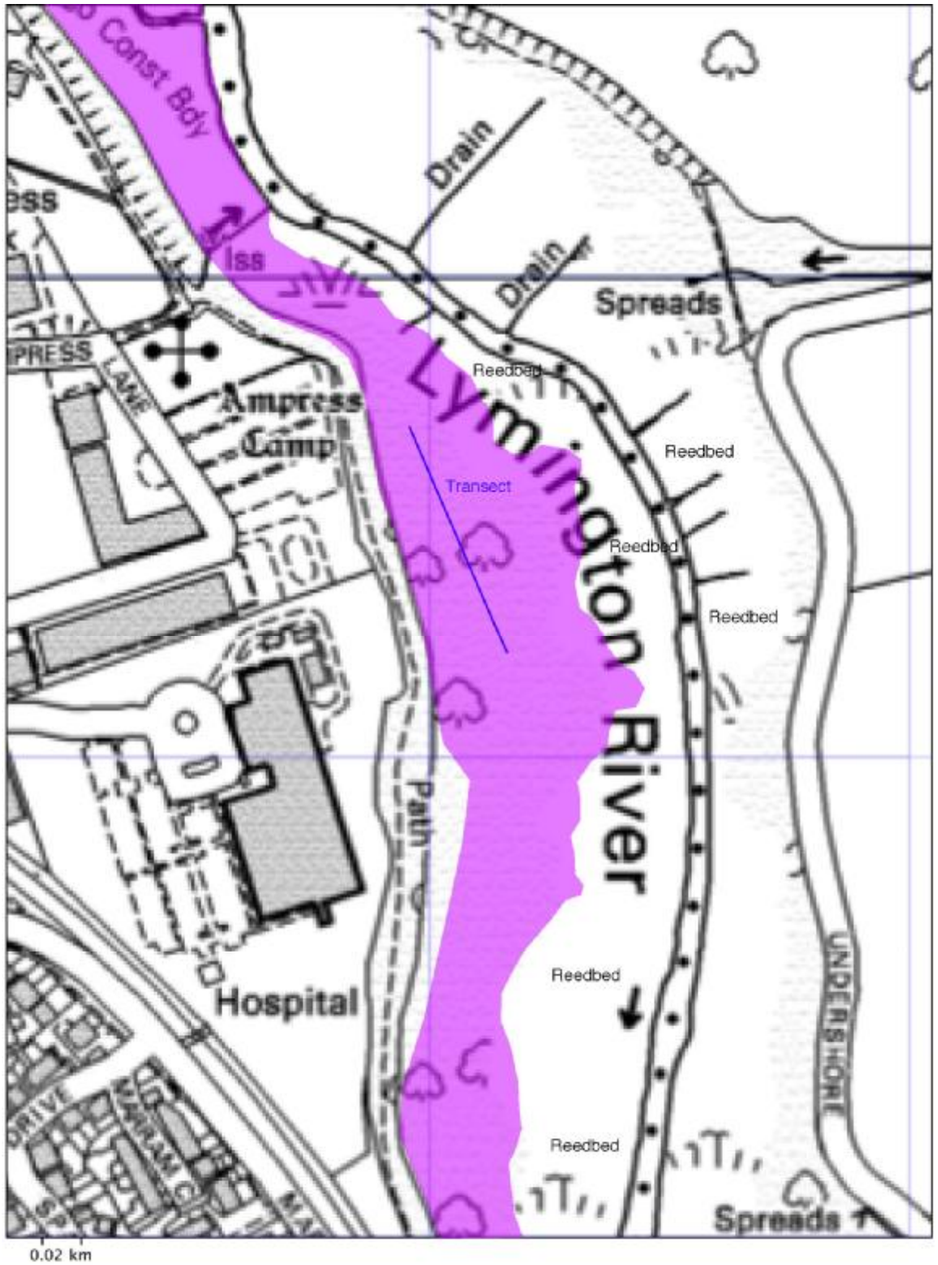
Survey Ampress Map 6

Route and waymarks on OS base, waypoint data given in Table 2

Botanical Survey and Assessment
3 Green Close, Woodlands, SO40 7HU
023 8029 3671

Impact of Skunk Cabbage

Vegetation Ampress Map 7



Wet woodland purple
Approximate line of transect blue

4.5 Data

SPECIES LIST 4
Ampress, Species List and Domin Quadrat Data

Species	Ampress	Constancy All	Constancy Skunk Cabbage Absent or Rare	Constancy Skunk Cabbage Removed	LA1a	LA1b	LA2a	LA2b	LA3a	LA3b	LA4a	LA4b	LA5a	LA5b	AW
TREES & TALL SHRUBS															
Acer pseudoplatanus	O	I	I	II							C	C			
Alnus glutinosa	D	V	V	V	C	C	C	C	C	C	C	C	C	C	
Crataegus monogyna	R	I	I	I									C	C	
Fraxinus excelsior	O	III	III	III	C	C			C	C			C	C	
Salix cinerea ssp oleifolia	A	III	III	III	C	C	C	C	C	C					
Viburnum opulus	O	I	I	I							1	C			1
UNDER SHRUBS															
Ribes nigrum	R														1
Ribes rubrum	O	I	I								1				1
Rosa canina agg	R														
GRASSES															
Brachypodium sylvaticum	R	I	II						2				2		
Phalaris arundinacea	O	II	IV		3		2		2				3		
OTHER VASCULAR PLANTS															
Alisma plantago-aquatica	R														
Angelica sylvestris	R	I	II				4				2				
Apium nodiflorum	O														
Athyrium filix-femina	F	V	V	IV	5	2	5		4	1	7	5	2	2	
Callitriche stagnalis	O														
Caltha palustris	F	V	V	III	5	3	4	3	3	2	3		1		
Cardamine flexuosa	R	I	I						1						
Cardamine pratensis	O	I		I		2									
Carex acutiformis	A LD	I	I		6										
Carex paniculata	A	III	V	I	1		7		5		3		3	1	
Carex remota	A	V	V	V	2	5	4	4	3	3	3	3	4	3	1
Chrysosplenium oppositifolium	A	III	III	II		1	5		3		4	8			1
Circaea lutetiana	O	IV	III	IV	2	2		1	1	2	2	2			
Cirsium vulgare	R														
Dryopteris carthusiana	R	I	I		1										1
Dryopteris dilatata	R	II	II	I					1				2	1	
Filipendula ulmaria	F	IV	V	II	3		3		3	3	5	1	1		
Galium palustre	A	IV	IV	III	4	4	4	4	4	1			2		
Geum urbanum	F	II	II	I	1	2			3						
Hedera helix	O	I	II		1								2		
Impatiens glandulifera	F	IV	IV	IV			5	6	5	4	3	8	3	4	
Iris pseudacorus	O	I	I								4				
Juncus effusus	R	I	I								2				
Lemna minor	R	I		I		2									
Lycopus europaeus	O	I		I				1							
Lysichiton americanus	O [LD]	III	II	III		2	4	2		1			1		
Lysimachia nemorum	O	I	II						1		2				1
Lysimachia nummularia	F	III	II	III	4	4	5	5		3					
Lysimachia vulgaris	F	II	II	I		2	4						4		

Species	Ampress	Constancy All	Constancy Skunk Cabbage Absent or Rare	Constancy Skunk Cabbage Removed	LA1a	LA1b	LA2a	LA2b	LA3a	LA3b	LA4a	LA4b	LA5a	LA5b	AW
Mentha aquatica	R	I	I								2				
Myosotis scorpioides	F	I	I	I			4	5							
Oenanthe crocata	R														
Osmunda regalis	R														
Prunella vulgaris	R														
Ranunculus repens	R														
Rubus fruticosus	R	I	I						2						
Rumex sanguineus	R	I		I				1							
Sanicula europaea	R														1
Scirpus sylvaticus	F LD														1
Scutellaria galericulata	F	III	IV	II	4				4	2	3	2	3		
Senecio jacobaea	R	I	I						1						
Solanum dulcamara	O	I	I										2		
Urtica dioica	R														
Valeriana dioica	A	IV	IV	III	6			2	6	5	7	2	8		
Valeriana officinalis	R	I		I						1					
Veronica montana	F	IV	V	III	2		3		3	3	2	3	4	3	1
MOSSES															
Brachythecium rivulare	O	II	I	II						2			2	2	
Calliergon cordifolium	O	I		I		4									
Calliergonella cuspidata	A	II	II	II	4	7	1			6					
Fissidens taxifolius	R	I		I				1							
Homalia trichomanoides	R	I	I		2										
Hookeria lucens	F	II	I	III				2		4	1			4	
Kindbergia praelongum	F	IV	IV	III	3	4		3	3		1		3	6	
Oxyrrhynchium hians	F	IV	III	V		2	4	5	4	3	4	4		3	
Plagiothecium denticulatum	R	I		I						3					
Rhizomnium punctatum	F	III	II	IV				2	3	4	1	3		4	
LIVERWORTS															
Chiloscyphus pallescens	A	IV	III	IV	2	5		5	4	5			4	3	
Pellia epiphylla	R	II	II	I		3			1		1				
Riccardia chamedryfolia	F	III	I	IV		3		4	3	2				2	
Mud					4	8	2	7	2	7	2	4	3	9	

Key
LA1a = Quadrat placed on area in which Skunk Cabbage ***Lysichiton americanus*** had not become dominant
LA1b = Quadrat placed on area where Skunk Cabbage ***Lysichiton americanus*** had become dominant, but had been removed the previous year
C = Canopy species
AW = Ancient Woodland Vascular Plants

SPECIES LIST 5
Ampress, Quadrat Data, with Domin Cover Values Converted to Mean Percentage Cover Values

Species	LA1a	LA1b	LA2a	LA2b	LA3a	LA3b	LA4a	LA4b	LA5a	LA5b
Viburnum opulus							0.3			
Ribes rubrum							0.3			
Brachypodium sylvaticum					1.5				1.5	
Phalaris arundinacea	4.3		1.5		1.5				4.3	
Angelica sylvestris			9.2				1.5			
Athyrium filix-femina	16.4	1.5	16.4		9.2	0.3	39.4	16.4	1.5	1.5
Caltha palustris	16.4	4.3	9.2	4.3	4.3	1.5	4.3		0.3	
Cardamine flexuosa					0.3					
Cardamine pratensis		1.5								
Carex acutiformis	26.4									
Carex paniculata	0.3		39.4		16.4		4.3		4.3	0.3
Carex remota	1.5	16.4	9.2	9.2	4.3	4.3	4.3	4.3	9.2	4.3
Chrysosplenium oppositifolium		0.3	16.4		4.3		9.2	55.7		
Circaea lutetiana	1.5	1.5		0.3	0.3	1.5	1.5	1.5		
Dryopteris carthusiana	0.3									
Dryopteris dilatata					0.3				1.5	0.3
Filipendula ulmaria	4.3		4.3		4.3	4.3	16.4	0.3	0.3	
Galium palustre	9.2	9.2	9.2	9.2	9.2	0.3			1.5	
Geum urbanum	0.3	1.5			4.3					
Hedera helix	0.3								1.5	
Impatiens glandulifera			16.4	26.4	16.4	9.2	4.3	55.7	4.3	9.2
Iris pseudacorus							9.2			
Juncus effusus							1.5			
Lemna minor		1.5								
Lycopus europaeus				0.3						
Lysichiton americanus		1.5	9.2	1.5		0.3			0.3	
Lysimachia nemorum					0.3		1.5			
Lysimachia nummularia	9.2	9.2	16.4	16.4		4.3				
Lysimachia vulgaris		1.5	9.2						9.2	
Mentha aquatica							1.5			
Myosotis scorpioides			9.2	16.4						
Rubus fruticosus					1.5					
Rumex sanguineus				0.3						
Scutellaria galericulata	9.2				9.2	1.5	4.3	1.5	4.3	
Senecio jacobaea					0.3					
Solanum dulcamara									1.5	
Valeriana dioica	26.4			1.5	26.4	16.4	39.4	1.5	55.7	
Valeriana officinalis						0.3				
Veronica montana	1.5		4.3		4.3	4.3	1.5	4.3	9.2	4.3
Brachythecium rivulare						1.5			1.5	1.5
Calliergon cordifolium		9.2								
Calliergonella cuspidata	9.2	39.4	0.3			26.4				
Fissidens taxifolius				0.3						
Homalia trichomanoides	1.5									
Hookeria lucens				1.5		9.2	0.3			9.2
Kindbergia praelongum	4.3	9.2		4.3	4.3		0.3		4.3	26.4
Oxyrrhynchium hians		1.5	9.2	16.4	9.2	4.3	9.2	9.2		4.3
Plagiothecium denticulatum						4.3				

Rhizomnium punctatum				1.5	4.3	9.2	0.3	4.3		9.2
Chiloscyphus pallescens	1.5	16.4		16.4	9.2	16.4			9.2	4.3
Pellia epiphylla		4.3			0.3		0.3			
Riccardia chamedryfolia		4.3		9.2	4.3	1.5				1.5

TABLE 2
Ampress Waypoint Data

Name	Zone	Easting	Northing	Comment
LA1a	SZ	32249	96912	Alder dominant with Sallow & Ash saplings, free of Skunk Cabbage
LA1b	SZ	32238	96907	Alder dominant with Sallow & Ash saplings, recolonisation after Skunk Cabbage removal
LA2a	SZ	32270	96872	Open Alder with Sallow & Ash saplings, some recent Skunk Cabbage colonisation
LA2b	SZ	32259	96882	Open Alder with Sallow & Ash saplings, recolonisation after Skunk Cabbage removal
LA3a	SZ	32264	96856	Alder dominant with Sallow, Hawthorn & Ash saplings, free of Skunk Cabbage
LA3b	SZ	32271	96851	Alder dominant with Sallow, Hawthorn & Ash saplings, recolonisation after Skunk Cabbage removal
LA4a	SZ	32258	96831	Alder dominant with Sycamore, free of Skunk Cabbage
LA4b	SZ	32268	96831	Alder dominant with Sycamore, recolonisation after Skunk Cabbage removal, Himalayan Balsam invading
LA5a	SZ	32290	96816	Alder dominant with Sallow, Hawthorn & Ash, closed canopy, some recent Skunk Cabbage colonisation
LA5b	SZ	32288	96826	Alder dominant with Sallow, Hawthorn & Ash, closed canopy, recolonisation after Skunk Cabbage removal

4.6 Photos

All photographs taken on site are shown in a web gallery Harcourt & Ampress Gallery. Selected photographs are shown here.

Photo 9. Ampress. Quadrat LA01a, swamp woodland (W5c), showing a stand that had remained free of Skunk Cabbage.

Photo 10. Ampress. Quadrat LA01b, adjacent swamp woodland (W5c), showing a stand that has recently had Skunk Cabbage removed. The bare peat has been well colonised by bryophytes and rapid colonisers such as ***Carex remota***.

Photo 11. Ampress. Quadrat LA04a, swamp woodland (W5c), showing a stand that had remained free of Skunk Cabbage.

Photo 12. Ampress. Quadrat LA04b an adjacent, swamp woodland (W5c), showing a stand that has recently had Skunk Cabbage removed. Himalayan Balsam has invaded the bare peat.

5.0 DISCUSSION

5.1 Impact of Skunk Cabbage ***Lysichiton americanus***

5.1.1 Vulnerable Habitats

Skunk Cabbage ***Lysichiton americanus*** is a species of wet woodlands and is strongly limited by soil wetness. From observations at Harcourt Wood, Area 2 and in well developed invasions in similar riverine woodlands in Sussex, the species is unlikely to be able to invade damp but well drained alluvial woodland (hardwood floodplain woodland) dominated by Ash, Hazel etc. encompassed by NVC community Fraxinus excelsior – Acer campestris – Mercurialis perennis Woodland (W8). Within floodplain woodlands it is likely to be strongly confined to the wetter Alder or Willow dominated woodlands (softwood floodplain woodland) (see Peterken & Hughes (1995) for a description of floodplain woodland types). On floodplains these will include NVC communities Alnus glutinosa – Urtica dioica Woodland (W6) and Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland (W7).

The species will also colonise wooded valley mire and headwater wetlands. At Harcourt Wood it was spreading upstream into spring fed Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland (W7) headwaters wetlands. At Ampress it was growing in swamp woodland referable to Alnus glutinosa – Carex paniculata Woodland (W5) in spring fed valley peat.

The limit of its spread in relation to soil acidity is not entirely clear. The website "DEFRA American Skunk Cabbage ***Lysichiton americanus*** Fact Sheet" describes the habitats as nutrient-rich mud, both acid and basic, which is somewhat contradictory, nutrient rich habitats are rarely acid. Klingenstein & Alberternst (2010) are more clear and state: "as long as the site is wet, it has no specific soil requirements (from light sand soils to heavy clay soils of acid, neutral or basic reaction) and can grow in shade or full light". They also state "vegetation studies in the Taunus area of Germany clearly showed that mosses (e.g. ***Sphagnum*** species), ***Viola palustris***, orchid species and other plants are displaced within some years". The ***Sphagnum*** species and ***Viola palustris***, indicate that Skunk Cabbage is capable of invading low productivity bog woodland (Betula pubescence – Molinia caerulea Woodland, Juncus effusus sub-community, W4b & Sphagnum sub-community, W4c).

In Hampshire the species has invaded two of the main types of established species rich wet woodland; swamp Alder woodland (W5) and flushed Alder wood (W7). It is also capable of invading bog woodland (W4b & W4c) but has not yet been recorded as doing so here.

5.1.2 Effect on Native Vegetation

Skunk Cabbage ***Lysichiton americanus*** is a bulky shade casting perennial. It dies down in winter but flowers very early and closes its leaf canopy early; it was fully closed by mid May at Harcourt Wood. It has clear and obvious effects on native vegetation, totally displacing nearly all species in large dense patches due to competition for light. The species is confirmed by this study to be highly destructive of native wet woodland communities. In both the species rich communities examined, swamp Alder woodland (W5) and flushed Alder wood (W7), the character ground flora species of the NVC communities were disappearing in the

face of Skunk Cabbage invasion. This was reducing these distinctive communities to anonymous species poor wet woodlands.

In Germany Klingenstein & Alberternst (2010) assessed Skunk Cabbage as an invasive exotic, which is a threat to native vegetation. The "DEFRA American Skunk Cabbage Lysichiton americanus Fact Sheet" in contrast stated: "reports of it having an adverse impact on swamp communities in Germany require confirmation for naturally-spreading populations, as at the most affected site it had been deliberately planted in many different locations by a gardener", which seems complacent, especially as the allusion to multiple planting is not confirmed in the reference given (to the NOBANIS database). This study confirms it as an invasive exotic, which is a threat to native vegetation in Britain.

The implication in the DEFRA Fact Sheet that it has poor dispersal powers and is not therefore a threat, is not borne out by either this study or by Klingenstein & Alberternst (2010). The latter described several examples of quite rapid spread within sites and mentioned that it appears to have dispersed via waterways 20 km downstream in Denmark. This study found it to have dispersed 870m upstream from its presumed introduction area by the millpond at Harcourt Wood. It has also spread at least 560m (Gadsby & Fox, 2010) from a presumed single introduction point at Ampress. The author has seen presumably water dispersed plants 500m downstream of the nearest garden in Sussex. None of this supports the statement in the fact sheet that "in GB, it spreads over several tens of metres from the point of introduction, but there are no reports of longer-distance dispersal". Again this seems unduly complacent. The evidence of Harcourt Wood, suggests that individual plants are capable of jumps of tens of metres, i.e. this distance is the distance travelled by one generation. Subsequent shorter distant dispersal once this plant has matured then appears to lead to exponential expansion between widely dispersed clumps. Observing young colonies before exponential expansion between the early isolated colonies has occurred, may give an unduly benign impression of the species.

The upstream spread at Harcourt also suggests that bird dispersal of the berries may be occurring, leaving the potential for long distant jumps to other high quality wet woodlands. The author has seen isolated plants in headwater wetlands not downstream of any garden in Sussex, which also suggests bird dispersal.

5.1.3 Quality of Habitats Invaded

Klingenstein & Alberternst (2010) make an interesting comment that "in contrast to most other alien plant species it is restricted to these more or less natural habitats which in Central Europe are rare and often highly endangered or protected." This reflects the author's experience of this species in Hampshire and Sussex, where it appears confined to high quality and otherwise pristine wet woodland habitats. All wet woodland is included within the BAP Priority Habitat Wet Woodland. This, however, is odd as wet woodland in general is a habitat that has rapidly expanded in the last two centuries. This has mainly occurred at the expense of rare and declining open wetland habitats that are much richer in declining species and are themselves BAP habitats (Sanderson, 2007). There are, however, high quality well established

wet woodland that are of considerable interest; ideally the BAP should have been directed at these. These include two Annex 1 Priority Habitats Directive Habitats:

- 91D0 * Bog woodland (NVC, wet sub-communities of Betula pubescence – Molinia caerulea Woodland, W4)

- 91E0 * Alluvial forests with ***Alnus glutinosa*** and ***Fraxinus excelsior*** (***Alno-Padion***, ***Alnion incanae***, ***Salicion albae***) (NVC mosaics of Fraxinus excelsior – Acer campestris – Mercurialis perennis Woodland, W8 and Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorosa Woodland, W7 with associated Alnus glutinosa – Carex paniculata Woodland, W5. Areas dominated by W5 in valley mires are not included).

High quality examples are usually ancient or long established woodlands, not recently established stands. American Skunk Cabbage ***Lysichiton americanus*** is likely to invade both Annex 1 habitats. The Harcourt Wood site includes high quality ancient examples of 91E0 * Alluvial forests in Area 2 and long established developing examples in Area 1.

Swamp woodlands (W5) are not included within the Annex 1, but probably should have been (website "Natura 2000 Habitats in Germany") and are of similar quality to the above where ancient or long established. These are also a preferred locus for Skunk Cabbage invasion, as seen at Ampress.

5.2 Conclusions

This survey demonstrated Skunk Cabbage ***Lysichiton americanus*** to be an invasive non-native species, which is a considerable threat to high quality native wet woodland habitat, a BAP habitat. This includes at least one Annex I Priority Habitat, (91E0 * Alluvial Forests) and data from Germany (Klingenstein & Alberternst, 2010). suggest that another (91D0 * Bog woodland) is vulnerable. Mature Skunk Cabbage colonies form large dense patches, which suppress large areas of the native ground flora.

Initial colonisation is slow but exponential expansion probably occurs as numbers build up, ending with almost total ground cover. The pattern of invasion is of a late succession species of stable habitats; many invasive exotics are pioneer ruderal species with more explosive early colonisation strategies. The slower early stages of colonisation may have given an impression that the species was less of a threat than it is and the assessment by DEFRA (The website "DEFRA American Skunk Cabbage ***Lysichiton americanus*** Fact Sheet") clearly under estimates the danger of this species. Invasion occurs in very wet situations and so far has only been seen in high quality habitats. The species absence from more accessible generalist habitats may have given it a lower profile than more ruderal invasive species that are more obvious in the general countryside or even urban situations.

The occurrence of upstream dispersal on the floodplain at Harcourt Wood suggests that bird dispersal of berries may be occurring, increasing the potential threat of this species to pristine habitats.

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