KNEPP CASTLE ESTATE

WILDLANDS PROJECT

TRANSECT SURVEY 2015

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1.0 Background

Much of the Knepp Castle Estate used to be arable land with some areas of pasture. Since 2001 the Knepp Wildlands Project has seen the end of arable cultivation and the gradual introduction of wide-ranging, grazing livestock to different parts of the estate.

Fallow deer were re-introduced into the central, historical deer park area (Area A) in 2002, followed by longhorn cattle, Exmoor ponies and Tamworth pigs. Adjacent land came into the scheme in 2004 (Area B) with the northern block (Area C north of the A272) added in 2006. The southern block (Area D) was the last part of the Estate to be added to the grazing area in 2009.

The transect survey forms part of the ongoing ecological monitoring of the Knepp Wildlands Project, described in the Knepp Baseline Ecological Survey of 2005 (Greenaway 2006).

The purpose of the transect survey is to record vascular plants along eight 30m belt transects which are located in four areas across the different parts of the Estate (Areas A-D). The transects were positioned to help monitor changes in vegetation structure and composition in the transitional areas (ecotones) between blocks of woodland or hedgerows and adjoining grassland areas.

The first transects were recorded in 2005 (by Kate Ryland of Dolphin Ecological Surveys with one transect recorded by Rich Howorth of Sussex Wildlife Trust) then repeated in 2010 (by Sophie Miller of SJM Ecology) and again in 2015 (by Kate Ryland with Penny Green, Knepp Estate Ecologist). This report presents the results of the 2015 survey.

2.0 Methodology

2.1 Transect methodology

The eight 30m belt transects that were set up in 2005 were located in four separate areas (see Table 1). The reasons for choosing these locations are discussed in the report of the 2010 transect survey (Greenaway and Miller 2010).

- Area A had been re-seeded in 2001 and grazed from 2002
- Area B had been re-seeded in 2004 and grazed from 2005
- Area C was grazed from 2006
- Area D was grazed intensively by horses in 2005 but from 2009 became part of the mixed, extensive grazing of the Knepp Wildlands Project

In 2005 wooden posts were installed to mark the starting points of the transects but unfortunately these did not remain in position so in 2010 and again in 2015 the 10-figure grid references (see Table 1) were used as the starting points. This is less satisfactory than using a fixed starting point for the transects because GPS accuracy can vary considerably.

15 contiguous 2mx2m quadrats were recorded in each belt transect. In each quadrat all vascular plants were recorded and cover estimated using the DOMIN scale of 1 to 10.

The Domin Scale

1 = <4% cover with few individuals	6 = 26-33% cover
2 = <4% cover with several individuals	7 = 34-50% cover
3 = <4% cover with many individuals	8 = 51-75% cover
4 = 4-10% cover	9 = 76-90% cover
5 = 11=25% cover	10 = 91-100% cover

The average height of vegetation (and sometimes the range of heights if there was an extreme variation within a quadrat) and the amount of bare ground were also recorded.

Digital photographs were taken along the line of each transect and these will be added to the photographic monitoring archive of the Estate.

The 2015 transect survey was carried out by Kate Ryland of Dolphin Ecological Surveys, assisted on some days by Penny Green, Knepp Estate Ecologist. Survey dates were15th July, 16th July, 22nd July, 30th July, 17th August 2015.

Table 1. Position of Transects (taken from the 2005 report)

Transect Number	Location	Direction of Transect	Description of Location
A1	TQ15272 22284	East	South end of Matches Wood, approximately 9m into woodland over an open bank
A2	TQ15184 22346	North-north-east	North edge of Spring Wood, approximately 10m into woodland
B1	TQ15752 205553	West	Mid point on the western edge of Jacksons Wood, approximately 10m into the woodland over a bank and ditch
B2	TQ16067 20643	North	North edge of Swallows Furzefield, ¼ of the way from the western edge of the wood, approximately 10m into the woodland over a bank
C1	TQ16146 23713	East	Eastern edge of Coates Furzefield, ½ way along the edge, approximately 12m into the wood on the ride edge near a tall birch tree. A fallen branch from the wood edge into the field crosses the barbed wire fence and marks the location
C2	TQ15756 23624	East	Eastern edge of Alder Copse, approximately 10m into the woodland at a path into the wood
D1	TQ14810 20106	East-north-east	Western side of lagg on the southern edge, approximately 1m from the hedgerow and approximately 7m north of a mature oak tree. Transect hits the ditch to the south of the hawthorn shrub
D2	TQ14427 20225	North	South edge of Lancing Brook lagg, approximately 1m from the hedge

2.2 Data analysis

2.2.1 Data analysis in 2010

The 2010 transect survey report included some analysis of the data comparing the 2005 and the 2010 survey results. Comparative graphs were presented the of Ellenberg scores for light and nitrogen, the amount of bare ground and the species diversity for each quadrat in every transect.

British vascular plant species are allocated Ellenberg's indicator values on a numeric scale. These are used as a measure of each species' tolerance of five important ecological variables; light, moisture, reaction (pH), nitrogen (soil fertility) and salt (Hill et al. 1999, Hill, Preston and Roy 2004).

Ellenberg values for light (L) are on a scale of 1 to 9. Plants that occur in deep shade score 1 whilst those that are found mostly in full sun score 9. For example, dog's mercury has a score of 3 which indicates that it is “a shade plant, mostly less than 5% relative illumination, seldom more than 30% illumination when trees are in full leaf”. In contrast bluebell and pendulous sedge have Ellenberg light scores of 5 i.e. “semi-shade plants, rarely in full light but generally with more than 10% relative illumination when trees are in leaf”. False oat-grass and rough meadow-grass score 7 because they are “plants generally in well lit places but also occurring in partial shade”.

Ellenberg values for nitrogen (N) are also measured on a scale of 1 to 9 where a score of 1 indicates plants of extremely infertile sites and a score of 9 indicates plants of extremely rich situations such as cattle resting places or near polluted rivers.

The full data that was used for the analysis in the previous report (Greenaway and Miller 2010) was not available during the preparation of this report and so it was not possible to replicate the graphs with the 2015 data added.

Additionally, in 2010 there appeared to be very similar results for Ellenberg scores for light and nitrogen in most transects between 2005 and 2010 so it may be too soon for any significant differences to be evident using this type of analysis. There were, however, greater differences apparent in the pattern of bare ground recorded along transects over the 5 year period.

2.2.2 Data analysis in 2015

The quadrat data from the 2015 survey is presented in a separate spreadsheet that will be held by the Estate ecologist. This will be available if a new set of graphs of Ellenberg values covering the 10 year period of the monitoring so far are required. The data can also be used for more detailed analysis of the vegetation changes that are being recorded along the transects.

Analysis of the 2015 results in this report is restricted to basic observations on the broad changes from 2005 to 2015 in vegetation structure, as shown in the average vegetation height (Table 2), changes in species frequency (Table 3) and the changing frequency of woody regeneration recorded in the transects (Tables 4 and 5).

3.0 Constraints

Species recording constraints encountered in 2005, when some of the grassland had been mown and grazed prior to the survey, were not repeated in either 2010 or in 2015.

Different individuals carried out the transect surveys in different years. This may mean that recorder bias has affected not only the species recorded but potentially also the estimates of cover of each species. In particular the cover of vegetative grasses in a large quadrat is not easy to estimate consistently between recorders with a high degree of accuracy.

However, the most significant constraint is that relying on a 10-figure grid reference to determine the starting point of each transect is highly likely to cause slight variations in transect location each time the survey is carried out. The accuracy of hand-held GPS units has improved greatly in recent years but it varies between different devices and according to weather conditions, canopy cover and other factors. It is still quite usual to have no better than a 4m margin of error.

Using Ellenberg values in the 2010 data analysis to identify trends in vegetation was felt to address potential discrepancies arising from potential shifts in the transect positions. This may be a good reason to repeat that particular analysis with the 2015 data when resources are available.

Ideally the transect locations should be fixed using some kind of permanent marker so that any future analysis of the results would have a higher degree of confidence. It might be more feasible to use buried transponders rather than large above-ground markers, which can be knocked over if livestock use them as scratching posts. Posts can also be attractive features for animals and if livestock tend to congregate around posts this could have a local impact on the vegetation and distort the results of plant recording along the transects.

4.0 Results

4.1 Transect descriptions

Transect A1

This transect starts in Matches Wood, a heavily grazed woodland with extensive bare ground. It extends over a sparsely vegetated bank and ditch with rabbit burrows in the ditch. There is a distinct transition to the grass-dominated field which has a taller but quite uniform sward.

Transect A1

Transect A2

Transect A2 starts in Spring Wood, an area of plantation with limited understorey and few signs of successful woody seedling recruitment.

Transect A2

The bank and ditch on the edge of the woodland show considerable evidence of deer browsing and trampling with the regrowth on coppiced stools being repeatedly browsed.

The area of grassland to the north of the wood is damp with locally frequent rushes and a reasonably tussocky structure. This grades into a drier, more uniform sward further into the field.

Transect B1

This transect on the western edge of Jacksons Wood has a particularly high proportion of bare ground and low sward with poor structural diversity due to intense rabbit activity both in the woodland and in the adjoining fields.

Transect B1

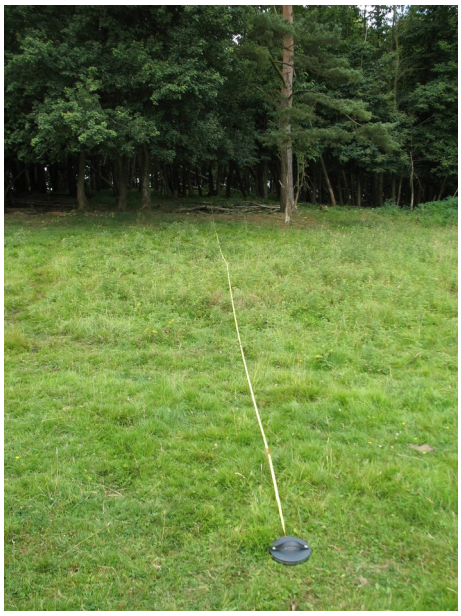
There is distinct browse line within the woodland and little shrub layer, though some patches of bramble and bracken occur in the northern parts of the wood.

Transect B1 from the field

Transect B2

Transect B2 extends from the northern edge of Swallows Furzefield, an area of sweet chestnut coppice, into the upper slopes of a damp, riverside field. The woodland floor has large bare areas interspersed with stands of redshank, nettle and grasses. Deadwood is present throughout the copse. Creeping thistle is locally prominent in the field but overall the sward is quite short.

Transect B2



Transect B2 from the field

Transect C1

This transect starts within Coates Furzefield and crosses a woodland ride then a bank and ditch before emerging into the adjacent field. The grassy ride has tall bracken on its edges and the bank supports both bare areas and taller vegetation. Outside the woodland the grassland sward is becoming quite tussocky with some damp flushes and the entire transect shows reasonable variation in vegetation structure.

Transect C1

Transect C2

C2 is a particularly varied transect which emerges from Alder Copse via a herb-rich ride. The transect crosses an old stump on the ride which supports tall herb vegetation such as nettle and creeping thistle.

Transect C2

Several ancient woodland indicator species are also present, including a single early purple orchid. From the woodland edge the sward becomes progressively less diverse and has a generally short, improved sward.

Transect D1

This transect runs from the edge of a hedgerow into an open field and crosses a small ditch. The field is quite heavily grazed and the sward is patchy with some stands of thistle and nettle and areas of bare ground.

There is much rabbit activity associated with the hedgerow and parts of the hedge base show a low browse line. The ditch flora is quite well developed but the ditch was dry at the time of the survey.

Transect D1

Transect D2

This transect was set up when Lancing Brook lagg was horse-grazed pasture. Since it was last surveyed in 2010 there has been extensive wetland creation along the lagg and the area is now a diverse wetland with open water and fen vegetation.

Transect D2

This has changed the vegetation structure and diversity along the transect enormously and provides a good illustration of the impact that wetland creation work can have in a very short time.

View of the new wetland in Lancing Brook lagg

4.2 Trends in vegetation

4.2.1 Vegetation height

Following the 2010 report format, the average height of vegetation in each quadrat is given in the table below along with comments on the vegetation structure in each transect.

Table 2. Height of vegetation (adapted from the 2010 report)

Transect Number	Quadrat Number	Average Vegetation Height (cm)			Comments on Vegetation Structure
		2005	2010	2015	
A1	*1*	0	3	0	2005: Woodland floor is almost bare apart from tree seedlings. The canopy is uniform with a sparse, spindly shrub layer. The bank and ditch are generally bare with some bramble etc. The field has an even, uniform sward. 2010: Woodland floor continues to be almost bare with more species all at very low cover. Still a clear demarcation between woodland and grassland. Except for the increase in average height of the sparse woodland ground flora the average height of the vegetation is lower in 2010 than it was in 2005. 2015: Woodland floor and the bank on its edge remain largely bare with rabbit burrows in the ditch adjacent to the bank. The grassland sward height resembles the 2005 results though with a little more variation. Demarcation between woodland and grassland remains clear.
	2	0	3	3	
	3	0 (3m and 10m trees)	2	0	
	4	0 (10+m tree)	1	0	
	5	0	3	0	
	6	30 (0)	16	2	
	7	15	12	10	
	8	20	16	15	
	9	25	19	22	
	10	25	17	30	
	11	25	12	28	
	12	25	14	25	
	13	25	12	25	
	14	25	16	18	
	15	15	18	15	
A2	*1*	10 (1m &10m tree)	9	30	2005: Limited structural diversity in the woodland itself and an abrupt transition from woodland edge to the field. The woodland canopy is uniform throughout the plantation. The grassland sward is also uniform and this transect has two distinct zones with little transitional habitat. 2010: Higher level of bare ground in the woodland quadrats in 2010 and higher average height of ground flora although a lower species diversity. Still two distinct zones with limited transitional habitat. Overall height of vegetation increased. 2015: More variation becoming apparent in the grassland sward where rush tussocks develop and grasses are closely grazed. Woodland has a mixture of bare ground and stands of tall herbs.
	2	10	13	17	
	3	10	16	6	
	4	10	17	4	
	5	0 (10)	17	4	
	6	40	10	10	
	7	20	25	20	
	8	15	32	42	
	9	10	19	50	
	10	15	22	12	
	11	10	21	7	
	12	5	16	5	
	13	10	18	3	
	14	10	11	3	
	15	10	8	8	
B1	*1*	0	16	3	2005: Woodland section desiccated. Ground flora formerly dominated by bluebell, common cleavers etc. Tall, even canopy and diverse shrub layer. Bank and ditch support dense bramble, nettle etc. Field topped and has a sparse, uniform sward with many bare patches on the dry, cracked ground. 2010: Overall less bare ground in 2010.Grassland areas recovering from cutting with consistently taller vegetation. Still a clear demarcation between woodland and grassland zones.
	2	0	22	2	
	3	5 (30)	21	3	
	4	10	28	5	
	5	10	7	3	
	6	0 (5-60)	10	0	
	7	60 (5)	20	17	
	8	5	22	5	
	9	5	17	3	
	10	5	18	3	
	11	5	16	3	

Transect Number	Quadrat Number	Average Vegetation Height (cm)			Comments on Vegetation Structure
		2005	2010	2015	
	12	5	25	5	2015: A significant return to very low, sparse vegetation across the transect apart from within the ditch. Very high levels of rabbit activity noted.
	13	5	16	5	
	14	5	13	8	
	15	5	17	4	
B2	*1*		14	0	NB. KR did not survey B2 in 2005 and vegetation heights were not recorded. 2010: Large increase in bare ground in woodland. Two distinct zone, little transitional habitat. 2015: Woodland bare ground remains extensive. Grassland sward is low apart from stands of thistle.
	2		17	0	
	3		16	1	
	4		19	4	
	5		6	3	
	6		10	1	
	7		14	1	
	8		16	5	
	9		13	8	
	10		9	15	
	11		11	15	
	12		15	15	
	13		14	20	
	14		16	7	
	15		19	4	
C1	*1*	5 (40)	24	25	2005: Transect crosses a woodland ride and bank/ditch on wood edge – these sections show greatest structural variation. The grassland edge was mown but not grazed whilst the final section was both mown and grazed so had a very uniform sward. 2010:The ride/wood edge/field demarcation still apparent. Vegetation mostly taller than 2005 with localised effects of herbivore activity showing in Q14, which has a lot of bare ground. 2015: Little change apparent within the woodland but a decrease in vegetation height from 2010 levels is evident across much of the rest of the transect.
	2	10	14	14	
	3	10 (1)	15	10	
	4	30	32	12	
	5	80 (0)	45	30	
	6	80 (0)	100	22	
	7	50 (5)	19	32	
	8	5 (20)	14	11	
	9	5	18	8	
	10	20	26	18	
	11	5	52	15	
	12	5	65	15	
	13	5	12	5	
	14	5	7	8	
	15	5	25	17	
C2	*1*	20	107	10	2005: Has a varied structure in the woodland edge though with a rather abrupt transition to the field. Grassland sward is uniform and was sheep grazed earlier in the year. 2010: Vegetation taller in woodland zone, similar in the grassland zone with signs of a more species rich ecotone of somewhat shorter vegetation. Overall more bare ground in 2010. 2015: Vegetation in the grassland appears to be shorter overall but the varied woodland edge structure is still apparent.
	2	10 (20)	90	55	
	3	30 (5-80)	58	68	
	4	10 (100)	13	110	
	5	10	10	27	
	6	10	9	10	
	7	15	7	8	
	8	15	8	6	
	9	15	10	6	
	10	15	14	8	
	11	15	13	8	
	12	15	14	10	
	13	10	11	5	
	14	10	11	7	
	15	15	17	4	
D1	*1*	10	12	10	2005: Heavily horse grazed and parched grassland with a very low, even sward until the edge of the ditch where the vegetation is more lush. The ditch contains ungrazed, tall herb species and therefore has a much greater vegetation height.
	2	5	8	2	
	3	2	13	2	
	4	2	42	7	
	5	2	18	7	

Transect Number	Quadrat Number	Average Vegetation Height (cm)			Comments on Vegetation Structure
		2005	**2010**	**2015**	
	6	3	27	10	2010: Taller vegetation and less bare ground reflecting the reduction in grazing pressure. 2015: A return to shorter, more heavily grazed vegetation with patches of bare ground across the transect. Rabbit activity very noticeable in the hedgerow at the start of the transect.
	7	3	19	12	
	8	2 (10)	10	8	
	9	2	63	12	
	10	3	27	15	
	11	3	63	15	
	12	10	78	5 - 45	
	13	15	103	8 - 60	
	14	15 (100)	18	15	
	15	100	38	6	
D2	*1*	40	88	0 - 100	2005: A taller grass dominated sward, but horse grazed and trampled causing a decrease in structural diversity. Occasional tussocks of rushes and tufted hair-grass provide the main variation. 2010: Reduction in intensity of grazing allowing further structural diversity to develop, together with areas of bare ground. 2015: Wetland creation has transformed most of this transect from grassland to wetland with shallow open water. This has brought about dramatic changes in both the vegetation structure and the species present.
	2	30	10	100	
	3	15	7	100	
	4	20	8	30	
	5	20	35	100	
	6	20	28	70	
	7	30	24	100	
	8	25	75	120	
	9	40	21	100	
	10	30	24	80	
	11	30	17	90	
	12	30	19	100	
	13	40	24	100	
	14	40	48	0 - 70	
	15	40 (80)	15	30	

4.2.2 Species diversity and abundance

The total number of species recorded in the transects during the three surveys is very similar and although there has been a slight increase from 2005 to 2015 this is not considered to be significant. Recorder bias/expertise, the slightly shifting location of transects and seasonal differences would easily account for this level of variation.

- 2005 – about 120 species recorded
- 2010 – about 126 species recorded
- 2015 – about 130 species recorded

In some cases it was only possible to identify plants to genus not species level, especially when very small or heavily grazed specimens were present. In addition, many species were recorded at very low frequency, often only a single plant, which makes comparison of species totals a weak tool for analysis of real changes in vegetation composition.

The separate 2015 results spreadsheet includes full data on species presence and abundance for each quadrat in all the transects. Table 3 summarises the species recorded in the transect surveys in each year and shows how many transects each species was present in.

Table 3. Species frequency by transects in 2005, 2010 and 2015

- Species highlighted in green are woody species (mostly tree and shrub seedlings).
- Species highlighted in blue were present in at least 75% of transects (i.e. 6 transects) in any of the survey years.
- Bramble (Rubus fruticosus agg.) is the only taxa that falls within both categories and is highlighted in dark green.

Species	2005 Transects	2010 Transects	2015 Transects
Acer campestre seedling		1	2
Acer pseudoplatanus seedling		1	1
Achillea millefolium	1	1	
Agrostis capillaris & A. stolonifera combined	8		
Agrostis capillaris	4	8	7
Agrostis stolonifera	4	8	8
Ajuga reptans	2	1	2
Alisma plantago-aquatica			1
Alopecurus geniculatus	1	2	3
Alopecurus pratensis	2	3	4
Anagallis arvensis	4	1	3
Anthoxanthum odoratum	1	1	1
Aphanes arvensis	3		
Apium nodiflorum		1	1
Arctium minus	2	1	2
Arrhenatherum elatius	5	4	2
Arum maculatum	1		
Ballota nigra		1	1
Betula pendula seedling			1
Bidens cernua/tripartita			1
Brachypodium sylvaticum	4	4	4
Bromus hordeaceus	4	1	
Calystegia sepium		1	
Cardamine hirsuta	1		
Cardamine pratensis	1	1	
Carex flacca	1		
Carex hirta	1		1
Carex otrubae			1
Carex pendula	1	1	1
Carex remota	2		1
Carex spicata	1		
Carex sylvatica	1	2	3
Carex sp.			3
Carpinus betulus seedling	1	1	3
Castanea sativa tree			1
Centaurea nigra	1	2	1
Centaurium erythraea	3		
Centaurium pulchellum	1		2
Cerastium fontanum	7	7	6
Circaea lutetiana	1	1	
Cirsium arvense	7	8	5
Cirsium palustre	1	2	
Cirsium vulgare	4		4
Crataegus monogyna seedling	1	1	6
Cruciata laevipes	1	1	2
Cynosurus cristatus	5	4	5

Species	2005 Transects	2010 Transects	2015 Transects
Dactylis glomerata	7	7	5
Deschampsia cespitosa	1	1	
Deschampsia flexuosa		2	
Digitalis purpurea		1	1
Dryopteris dilatata		1	
Elytrigia repens	2		
Epilobium ciliatum		2	1
Epilobium hirsutum		2	
Epilobium sp.			3
Euonymus europaeus seedling	1		2
Festuca arundinacea (Schedonorus arundinaceus)	1	3	3
Festuca pratensis (Schedonorus pratensis)	3	2	
Festuca rubra	6	4	
Fraxinus excelsior seedling	2	1	5
Galeopsis tetrahit			1
Galium aparine	7	8	2
Galium palustre			1
Galium verum		1	
Geranium dissectum	3	2	2
Geranium molle			1
Geranium robertianum		1	1
Geum urbanum	3	3	4
Glechoma hederacea	5	6	3
Glyceria fluitans		1	2
Gnaphalium uliginosum		1	
Hedera helix			3
Heracleum sphondylium	1		
Holcus lanatus	8	8	8
Holcus mollis	2	1	2
Hordeum secalinum	2	1	2
Hyacinthoides non-scripta	2	5	3
Hypericum perforatum		2	
Hypericum pulchrum		1	
Hypochaeris radicata	1		1
Juncus acutiflorus	1		
Juncus bufonius	3	1	3
Juncus conglomeratus	1		1
Juncus effusus	6	6	6
Juncus inflexus	3	2	2
Kickxia elatine	3		
Kickxia spuria	1		
Lapsana communis	2	1	
Lathyrus pratensis	1	1	1
Lemna minor			1
Lepidium campestre	1		
Leucanthemum vulgare	1	1	
Lolium perenne	8	6	7
Lonicera periclymenum	3	2	3
Lotus corniculatus	2	5	3
Lotus pedunculatus	1	2	4
Lycopus europaeus	1	2	2
Lysimachia nummularia	1	1	1
Mentha aquatica	1	3	2
Mercurialis perennis	3	3	4
Moehringia trinervia	1	2	3
Myosotis arvensis	1		

Species	2005 Transects	2010 Transects	2015 Transects
Myosotis discolor		1	
Myosotis ramosissima	2		
Myosotis sylvatica	2		1
Myosoton aquaticum			1
Oenanthe crocata	1	2	2
Orchis mascula			1
Persicaria hydropiper			4
Persicaria maculosa	1	1	2
Phalaris arundinacea			1
Phleum bertolonii	3	8	6
Phleum pratense	2	1	6
Picris echioides (Helminthotheca echioides)		2	
Plantago lanceolata	1	2	
Plantago major	7	4	4
Poa annua	4	6	1
Poa nemoralis	1	1	
Poa pratensis		3	
Poa trivialis	8	8	6
Polygonum aviculare	1	1	
Potentilla erecta		1	1
Potentilla reptans	1	3	4
Potentilla sterilis			1
Primula vulgaris		2	2
Prunella vulgaris	4	5	6
Prunus spinosa seedling	3	4	4
Pteridium aquilinum	2	1	1
Pulicaria dysenterica	1	4	3
Quercus robur seedling	3	1	4
Ranunculus acris	2	2	2
Ranunculus repens	8	8	8
Ranunculus sceleratus		1	
Rosa arvensis			1
Rosa canina			1
Rubus fruticosus agg.	2	7	8
Rumex acetosa	2	1	1
Rumex conglomeratus		2	3
Rumex crispus	8	2	7
Rumex obtusifolius	2	2	1
Rumex sanguineus	4	8	4
Rumex sp.			1
Sagina procumbens	2		
Salix caprea seedling		1	
Salix cinerea seedling			1
Sambucus nigra seedling		1	2
Scrophularia nodosa		1	1
Senecio erucifolius		2	
Senecio jacobaea		4	5
Silene dioica		1	1
Sonchus asper	3	6	
Sparganium erectum			1
Stachys sylvatica	1	1	1
Stellaria alsine			1
Stellaria graminea	2	3	3
Stellaria holostea	1	3	3
Stellaria media		4	2
Succisa pratensis		1	

Species	2005 Transects	2010 Transects	2015 Transects
Tamus communis	1	1	2
Taraxacum sp.		1	2
Teucrium scorodonia	2	1	1
Trifolium campestre	2		
Trifolium dubium	3	1	
Trifolium pratense	3	1	1
Trifolium repens	7	8	8
Tripleurospermum inodorum	3	1	
Typha latifolia			1
Urtica dioica	6	8	8
Veronica arvensis			1
Veronica beccabunga			2
Veronica chamaedrys	4	4	6
Veronica hederifolia	2		
Veronica montana	2		1
Veronica officinalis	1		2
Veronica polita	1		
Veronica serpyllifolia	5	5	5
Veronica sp.			1
Vicia cracca	1		
Vicia hirta		1	
Vicia sativa		1	1
Vicia tetrasperma		1	3
Viola arvensis	2		
Viola riviniana	4	5	5
Vulpia bromoides		1	
Total number of taxa recorded	**120**	**126**	**130**

Species names in this table follow those used in the original transect monitoring reports but the accepted new nomenclature, from the New Flora of the British Isles. 3rd Edition. C. A. Stace (2010). Cambridge University Press, is shown in parenthesis where appropriate.

The most frequently recorded plants are inevitably all common and widespread species typical of agriculturally improved grassland habitats. Interestingly, red fescue *Festuca rubra* and prickly sow-thistle *Sonchus asper*, which were both recorded quite frequently in 2005 and 2010, were not recorded in transects during the 2015 survey.

4.2.3 Woody seedlings

Changes in the species diversity and frequency of woody species in the transects, particularly tree and shrub seedlings, is important information for the Knepp Wildlands Project. The location and proportion of trees and scrub regeneration in different parts of the Estate will show a direct response to grazing pressure from the wide-ranging livestock and from native herbivores.

Table 4. Presence of woody species in transects.

N = number of transects where each species was recorded

Species	2005 Transects	2010 Transects	2015 Transects
Acer campestre	0	1	2
Acer pseudoplatanus	0	1	1
Betula pendula	0	0	1
Carpinus betulus	1	1	3
Castanea sativa	0	0	1
Crataegus monogyna	1	1	6
Euonymus europaeus	1	0	2
Fraxinus excelsior	2	1	5
Prunus spinosa	3	4	4
Quercus robur	3	1	4
Rosa arvensis	0	0	1
Rosa canina	0	0	1
Rubus fruticosus agg.	2	7	8
Salix caprea	0	1	0
Salix cinerea	0	0	1
Sambucus nigra	0	1	2
Total number of woody species recorded in each year	**7**	**10**	**15**
Sum of the number of times different woody species were recorded in transects in each year (Note, this does not indicate the actual number of individuals or seedlings that are present, just the number of records)	**13**	**19**	**42**

The table above shows that there is a gradual increase in the number of woody species that are being recorded across all the transects and in the number of records of woody species in the transects. However, it does not show the actual number of seedlings or individual woody plants present nor does it show how long the seedlings are surviving past germination and their first year of growth.

Table 5. Spread of woody species across transects

Transect	Number of quadrats with woody species	Number of different woody species per transect
A1	6	6
A2	11	8
B1	10	3
B2	10	7
C1	10	6
C2	13	6
D1	6	5
D2	1	1

Table 5 illustrates that there are woody seedlings germinating in the quadrats recorded at some distance away from the woodland edges, especially in transects A2, B1, B2, C1 and C2. This trend is not apparent in transects A1, D1 and D2.

Examination of the quadrat data (see separate spreadsheet) makes it clear that in the vast majority of cases the cover of woody seedlings in each quadrat is very low, typically 1 or 2 on the Domin scale (i.e. few or several individuals).

The exception is bramble *Rubus fruticosus* which more often occupies from 4% up to 75% of a 2m x 2m quadrat, most notably in transects A2, B1, C1 and C2. In transect C2 sycamore *Acer pseudoplatanus* and blackthorn *Prunus spinosa* were recorded with some frequency in several quadrats.

The presence of bramble is, of course, an important factor in promoting the survival of woody seedlings in the presence of grazing and browsing animals as it can act as protection for the young seedlings in the early years of growth.

5.0 Discussion

5.1 The 2010 transect survey

The 2010 transect survey report (Greenaway and Miller 2010) marked 8 years since the beginning of the Knepp Wildlands Project when the first fallow deer were introduced to the historical Deer Park area.

That report compared the results of the first two transect surveys of 2005 and 2010 and found that there had been some small changes in the number of plant species recorded and very little difference in the overall pattern of Ellenberg scores for light and nutrient between the two surveys. Changes in the vegetation structure noted in 2010 included an increase in the amount of bare ground, a loss of woodland ground cover and very few records of tree seedlings in the transects.

The 2010 report expressed concern that "*the loss of woodland ground cover and the low level of structural change and woody species seedling recruitment…..is an indication that herbivore numbers, especially those of fallow deer, are too high, as there are also wild roe deer present*."

It further stated that "*at present stocking levels, the results from transect surveys, fixed-point photography...and visual assessment indicate a simplification of woodland vegetation structure rather than a diversification in Areas A, B and C*."

The report goes on to suggest that at 2010 stocking levels the Wildlands project area will tend to progress towards a wood pasture structure at the expense of more complex woodlands with ground flora, understorey and canopy layers. This could lead to a loss of diversity resulting from over-grazing in woodland areas which will not be balanced by the development of wood pasture habitat.

5.2 The 2015 transect survey

5.2.1 Seedling recruitment and grazing pressure

In this report a very simple analysis of transect data from 2005 to 2015 is presented, largely in tabular form, using information taken from the 2010 report and the 2015 survey results.

The analysis attempts to shed further light on the observation made in 2010 that grazing pressure is too high to allow successful woody seedling recruitment.

The 2015 results show a numeric increase from 2010 in:

- the number of woody species recorded
- the number of transects that contain woody species
- the number of quadrats within transects that contain woody species

However, these apparently very positive result needs to be treated with some caution.

Whilst the number of transects with woody species present is showing an increase and the diversity of woody species in the transects is also increasing, it is possible that none of the woody seedlings recorded are actually surviving beyond their first year of growth.

The overwhelming majority of woody species recorded were tiny seedlings and virtually no older saplings were observed either in the transects or in adjoining areas of woodland. This tends to support the assertion that grazing pressure in many areas may indeed be too high to favour woody seedling recruitment and their persistence beyond the first year of growth.

Now that there is data of vegetation along the transects spanning 10 years it is disappointing and a little surprising that there are still no signs at all of woody saplings becoming established on the woodland edges and in adjoining grassland areas.

5.2.2 The impact of rabbits

Observations during the survey suggest that the suppression of seedling recruitment could well be due to a combination of very high rabbit numbers as well as over-grazing by livestock and deer.

Rabbit activity in the woodland edges is very widespread and locally intense with many large burrows and associated areas of bare ground. Such high levels of rabbit activity may be making any existing bramble thickets less viable as protection for tree and shrub seedling from larger herbivores. Rabbits often use bramble thickets as cover and may dig extensive burrow systems in their shelter.

Rabbit populations undergo natural fluctuations but their numbers are usually kept in balance by their many natural predators and cycles of disease such as myxomatosis.

The largely rabbit-proof grazing exclosure which is present to the west of Swallows Furzefield near transect B2 is a very interesting feature. Within the fence there is abundant poplar suckering, a taller grassy sward and a much higher proportion of tall, flowering creeping thistle and other herbs.

The impacts of rabbit grazing and digging are very pronounced on the outside of the fence adjacent to Swallows Furzefield, and the woodland itself has very high levels of rabbit activity and a very impoverished ground flora.

5.2.3 The southern block

Most of the southern block was left fallow for seven years between 2002 and 2009 before cattle, pigs, deer and ponies were introduced. Transects D1 and D2 were originally placed in fields that had been heavily grazed horse pasture, a rather atypical habitat in this part of the Estate.

The profound changes in the vegetation of transect D2 are entirely the result of post-2010 wetland creation. The changes are ecologically valuable and interesting but of limited use as data for ongoing monitoring of herbivore driven vegetation change. In contrast, transect D1 appears to have changed very little from its state in 2005, when it was considered to be over-grazed horse pasture of little ecological interest.

Most of the southern block is visually very different from the rest of the Wildlands project area because it has a much higher cover of scrub, especially sallow *Salix spp.* and much more extensive tall herb vegetation. These differences in vegetation structure were noted in the 2010 transect report and were still apparent in 2015.

There is an additional transect in this block that was installed in 2007 and will be surveyed again in 2017. This should yield interesting information about the way that vegetation has developed in the majority of the southern block over a decade.

5.3 Recommendations

It is outside the scope of this report to undertake a full and detailed statistical analysis of the transect survey results over the last 10 years and no attempt was made to update the graphs of Ellenberg values, bare ground or species diversity from the 2010 report.

However, the 2015 survey data is stored in spreadsheet form that will lend itself to further analysis in future if resources allow, perhaps with help from academic partnerships that have been developed through the Wildlands Project.

It would be very informative to carry out a closer analysis of the actual numbers of woody seedlings recorded in each quadrat, the survival of woody seedlings to become saplings and any correlation between the presence of bramble and increased seedling survival. This data is needed to help gain a better understand the impacts of grazing on long term vegetation change and whether livestock grazing levels, deer numbers and rabbit numbers are currently too high.

It would be extremely useful if the transect starting points could be permanently marked at fixed points. This would allow far greater accuracy in repeat surveys and would enable much more direct comparison to be made of the survey results over time.

As an addition to the existing ground level fixed point photographic record of the Wildlands Project, it would be very valuable to carry out regular aerial photographic surveys of the Estate, including the transect areas, to help broaden the analysis of changing vegetation structure and the spread of scrub over time. Such photography is now easy and relatively cheap to carry out using remotely operated drones (UAVs).

5.4 Conclusion

There is growing evidence from the transect data and from personal observations that current grazing and browsing pressure from the combined impact of livestock, deer and rabbit populations is too high to allow successful woody species recruitment in many parts of the Wildlands project area.

The impacts are most obvious in the northern and central blocks (where there was little time for woody species to become established before grazing animals were introduced) and less evident in the southern block. However, even in the southern block there are very noticeable browse lines at rabbit height in areas of scrub.

The number of livestock and fallow deer present across the Estate should certainly be reviewed in the light of these results.

Reducing the number of rabbits would be very beneficial but there is a danger that any artificial intervention in rabbit population dynamics, such as culling, will simply create a population vacuum which will quickly be filled by new generations of rabbits.

Sustainable control of rabbit numbers through natural processes should be an essential part of a rabbit control strategy, in addition to any major intervention to reduce their numbers in the short term. This should include efforts to promote strong populations of their native predators.

Woodland biodiversity in particular is very likely to be adversely affected by this in the medium to long term by excessive grazing and browsing, but there is also likely to be an impact on the future development of high wildlife value scrubby and intermediate habitats across almost all areas of former arable and pasture land.

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