

An application of Pantheon to a Windsor Forest dataset

Allan L. Drewitt¹ and Jon Webb²

¹ Mail Hub, Natural England, County Hall, Spetchley Road, Worcester WR5 2NP

² Natural England, Suite D, Unex House, Bourges Boulevard, Peterborough PE1 1NG

Introduction

The results of a 1993 survey of Windsor Forest are described and assessed, with an emphasis on species associated with decaying wood. Much of the assessment was undertaken using Pantheon, an online analytical tool for invertebrates in England developed by Natural England and the Centre for Ecology and Hydrology.

Windsor Forest and Great Park, Berkshire (VC 22)

This large site complex supports the richest wood-decay beetle fauna in Britain (Alexander, 2003). Designated a Site of Special Scientific Interest in 1973 and declared a Special Area of Conservation under the EU Habitats Directive in 2005, it is the largest continuous tract of woodland and parkland in Berkshire and, indeed, the largest continuous tract of old trees in one ownership outside the New Forest (Alexander & Green, 2013).

The site supports a range of habitats, including coniferous and mixed plantations, broadleaved woodland, wood-pasture and parkland, with ancient oak *Quercus* pollards scattered throughout the area. Over 7000 ancient and veteran trees occur in a mosaic of unimproved grassland and grass-heath and these are the main source of the area's considerable invertebrate interest. Nearly 2000 species of beetle have been recorded, including many threatened species and some which are extremely rare (Alexander & Green, 2013).

The 1993 survey

In 1993 Keith Porter, then working for English Nature, carried out a survey of saproxylic Diptera at Windsor Forest. Fortunately, he also retained a substantial by-catch of Coleoptera. The survey used bespoke flight interception traps (FIT) and malaise traps installed in the forest at several locations: Manor Hill (SU958397), Lipper Pond (SU951703), Russell Pond (SU956729), Hornbeam (SU952698) and South Forest (SU945705). All traps were located following on-site visits by Keith Porter and Ted Green with the aim to site traps in glades or across flight lines where Diptera and Coleoptera were most likely to be intercepted. All traps were operated between early May and late October and emptied every 3-4 weeks.

The interception traps were constructed from sheet acrylic and held in a frame over a collecting trough filled with dilute formalin solution. They were positioned approximately 1 m above the ground in glades adjacent to large mature trees with the aim of catching flying insects. The predominant mature tree species were beech *Fagus sylvatica* and oak and the habitat was wood pasture. The locations were

selected on the advice of Ted Green based on his considerable knowledge of Windsor Forest. The malaise traps were standard black sides and white roof traps and a single malaise was positioned on the ground at each location, again within clearings in the forest adjacent to large mature trees. Collecting bottles held a 10% solution of formaldehyde to preserve the catch.

After collection the samples were washed out to remove the formalin and stored in a solution of propylene glycol and 5% phenoxetol to preserve the specimens, and subsequently sorted into taxonomic order. The Coleoptera were further sorted and batched early in 2017 before identification.

Results

A total of 2,400 individual specimens were collected from all locations combined, from which 348 species were identified. The most frequently recorded species, in order of abundance, were *Bradycellus harpalinus* (Audinet-Serville) (Carabidae), *Athous haemorrhoidalis* (Fabricius) (Elateridae), *Aphthona euphorbiae* (Schrank) (Chrysomelidae), *Sciodrepoides watsoni* (Spence) (Leiodidae), *Malthinus seriepunctatus* Kiesenwetter (Cantharidae) and *Trixagus carinifrons* (De Bonvouloir) (Throscidae), which together represented over 20% of all records.

The catch showed some striking differences between locations. Manor Hill produced the greatest number of specimens (around 40% of the total) and, of these, *Bradycellus harpalinus* was most abundant, followed by *Trixagus carinifrons*, *Tomoxia bucephala* (Costa, A.) (Mordellidae), *Anisotoma humeralis* (Fabricius) (Leiodidae), *Dryocoetes villosus* (Fabricius) (Curculionidae) and *Dalopius marginatus* (Linnaeus) (Elateridae). By contrast, the results from Lipper Pond included many more *Sciodrepoides watsoni*, *Denticollis linearis* (Linnaeus) (Elateridae) and *Corticicara gibbosa* (Herbst) (Latridiidae).

Comparison between the malaise and FIT revealed that the former collected nearly all the Elateridae specimens, including all the *Athous haemorrhoidalis*, *Dalopius marginatus* and *Agriotes acuminatus* (Stephens), while the FIT collected all the *Bradycellus harpalinus* and the great majority of the *Sciodrepoides watsoni*, *Trixagus carinifrons*, *Anisotoma humeralis* and the Tachyporinae. While it is difficult to know the effect of location on these results, the complete absence of some of the most abundant species in each type of trap does seem to indicate different levels of suitability between the trapping methods for particular species. Such differences have been recorded elsewhere, for example at Richmond Park where *Dorcatoma chrysomelina* Sturm (Ptinidae) was taken by FIT but not by malaise traps (Hammond & Harding, 1991).

A total of 41 species recorded by this survey have a conservation status, including nine Red Data Book species, 31 Nationally Scarce species and a single Nationally Rare species. The majority of these species (70%) are associated with dead wood habitats and these are listed in Table 1. Of the others, species with British rarity status include the Nationally Scarce species *Quedius invreae* Gridelli (Staphylinidae), *Platydracus latebricola* (Gravenhorst) (Staphylinidae), *Catopidius*

depressus (Murray) (Leiodidae), *Catops longulus* Kellner (Leiodidae), *Oedostethus quadripustulatus* (Fabricius) (Elateridae), *Hippodamia variegata* (Goeze) (Coccinellidae), *Scymnus schmidti* Fürsch (Coccinellidae), *Mordellistena variegata* (Fabricius) (Mordellidae), *Lasiorrhynchites olivaceus* (Gyllenhal) (Rhynchitidae), *Sibinia primita* (Herbst) (Curculionidae) and the Nationally Rare *Mordellistena pseudoparvula* Ermisch (Mordellidae).

Assessment

Analysis of the results was undertaken using Pantheon, an online tool designed to provide a consistent and standardised approach to the assessment of the conservation importance of a sample or site (Webb *et al.*, 2017). Users can simply paste lists of invertebrates into Pantheon which then analyses the species and attaches a range of information including habitat associations and conservation status. An example of a summary output from Pantheon using the Windsor data is shown in fig. 1.

Pantheon has information on 284 of the 348 species identified from the 1993 Windsor data. Of these, 105 (37%) are associated with decaying wood (representing 8% of all such species in the Pantheon database). The majority of these (72%) depend on decaying sapwood and bark, including such rarities as *Agathidium confusum* Brisout de Barneville (Leiodidae), *Trichonyx sulcicollis* (Reichenbach) (Staphylinidae), *Euplectus nanus* (Reichenbach) (Staphylinidae), *Teredus cylindricus* (Olivier) (Bothrideridae), *Ampedus rufipennis* (Stephens) (Elateridae) and *Oxylaemus variolosus* (Dufour) (Bothrideridae). Twenty-two species are associated with fungal fruiting bodies, including *Bolitochara lucida* (Gravenhorst) (Staphylinidae), *Tritoma bipustulata* (Fabricius) (Erotylidae), *Diplocoelus fagi* (Chevrolat in Guérin-Méneville) (Biphylidae), *Pseudotriphyllus suturalis* (Fabricius) (Mycetophagidae) and *Hallomenus binotatus* (Quensel) (Tetratomidae) and 22 are associated with heartrot, including *Epiphaniis cornutus* Eschscholtz (Eucnemidae), *Eucnemis capucina* Ahrens (Eucnemidae) and *Ampedus nigerrimus* (Lacordaire) (Elateridae).

Pantheon also provides data in a tabular format, including an assessment of the conservation importance of a sample based on various metrics such as rarity and threat status, with each species assigned a Species Quality Score (SQS) which contributes to an overall Species Quality Index (SQI) for a sample. The SQI is similar to the Saproxlic Quality Index developed by Fowles *et al.* (1999) for decaying wood species, although Pantheon calculates index values for a wider range of invertebrate orders associated with different habitats and resources. For example, in the case of the Windsor data, Pantheon calculates a Species Quality Index value of 239 for dead wood beetles and 155 for those associated with short sward and bare ground. Such values will, ultimately, provide a robust method of comparative site assessment and it is hoped that in the future recorders will routinely upload their records to the database and thus strengthen the relative assessment of individual sites. A comparison with other samples currently on Pantheon shows that the SQIs for the 1993 Windsor data are, as expected, relatively high.

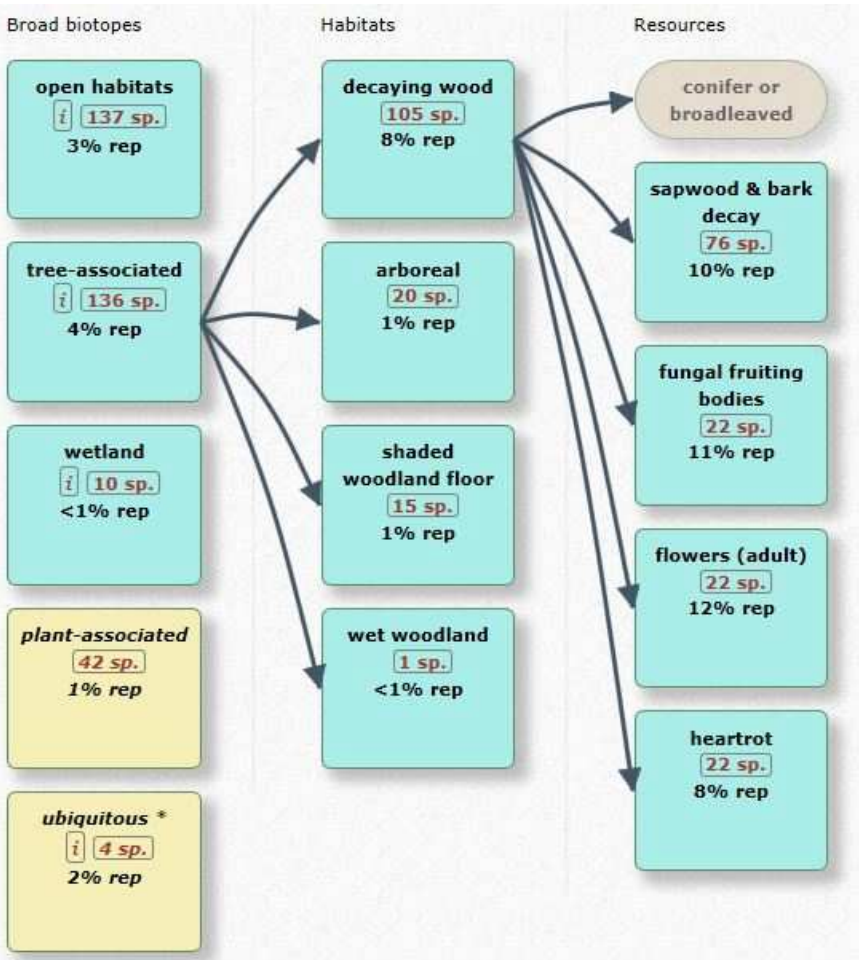


Fig. 1 An example of the hierarchal output from Pantheon for Windsor Coleoptera, with tree-associated fauna selected to indicate resources used by species associated with decaying wood.

Summary

The Windsor data represent an interesting snapshot from the early 1990s, recording a high number of important species collected during a relatively short time period using only flight interception and malaise traps. It might be informative to repeat such a survey in the near future for site monitoring purposes.

Pantheon is a useful tool for allocating species to particular biotopes, habitats and ecological resources. It also provides an up to date and consistent approach to

assessing site quality for species based on their conservation status. As such, it can be used to interpret monitoring data, to identify habitat management requirements and to highlight any changes in species composition resulting from conservation management. It can also be used to identify those locations worthy of consideration for statutory site protection. It is currently freely available as a beta version (<http://www.brc.ac.uk/pantheon/>), with the expectation that version 1.0 will be made available in April 2018.

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Table 1 Dead wood species recorded from Windsor Forest in 1993 including information on status*, Saproxylic Quality Index (SQI) score (Fowles *et al.*, 1999), the Pantheon Species Quality Score (SQS) and species' resource requirements indicated by the Pantheon database.

Species	Status	S Q I	S Q S	Sapwood and bark decay	fungal fruiting bodies	Heart rot
Carabidae						
<i>Dromius quadrimaculatus</i> (Linnaeus)			1			
Histeridae						
<i>Abraeus perpusillus</i> (Marsham)		4	1			•
Leiodidae						
<i>Agathidium confusum</i> Brisout de Barneville	<i>RDB I</i>	24	4	•		
<i>Anisotoma humeralis</i> (Fabricius)		2	1	•		
<i>Anisotoma orbicularis</i> (Herbst)		2	1	•		
Staphylinidae						
<i>Bolitochara bella</i> Märkel			1		•	
<i>Bolitochara lucida</i> (Gravenhorst)	<i>RDB I</i>	2	4		•	
<i>Bolitochara obliqua</i> Erichson			1	•	•	
<i>Coryphium angusticolle</i> Stephens		2	1	•		
<i>Dinaraea aequata</i> (Erichson)		1	1	•		
<i>Dropephylla gracilicornis</i> (Fairmaire & Laboulbène)	<i>N</i>		4	•		
<i>Dropephylla ioptera</i> (Stephens)		1	1	•		
<i>Dropephylla vilis</i> (Erichson)		1		•		
<i>Euplectus nanus</i> (Reichenbach)	<i>RDB I</i>	24	4	•		•
<i>Gabrius splendidulus</i> (Gravenhorst)		1	1	•		
<i>Gyrophaena affinis</i> Mannerheim			1		•	
<i>Gyrophaena fasciata</i> (Marsham)			1		•	
<i>Leptusa pulchella</i> (Mannerheim)		2	1	•		
<i>Quedius mesomelinus</i> (Marsham)			1			
<i>Scaphidium quadrimaculatum</i> Olivier		2	1	•	•	
<i>Scaphisoma agaricinum</i> (Linnaeus)		2	1	•	•	
<i>Sepedophilus bipunctatus</i> (Gravenhorst)	<i>Nb</i>	8	4	•		•

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<i>Sepedophilus littoreus</i> (Linnaeus)		2		•		
<i>Trichonyx sulcicollis</i> (Reichenbach)	<i>RDB 2</i>	32	8	•		•
Buprestidae						
<i>Agrilus angustulus</i> (Illiger)	NS	8	4	•		
<i>Agrilus biguttatus</i> (Fabricius)		8	1	•		
Eucnemidae						
<i>Epiphanis cornutus</i> Eschscholtz		8	1			•
<i>Eucnemis capucina</i> Ahrens	<i>RDB 1</i>	32	16			•
Elateridae						
<i>Ampedus balteatus</i> (Linnaeus)		2	1			•
<i>Ampedus nigerrimus</i> (Lacordaire)	<i>RDB 1</i>	32	16			•
<i>Ampedus rufipennis</i> (Stephens)	<i>RDB 2</i>	24	8	•		
<i>Denticollis linearis</i> (Linnaeus)		1	1	•		
<i>Melanotus villosus</i> (Geoffroy in Fourcroy)		1	1	•		•
<i>Stenagostus rhombeus</i> (Olivier)		4	1	•		
Cantharidae						
<i>Malthinus flaveolus</i> (Herbst)		1	1	•		
<i>Malthinus seriepunctatus</i> Kiesenwetter		2	1	•		
<i>Malthodes minimus</i> (Linnaeus)		1	1	•		
Bostrichidae						
<i>Lyctus brunneus</i> (Stephens)		4	1	•		
Ptinidae						
<i>Anobium fulvicorne</i> (Sturm)		1	1	•		
<i>Dorcatoma chrysolina</i> Sturm		4	1			•
<i>Dorcatoma flavicornis</i> (Fabricius)	<i>Nb</i>	8	4			•
<i>Grynobius planus</i> (Fabricius)		2	1	•		
<i>Hedobia imperialis</i> (Linnaeus)			4	•		
Lymexylidae						
<i>Lymexylon navale</i> (Linnaeus)	NS	32	4	•		•

Species	Status	S Q I	S Q S	Sapwood and bark decay	fungal fruiting bodies	Heart rot
Cleridae						
<i>Korynetes caeruleus</i> (De Geer)	NS	8	4	•		•
<i>Thanasimus formicarius</i> (Linnaeus)		4	1	•		
Malachiidae						
<i>Axinotarsus marginalis</i> (Laporte)				•		
<i>Malachius bipustulatus</i> (Linnaeus)		1	1	•		
Sphindidae						
<i>Aspidiphorus orbiculatus</i> (Gyllenhal)		2	1	•		
<i>Sphindus dubius</i> (Gyllenhal)	Nb	8	4	•		
Nitidulidae						
<i>Eपुरaea biguttata</i> (Thunberg)		2	1	•	•	
<i>Eपुरaea marseuli</i> Reitter		1	1	•	•	
<i>Eपुरaea pallescens</i> (Stephens)		2		•	•	
Monotomidae						
<i>Rhizophagus depressus</i> (Fabricius)		2	1	•		
<i>Rhizophagus bipustulatus</i> (Fabricius)		1	1	•		
<i>Rhizophagus dispar</i> (Paykull)		1	1	•	•	
<i>Rhizophagus ferrugineus</i> (Paykull)		2	1	•		
Cucujidae						
<i>Pediacus dermestoides</i> (Fabricius)		4	1	•	•	
Cryptophagidae						
<i>Cryptophagus ruficornis</i> Stephens	N	8	4	•	•	
Erotylidae						
<i>Dacne bipustulata</i> (Thunberg)		2	1		•	
<i>Tritoma bipustulata</i> Fabricius	Na	16	4		•	
Biphyllidae						
<i>Diplocoelus fagi</i> (Chevrolat in Guérin-Ménéville)	Nb	8	4		•	
Bothriideridae						
<i>Oxylaemus variolosus</i> (Dufour)	RDB 3	24	8	•		

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Species	Status	S Q I	S Q S	Sapwood and bark decay	fungal fruiting bodies	Heart rot
<i>Teredus cylindricus</i> (Olivier)	<i>RDB 1</i>	32	16	●		●
Cerylonidae						
<i>Cerylon ferrugineum</i> Stephens		2	1	●		
Latridiidae						
<i>Enicmus rugosus</i> (Herbst)	<i>N</i>	8	4	●		
<i>Enicmus testaceus</i> (Stephens)		2	1	●		
<i>Melanophthalma suturalis</i> (Mannerheim)			1			
Mycetophagidae						
<i>Mycetophagus piceus</i> (Fabricius)		4	1		●	●
<i>Mycetophagus quadripustulatus</i> (Linnaeus)		2	1		●	
<i>Pseudotriphyllus suturalis</i> (Fabricius)	<i>NS</i>	4	4		●	
Ciidae						
<i>Cis boleti</i> (Scopoli)		1	1		●	
<i>Cis pygmaeus</i> (Marsham)		2	1	●		
<i>Octotemnus glabriculus</i> (Gyllenhal)		1	1		●	
Tetratomidae						
<i>Hallomenus binotatus</i> (Quensel)	<i>NS</i>	8	4		●	
<i>Tetratoma desmarestii</i> (Latreille)	<i>NS</i>	16	4	●		
Melandryidae						
<i>Orchesia undulata</i> Kraatz		4	1	●		
Mordellidae						
<i>Mordellistena neuwaldeggiana</i> (Panzer)	<i>NS</i>	16	4	●		
<i>Tomoxia bucephala</i> Costa	<i>NS</i>	16	4	●		●
Colydiidae						
<i>Bitoma crenata</i> (Fabricius)		4	1	●		
Tenebrionidae						
<i>Mycetochara humeralis</i> (Fabricius)	<i>NS</i>	16	4			●
<i>Nalassus laevioctostriatus</i> (Goeze)			1			

Species	Status	S Q I	S Q S	Sapwood and bark decay	fungal fruiting bodies	Heart rot
Pyrochroidae						
<i>Pyrochroa coccinea</i> (Linnaeus)		4	1	●		
Salpingidae						
<i>Vincenzellus ruficollis</i> (Panzer)		2	1	●		
Aderidae						
<i>Euglenes oculatus</i> (Paykull)	NS	8	4			●
Scraptiidae						
<i>Anaspis frontalis</i> (Linnaeus)		1	1	●		
<i>Anaspis garneysi</i> Fowler			1			●
<i>Anaspis fasciata</i> (Forster)		2	1	●		
<i>Anaspis lurida</i> Stephens		2	1	●		
<i>Anaspis maculata</i> (Geoffroy in Fourcroy)			1	●		
<i>Anaspis regimbarti</i> Schilsky			1	●		
Cerambycidae						
<i>Clytus arietis</i> (Linnaeus)		1	1	●		
<i>Grammoptera ruficornis</i> (Fabricius)		1	1	●		
<i>Pachytodes cerambyciformis</i> (Schrank)		2	1	●		
<i>Phymatodes testaceus</i> (Linnaeus)		4	1	●		
<i>Rutpela maculata</i> (Poda)		1	1	●		
<i>Stenurella melanura</i> (Linnaeus)		2	1	●		
Curculionidae						
<i>Dryocoetes villosus</i> (Fabricius)		2	1	●		
<i>Euophryum confine</i> (Broun)						●
<i>Pityophthorus pubescens</i> (Marsham)		2	1	●		
<i>Platypus cylindrus</i> (Fabricius)	Nb	8	4	●		
<i>Scolytus intricatus</i> (Ratzeburg)		2	1	●		
<i>Stereocorynes truncorum</i> (Germar)	Na	16	4			●
<i>Tomicus piniperda</i> (Linnaeus)			1	●		
<i>Xyleborus dryographus</i> (Ratzeburg)	Nb	8	4	●		

* Conservation status follows Alexander, 2014 and Alexander *et al.*, 2014: NS = Nationally Scarce (16-100 hectads) and NR = Nationally Rare (1-15 hectads). Status follows (Hyman 1992 and 1994) in italics where there is no recent review: Na = Nationally Scarce A (30 or fewer records); Nb = Nationally Scarce B (31-100 hectads), N = Nationally Notable (16-100 hectads); RDB 1 = Endangered; RDB 2 = Vulnerable; and RDB 3 = Rare.