A review of the fungi of Savernake Forest

A study for Buglife – Back from the Brink Oct 2021

Chris Knowles - Where the wild stuff is…

Saving the small things that run the planet

LOTTERY FUNDED

Table of Contents

Acknowledgements

Assistance and advice was gratefully accepted from:

Cameron Diekonigin, Martyn Ainsworth, Paul Rutter, Michael Jordan, Stuart Skeates, Malcolm Storey, and all field mycologists who took the time to record the fungi which created the datasets at the heart of this project.

Executive summary

In the UK, ancient trees and the wildlife that rely upon them are threatened by the increased prevalence of tree diseases, 'development', climate change and the missing generations of mature trees that has left an age gap between the existing veteran trees and those that will eventually become the "ancients of the future".

Buglife's 'Back from the Brink Project' has targeted a number of projects to assess the situation, create solutions, and engage with landowners and the public to ensure there is a future for the country's oldest trees.

This report was a result of a desk study commissioned as part of that work. Its purpose was to discover and collect all records of fungi over the last 50 years from Savernake Forest, and to assess that data and map the species. With a focus on the fungi that directly associate with ancient and veteran trees, the study would be able to develop a clear picture of the fungal diversity and distribution as well as offering practical solutions to maintain or even improve habitats for fungi.

Data was sought from any and all sources, including national databases, local records centres, fungus groups and individuals. These records were then collated into a single spreadsheet and filtered to remove duplicates where possible. A large proportion of the records were missing important areas of information, making it very difficult to process them automatically, and so these had to be checked and filtered manually.

After refining the data in this way the final dataset consisted of 8,872 records made up of 1,058 species in 405 genera. These records were then compared against existing lists of threatened, protected and priority species. To be able to focus on the target group of wood rotting, saprophytic fungi, the species were then divided into 9 categories based on their biology and ecology.

These categories included 3 target species groups:

Basidiomycete Saprotrophs – (usually typical mushroom or bracket shaped fungi)

Resupinate Saprotrophs – (typically with a flat, crust-like growth form)

Ascomycete Saprotrophs – (tending to be small, often as spots, lumps and discs)

Unfortunately, over 80% of all records had poor quality grid references, and so mapping these species into exact locations was not possible. Instead the data was applied to 1km^2 grid squares, which could be compared to more general areas of the forest.

The dataset was used to compare species against the current Guidelines for the Selection of biological SSSIs, which highlighted many good indicator species from a variety of assemblages and showed that Savernake is an important host site for Oak deadwood species.

Finally this report made recommendations for future monitoring and habitat management to improve the quality of data available and to improve habitat availability and quality for the very special wood-rotting fungi of Savernake Forest.

Introduction

Savernake Forest is home to many ancient trees, and due to its historical management as a royal hunting ground, (chiefly starting around 1300AD, with extensive tree planting that linked the existing smaller woods and coppices) it is one of only a few sites in the country to have had perpetual tree cover over the centuries. The forest has also benefitted from a continued supply of over-mature trees and dead wood habitat. The great diversity of wood rotting (saprophytic) species supported at Savernake critically relies on the continuity of the dead wood resource. Standing and fallen trees in various states of decay provide a wide range of habitats and niches for different species and the successive stages of their life cycles.

Ancient trees and the wildlife that relies on them are threatened by the increased prevalence of tree diseases, climate change and the age gap between the existing ancient trees and those that will eventually become the "ancients of the future".

The majority of Savernake Forest's 1,100 hectares are designated as a Site of Special Scientific Interest (SSSI)

The scope of this project

This study was commissioned by Buglife, as part of their Ancients of the Future/Back from the Brink work. The work was required to take the form of a desk study investigating all known records of the non-lichenised fungi found in Savernake Forest over the last 50 years.

These records were then used to identify and map geographical hotspots and key substrates/hosts. All species of conservation importance and those with legal protection were determined; and species whose ecology relies on mature trees and deadwood were classified then separated to be the main focus of this study. Management and monitoring recommendations were made in relation to these findings.

Figure 1. *Fistulina hepatica* (Beefsteak fungus), causing brown rot on Quercus (Oak).

Methodology

Data collection and selection

To access the data necessary for this desk study, national databases, local recording groups and individuals were approached to source any relevant records, all of which were then collated into a single list.

In the UK there are two national databases of fungi, the Fungal Records Database of Britain and Ireland (FRDBI) which is maintained by the British Mycological Society (BMS) and CATE2 which is maintained by the Fungus Conservation Trust (FCT).

All new records entered onto the FRDBI are already added to the NBN Atlas, however the FCT have an agreement with their network of recorders to not share their records in this way. Although the FCT helpfully provided access to the relevant CATE2 data, it remained a requirement of this project that all records included in this study will eventually be submitted to the NBN Atlas. Therefore, no data from CATE2 has been included.

This amounted to 46 relevant, but unusable records, covering 40 species in 34 genera. However, of these only 12 species were wood-rotting saprotrophs, and all but 2 of the 40 were common, widespread species which were not of local or national importance, so their exclusion from this study will not be detrimental to the results. Of the remaining two species, *Cortinarius camphoratus* is a red-listed mycorrhizal species that associates with *Abies* and *Picea* and *Fistulina hepatica* is an indicator species for ancient oak woods. Both were only captured with a 1km2 grid reference although a localised name narrowed down the area to around 30 ha. Other records of each species appeared in the dataset from other sources, so the omission of these two was not considered to be of great concern.

Contacting other local mycologists who may have had, or known of additional records that had not reached one of the national databases yielded hardly any additional data, but over 3,500 relevant records were provided within datasets provided by Natural England. A further 350+ unique records were extracted from data supplied by the Wiltshire & Swindon Biological Records Centre.

A total of over 67,000 records were found to be potentially relevant to the project. It was not possible to simply filter the dataset by either grid reference, or place names including 'Savernake' as thousands of records that needed to be included at this stage had no grid reference at all, and localised place names such as 'Ashlade Firs', 'Braydon Hook' and 'Cobham Frith' were often used, but not always with the same format or spelling.

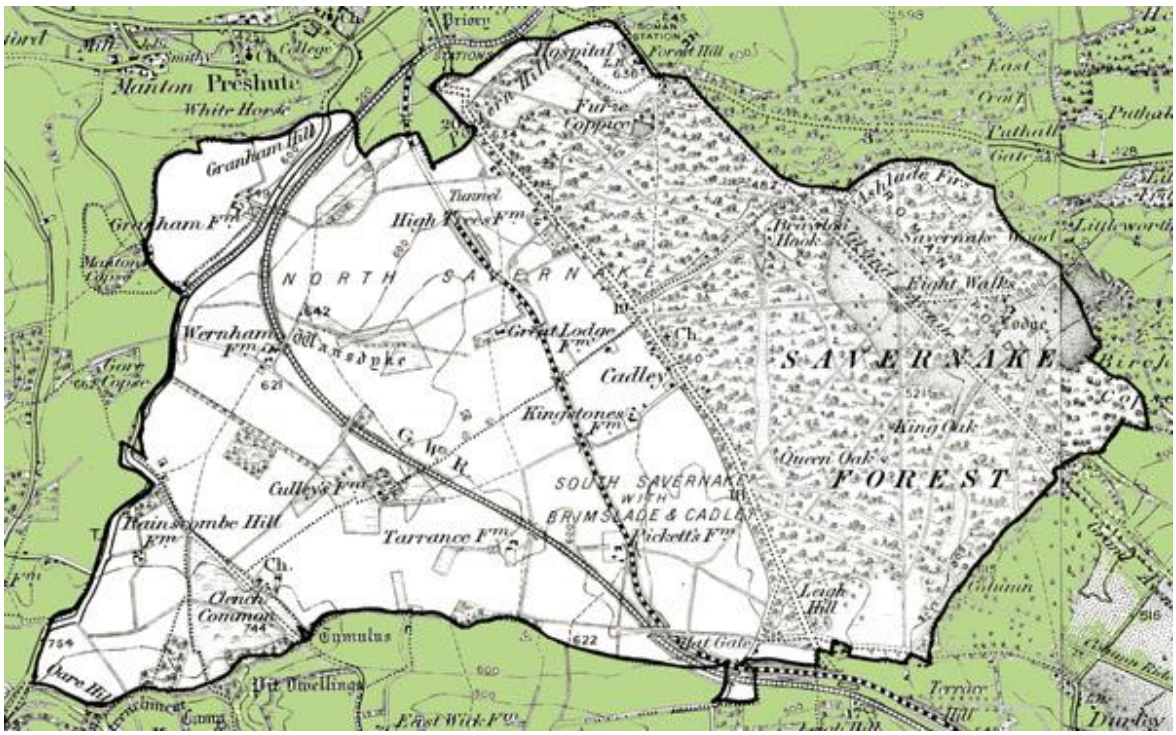


Figure 2. A partial map of Savernake Forest labelled with some of the local place and feature names.

The locations of these records were checked manually by site name. In addition, just over half of all the records had a wide, 6-digit grid reference, and also needed to be checked manually by location name for relevance.

This list was then checked for valid species, cleaned of duplicate entries and queried extensively to discover any over-looked or under-recorded groups.

After coarsely filtering the data in this way the dataset consisted of 8,872 records made up of 1,058 species in 405 genera.

This processed dataset was then compared against these lists of threatened, protected and priority species:

- IUCN - Red list of threatened species
- UK Biodiversity Action Plan – Priority species and habitats
- Section 41 – Priority species
- Schedule 8 - Wildlife and Countryside Act 1981
- Red Data List of Threatened British Fungi (2006)
- Red List of Fungi for Great Britain (2016)
- Red List of Fungi for Great Britain: Boletaceae

The data was also used to carry out SSSI assessments using:

- JNCC - SSSI Guidelines Chapter 14 – Non-lichenised fungi (2018)

To ensure that no records were missed during this process, up to two recent synonyms were added to each species, and the comparison filter also checked these for inclusion.

The taxonomy of each record was also checked at this point. All taxonomy that already matched the current name given in the National History Museum's UK Species Index

(UKSI) was left unchanged. However where records only had older names given, these were updated according to the preferred names and taxonomic opinions of Species Fungorum.

A secondary dataset was then created featuring only those species which corresponded with these priority species and red-lists.

After this, at every point that the dataset was filtered or adjusted by any factor, care was taken to identify any of these 'priority' species that would be omitted, and notes of these omissions were included with the results.

Working Area

The extent of Savernake Forest as accepted for this study is slightly larger than the Savernake Forest SSSI and consists of several distinctly separate areas of woodland. Figure 3. illustrates this overlap, with the SSSI units labeled numerically and the wider site labelled alphabetically for the separate compartments referred to in this study for all mapping and reporting (See Appendix A).

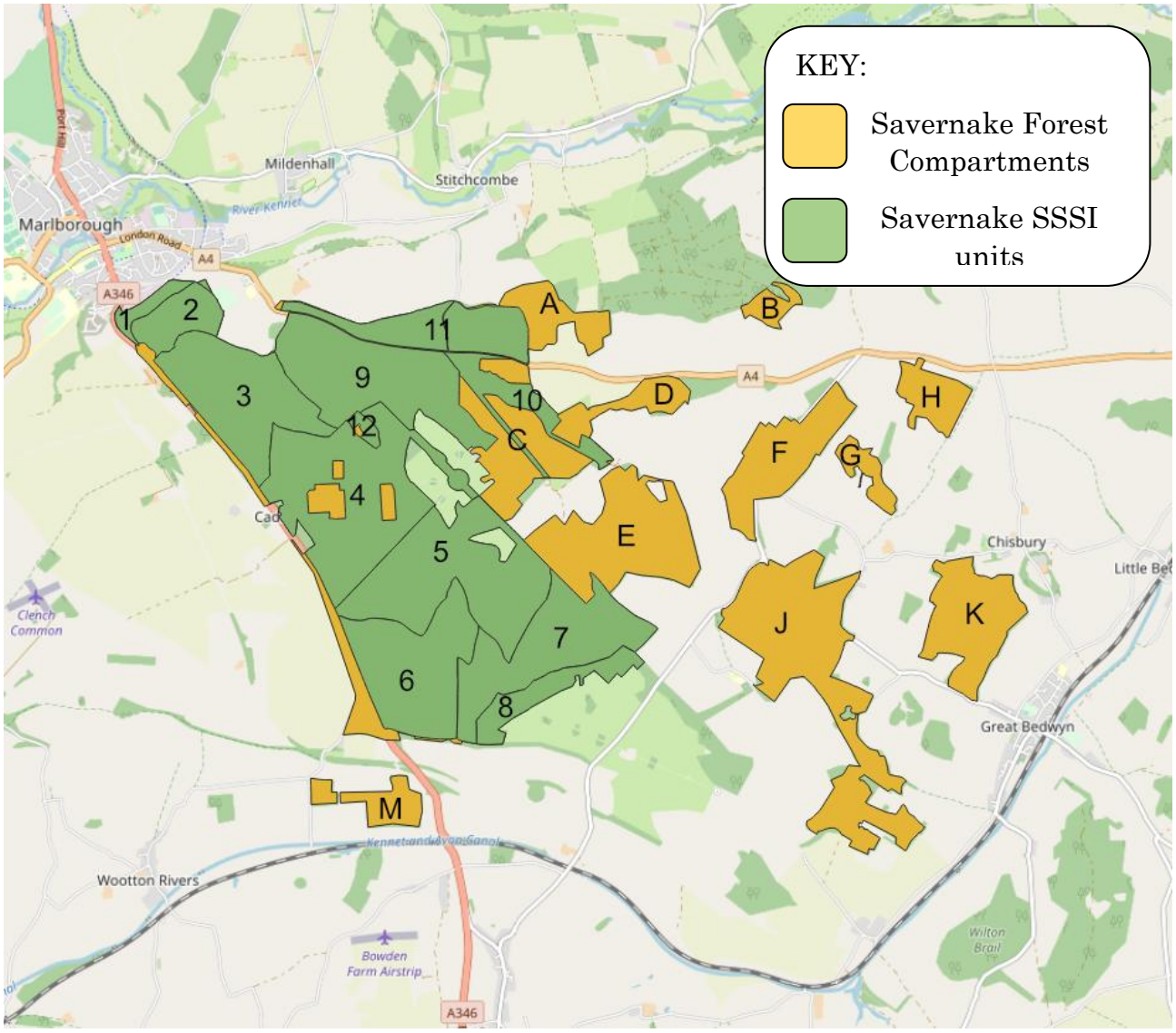


Figure 3. Map of Savernake Forest with SSSI units and remaining compartments marked.

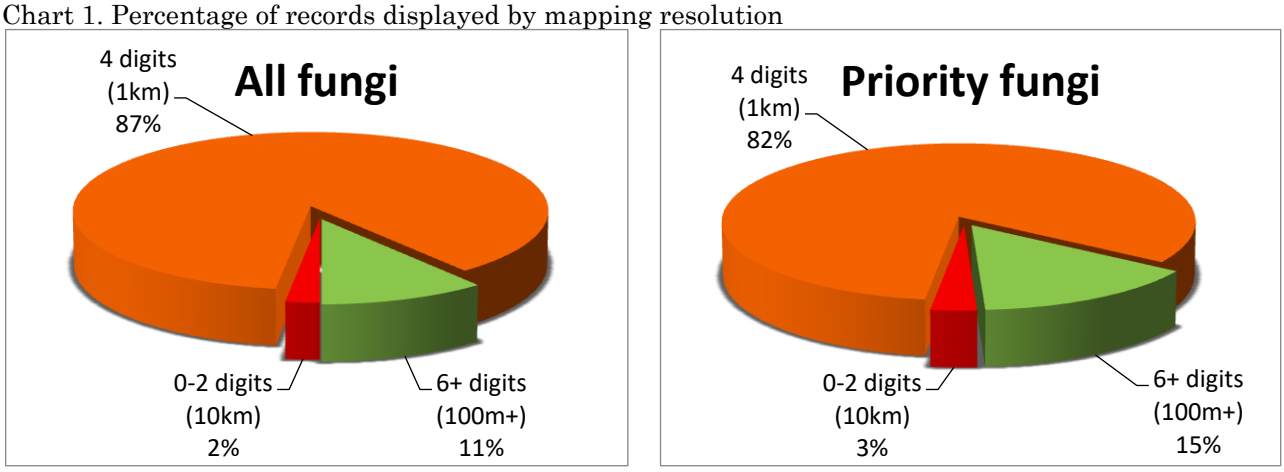
In the wider data set, 89% of all records had a poor grid reference, making it impossible to successfully map those records correctly. This in turn made it difficult to match individual records to compartments and habitats.

Chart 1 shows that while only 2% of all records had either no grid reference at all, or a 2 digit reference that only gives a resolution of a 10km square (encompassing almost the entire site). A further 87% of all records only had a 4 digit grid reference, which has a resolution of a 1km square, and so is not particularly useful for detailed mapping purposes.

The remaining 11% of records had 6 or more digits in their grid references, which provided a good enough resolution for contrasting them against compartments and habitats.

This issue was just as much of a problem with the 'priority' fungus records (as shown in Chart 1, Right).

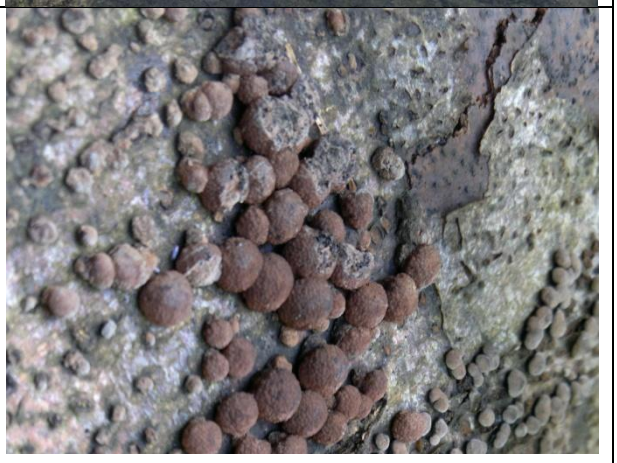
Chart 1. Percentage of records displayed by mapping resolution

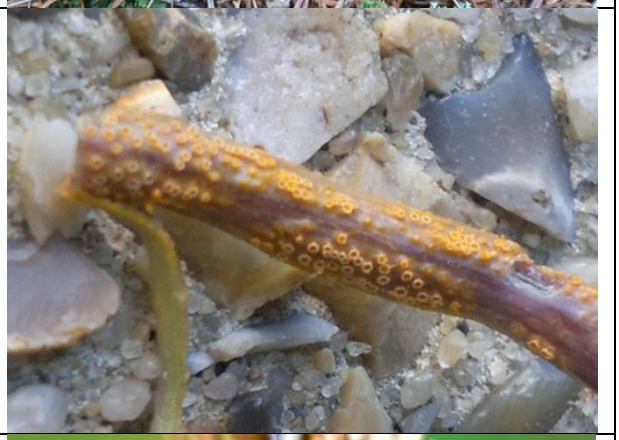
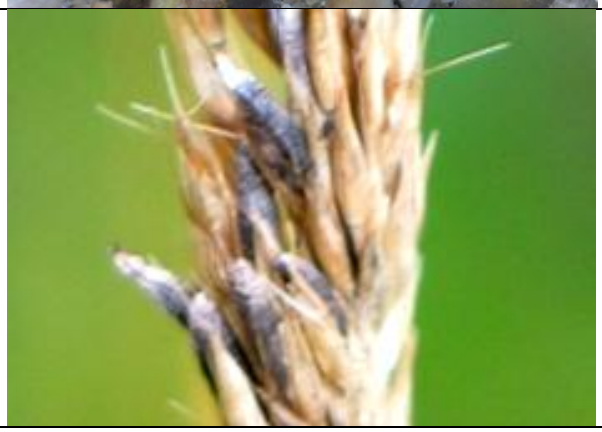


Separation of general records

The kingdom of fungi is taxonomically very large, and is represented by species in a wide variety of forms, fulfilling a broad range of ecological niches. For the purpose of this study, the records were divided into 9 categories. These categories were devised along a blend of genealogical, ecological and morphological lines and therefore the lines between these them are blurred and vague, Although this meant that many species could easily be assigned to more than one category, to achieve the goal of focussing this project on those species associated with mature, ancient and dead trees a consistent method was applied to categorising each species.

The categories used were:

Name of Category	Brief Description of Category	
Basidiomycete Saprophyte	A broad category including wood-rotting, mushroom-shaped (agaricoid) fungi, bracket fungi, jelly fungi and more. Some species are only parasitic on deadwood saprotrophs, but have been included here due to a shared reliance on the same underlying substrate.	
Resupinate Saprophyte	A wholly morphological distinction covering a wide range of crust-like fungi, including poroid species with this growing habit (on wood).	
Ascomycete Saprophyte	Many wood-rotting ascomycetes are very small, but those included here are most likely to be found on larger deadwood. Some species are only parasitic on wood-rotting fungi, but have been included here due to a shared reliance on the same underlying substrate.	

Ascomycete Other	This group includes all those ascomycetes more likely to be found on light, woody debris and litter or other substrates. Although they include wood-rotters, their substrate can be generated by very young trees and woody shrubs.	
Basidiomycete Other	This category is dominated by ectomycorrhizal agaricoid fungi, but includes litter-rotting saprotrophs, truffles and many others..	
Rusts	These fungi are associated with the soft growth parts of plants, like stems and leaves.	
Smuts	The ecology of these fungi relies on the reproductive systems of plants, and is not restricted to the target trees at all.	

Microfungi	This category includes several groups of mould-like fungi and similarly sized species.	
Myxomycetes	Slime molds have long been recorded alongside fungi on mycological systems, but they are not of the fungi kingdom.	

Only the first 3 of these categories are relevant to this study, as none of the other species have the same reliance on deadwood or mature and ancient trees as a substrate. However, a mapping exercise was carried out for all categories and all shapefiles and spreadsheets were provided along with this report.

Distribution of fungi in Savernake Forest

As previously mentioned, 89% of the records in this dataset could not be mapped accurately against the recording compartments (Figure 3). This issue was not biased towards any particular genera, but was apparent across the whole set of data. This meant that it was still possible to get a reasonable view of fungus hotspots by looking at geographical concentrations of records in relation to 1km square areas.

Unfortunately, as can be seen in Figure 4., when 4-digit grid references are used, large numbers of records cluster around the bottom left of grid squares, which is not a true representation of distribution – and makes it difficult to assign records to the correct compartments. For this reason the recorders of many 6 digit grid references avoid the problem with 4-digit grid references appearing on the bottom left of 1km grid squares, by centralising the reference in that grid square. (e.g. SU9373 becomes SU935735).

For the purpose of representing concentrations of fungal records with 4 digit grid references within 1km^2 areas, this method of centralising was used for the rest of this project. Records with more accurate grid references were not centralised.

In Figure 4. the left hand map shows concentrations of fungus records including those with 4-digit grid references, the right hand map with concentrations of fungi referenced by 6-digits or more (with centralised records removed).

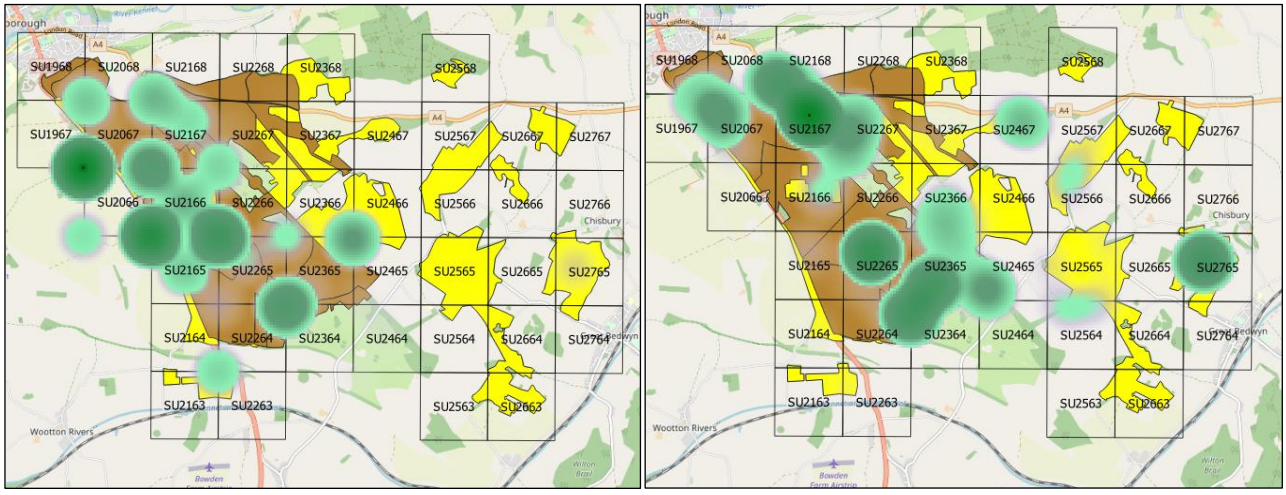
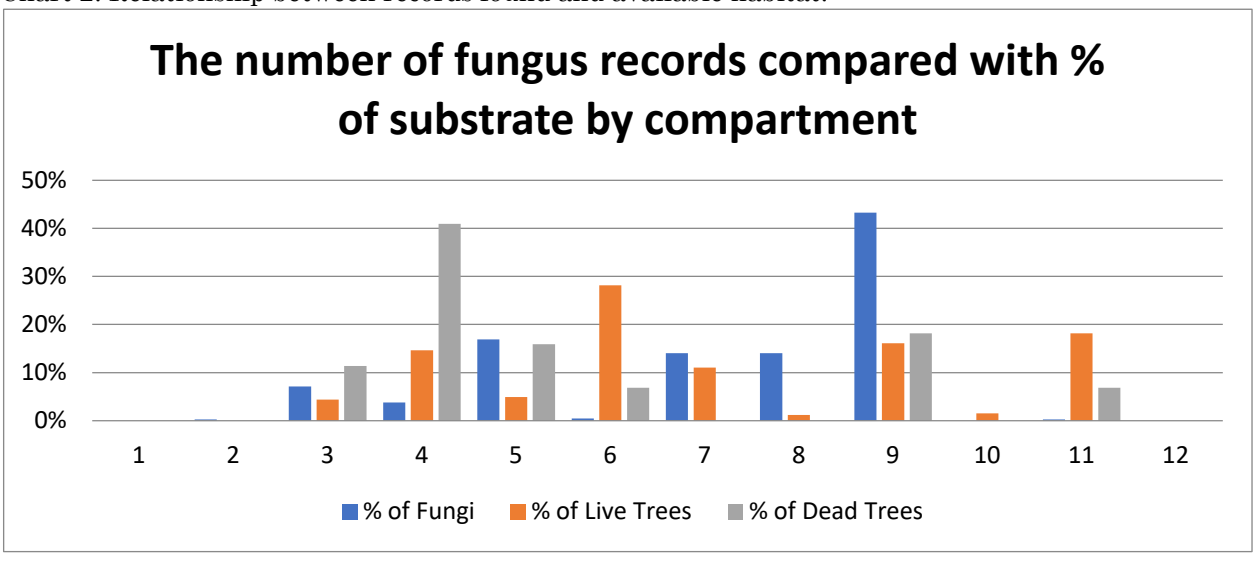


Figure 4. Heatmaps illustrating 4 digit and centralised 6-digit grid references (left) and with only accurate (6+ digit, non-centralised) grid references (right)

Using only the records that allowed for the more precise mapping used in Figure 4. (right), an attempt was made to compare the distribution of notable living and dead trees with the number of fungus records by each compartment. The fungus records were compared with data from the 2016 ancient tree and deadwood survey (Rutter, 2017). As can be seen in Chart 2, no correlation could be made between the datasets so it was not possible to explore how host/substrate availability was a major factor in either species distribution or recording bias.

Chart 2. Relationship between records found and available habitat.



Designated, red-listed and protected species

Using the agreed lists of threatened, protected and priority species which are detailed in the methodology, the fungi of Savernake Forest were checked and filtered to provide the following results:

Table 1. Priority species

Fungus Category	Records	Species	Genera
Basidiomycete Saprotrophs	5	2	2
Resupinate Saprotrophs	1	1	1
Ascomycete Saprotrophs	0	0	0
Ascomycete - Other	1	1	1
Basidiomycete - Other	27	11	12
Rusts	0	0	0
Smuts	0	0	0
Microfungi	0	0	0
Myxomycetes	0	0	0
Total	34	15	16

Of these species, those from the target categories (wood rotting saprotrophs) are shown in Table 2 with the priority/protected species lists they appear on, (see Appendix R for full table of priority species).

Table 2. Priority and Red-listed species on deadwood and mature/ancient trees.

Category	Basidio. Sapro.	Basidio. Sapro.	Resupinate Sapro.
Current Name	**Hericium erinaceus**	**Buchwaldoboletus lignicola**	**Mensularia nodulosa**
IUCN		Vulnerable	
UK BAP	Yes		
S41	European concern		
Schedule 8	Yes		
Red Data List 2006	Annex		Near Threatened
Red Data List 2016			
Red Data list Boletaceae		Vulnerable	

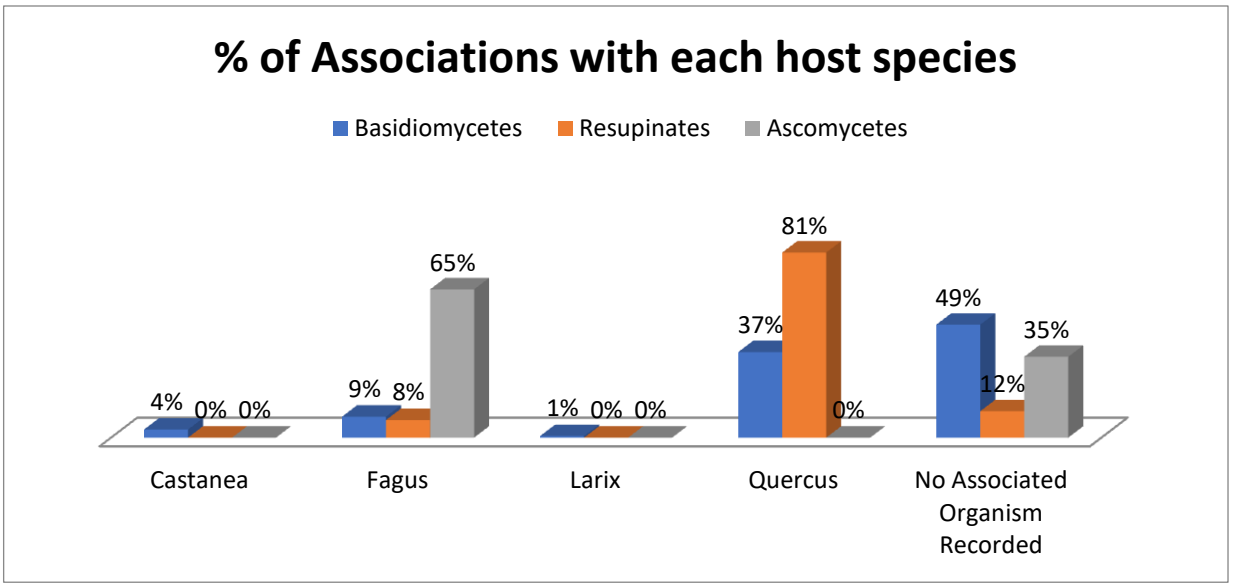
To assess which tree species support the greatest number of the target fungus species, a list of all substrates/associated organism was created. 23 species of woody plants and trees were identified from the full dataset, but only 4 of these were host to target groups on the priority/red-lists (See Appendix B).

Chart 3 illustrates Fagus and Quercus standing out as being the most important ancient trees for Savernake's red-listed and indicator species of wood-rotting fungi. Although a significant number of records had no details for host species (no associated organism), these records were distributed evenly throughout the data, and are therefore very unlikely to skew the results, (See Appendix JC for Priority species only).

A small number of records were not recorded as being in association with trees (Other). In the case of Polydesmia, this was because these tiny ascomycete fungi were parasitising another species of fungus, which in turn were parasitising or rotting the host tree/deadwood (*Polydesmia pruinosa* was recorded in association with *Diatrype disciformis, Jackrogersella multiformis* and *Biscogniauxia nummularia*). In the case of *Coprinopsis atramentaria*, the associated organism was wrongly recorded as grass

(Poaceae), due to the way this fungus can appear to be growing independently of trees. It would in fact have had an association with either the dead roots of a host tree, or buried wood. There are many more records in the full dataset that have similar reasons for associated organisms that are not trees being recorded in the details, but all have been verified as having some reliance on these hosts and associations.

Chart 3. Host species associations of priority and red-listed species of target fungus categories.



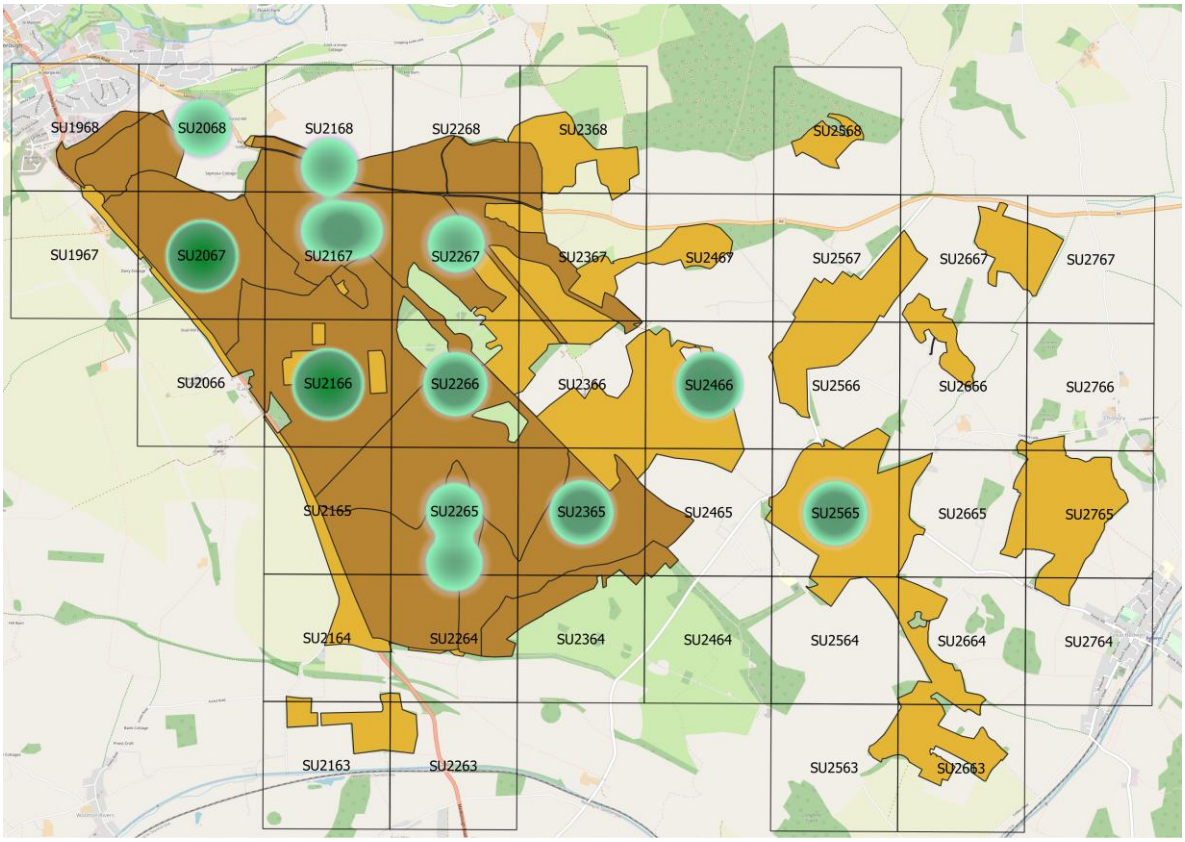


Figure 5. A Heatmap of priority species with a grid reference at 1km² accuracy or greater.

As the accuracy of grid references was poor even for priority species, it was necessary to create a map including records with a 1km^2 resolution to include a good proportion of the priority species.

Of the 16 priority fungus species occurring in Savernake Forest, 1 was only recorded with a 10km^2 grid ref. None of the species had any records with a grid ref. useful for relocating the fungi (10m^2 grid ref.), and just 5 could be mapped to a 100m^2 area.

However, with those limiting factors aside, there were clear hotspots in the distribution of these priority fungi that didn't match the maps of the full fungus dataset (Figure 4.) but give a clearer illustration of the location of these fungi in relation to 1km^2 grid squares and SSSI compartments.

Deadwood Saprotrophs and related species

The target species of this project were those fungi whose ecology was reliant on mature trees, or the dead wood of mature trees. This meant that species saprotrophic on woody litter (twigs, small debris, cones, leaf litter etc.) were not included under this definition, but fungi found on fallen branches and bark were. The boundaries of these categories were indistinct and prone to overlap, but best efforts were made to remain consistent in the categorisation process, with the allowance of exemptions.

Within this wide category of deadwood saprotrophs there is huge variation in the states and rates of wood rotting, fruitbody morphology and fruiting regularity. The next level of categorisation separated them into the following groups:

Table 3. Numbers of records and species categorised as deadwood saprotrophs

Category	Records	Genera	Species		Records with 6+ grid ref.	Species with 6+ grid ref.		Priority records	Priority Species
Basidiomycete Saprotrophs	2326	82	183		256	102		142	15
Resupinate Saprotrophs	388	39	63		44	27		26	2
Ascomycete Saprotrophs	782	49	67		38	18		17	1

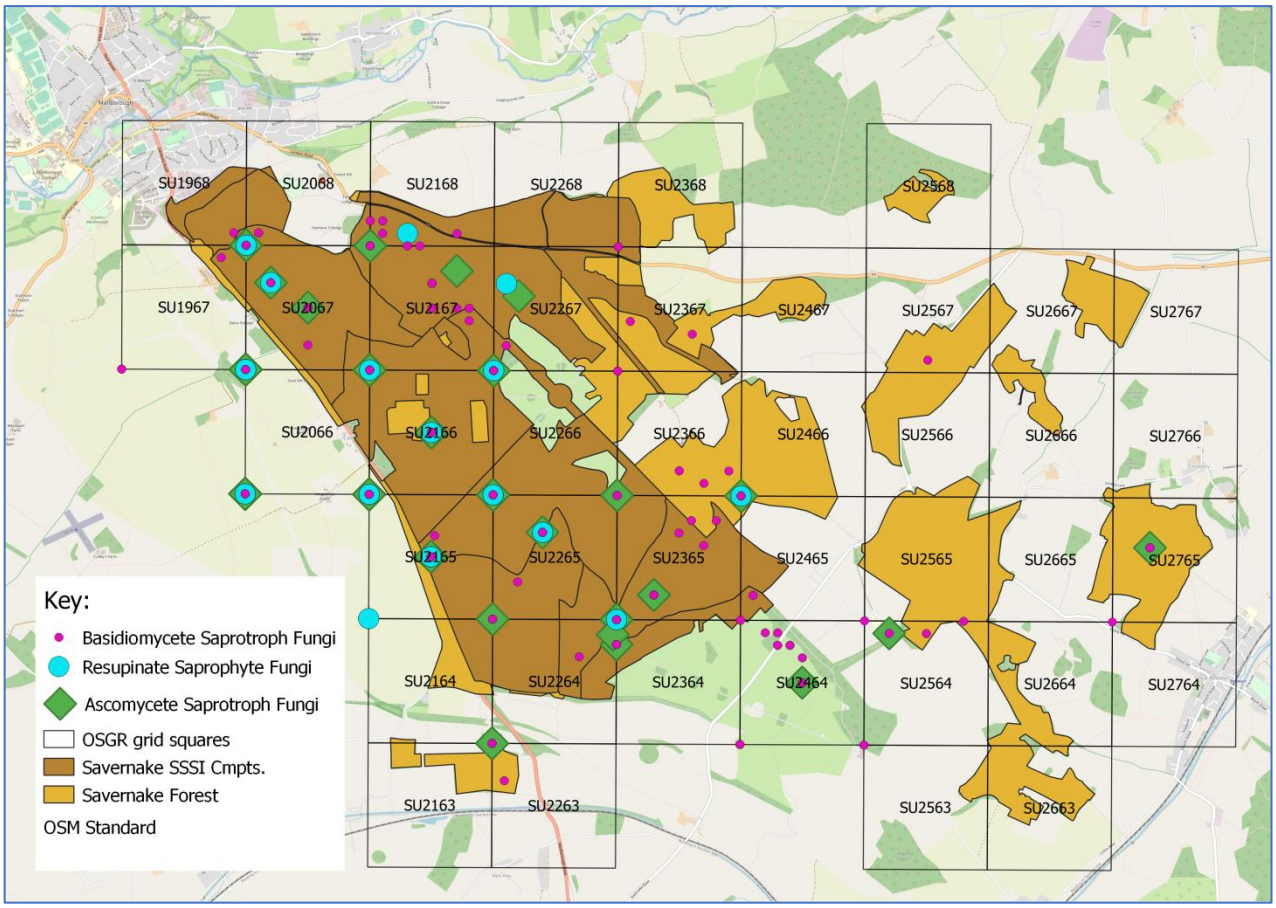
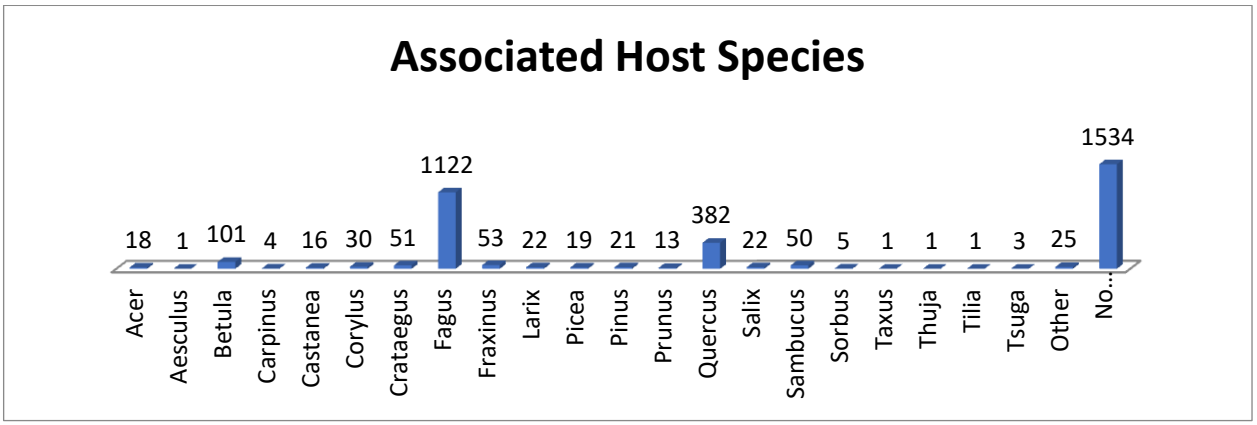


Figure 6. Distribution map of all target species with grid refs accurate to 4 or more digits.

The level of accuracy used in Figure 6. falsely appears to show the distribution of target species outwith the boundary of Savernake Forest. This was a symptom of using the 4 digit grid references which always appear at the bottom, left corner of a grid square. The records themselves could have referred to anywhere within that 1km^2. (Further maps plotting the distribution of each category can be found in Appendices Ia to Ic).

Chart 4. The number of target species associated with each host species.



The target species records were sorted and filtered by the organism (tree host) associated with them (Chart 4). 36% of the records had no associated organism recorded; 21% were recorded associating with Quercus; 18% were associated with

Fagus; 4% were associated with Ulmus; 3% were associated with Pinus; and 3% were recorded with associated organisms that were not tree species, (e.g. those species which were parasitically associated with fungi that were in turn associated with a tree species.) (Also see Appendices Ja and Jb)

Distribution of fungi

The central area of Savernake Forest designated as a SSSI had been divided into 12 compartments. Figure 7. illustrates the locations of the veteran trees and large standing or fallen deadwood which were tagged as part of a survey identifying important lichen hosts (Rutter, 2017). It can be observed from the map alone, that the veteran trees (52% Quercus, 40%Fagus, and 8% a mix of 12 other species) are almost entirely restricted to compartments 3,4,5,6,7,9,10,11 and 12.

Figure 7. Veteran trees and bulky deadwood within Savernake Forest SSSI.

However, due to the poor resolution of the majority of fungus records at Savernake, it was not possible to compare the distribution of fungi with the location of veteran trees, or individual compartments.

Figure 8. shows a close up of the 1km² 'SU2165'. 3% of records relating to this area had the grid reference 'SU2165', which placed a map point (a red star) at the bottom left of the square. This only meant that each record related to a fungus within that 1km2, which included a substantial area of compartments 4, 5 and 6, as well as an area

outside the SSSI compartments. 97% of the records had the 6 digit reference 'SU215655', which placed a map point at the centre of the square on the border of compartments 5 and 6. However, this grid reference (when used to centralise a large number of records) also referred to the whole area including all three compartments and the area outside the Forest. Only a single record with the 8 digit grid reference 'SU21536567' was marked with a pink dot in Compartment 5 and could therefore be located to within 10m2. This issue was repeated across the whole site with only 2-3% of records being directly comparable to the compartments or other features.

No similar tree or host data was available for other ecological units outside the SSSI at Savernake, although Units J (Bedwyn common) and K (Chisbury Wood) clearly support reasonable numbers of species (Figures 4. and 5.).

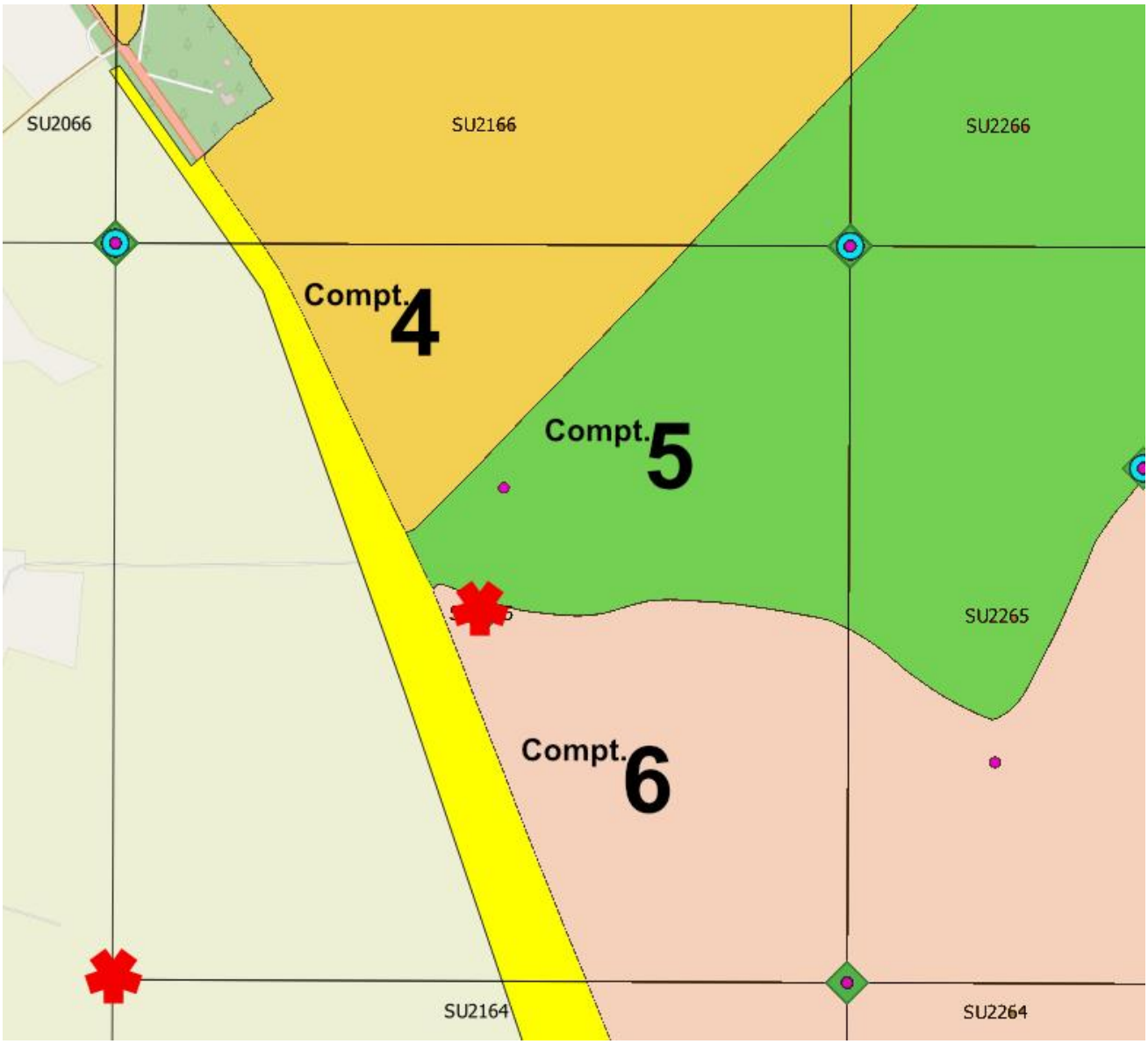


Figure 8. An illustration of the problem with comparing 4 digit grid references to landscape features.

As an alternative to assigning records to compartments, the target, wood-rotting/saprophytic fungi were grouped by the 1km2 they originated in. The map and table (see Appendix Q) give an overview of where concentrations of records were at Savernake, and this information can be loosely used to compare against groups of compartments.

Assessment using SSSI selection guidelines

Savernake Forest has been designated for a number of features including epiphytic lichens and habitats that could support priority species of fungi, but none of the fungi themselves. The filtered and corrected dataset created for this project was used to assess the fungi of Savernake Forest against the current Guidelines for the Selection of biological SSSIs –Chapter 14, Non-lichenised fungi (Bosanquet et al, 2018). It is important to note however, that these guidelines do not include all of the important fungal assemblages likely to be found in different habitat within the park, as there were no accepted scoring systems for those assemblages at the time of this project. Appendix K lists a number of assemblages that are acknowledged in the guidelines, but do not have scoring systems.

Additionally, a draft version of an assessment for thermophilous boletes (Smith, 2012) was applied to the dataset as Savernake was host to some of the indicator species for this assemblage.

Of the six assemblages with selection guidelines, four were relevant to the habitats found in the park. The guidelines for coastal sand dune fungi and Caledonian pinewood fungi assemblages were not looked at for this research, the comparisons to the remaining assemblages follow here:

Tooth fungi associated with oak, beech or sweet chestnut

(Stipitate hydnoid fungi predominantly mycorrhizal with Quercus, Castanea and Fagus. Habitats include woodland, lowland heath and other habitats where the host trees occur)

7 species/species aggregates were used to assess sites for this assemblage. The threshold for SSSI selection in the south and south-east of England was 5 of these species/species aggregates.

Assessed as a single site, Savernake Forest had 0 species/species aggregates present, failing to meet the threshold for this assemblage. (See Appendix L for species list).

Beech deadwood

(Saprotrophs of beech in parkland, wood pasture, or woodland)

30 species were used to assess sites for this assemblage. The threshold for SSSI selection was 15 of these species.

Assessed as a single site, Savernake Forest had 8 species present, failing to meet the threshold for this assemblage. (See Appendix M for species list).

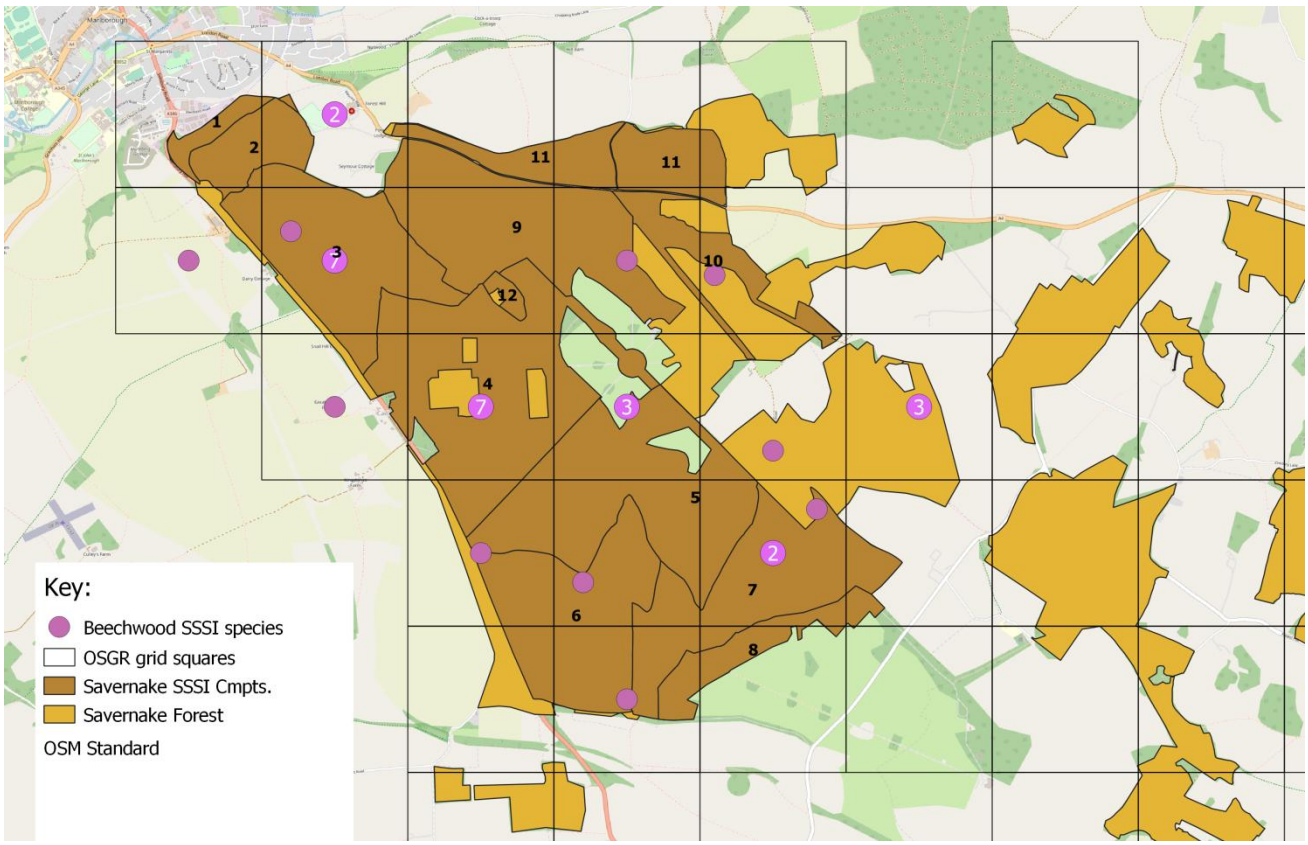


Figure 9. Distribution of Beech Deadwood assemblage

According to the available data, this assemblage was distributed across most of the SSSI compartments. but not in the outlying woods beyond.

Oak Deadwood

(Saprotrophs of oak in parkland, wood pasture, or woodland)

16 species were used to assess sites for this assemblage. The threshold for SSSI selection was 8 of these species.

Assessed as a single site, Savernake Forest had 9 species present, surpassing the threshold for this assemblage. (See Appendix N for species list).

Figure 10. *Grifola frondosa, one of the indicator species for the Oak deadwood assemblage.*

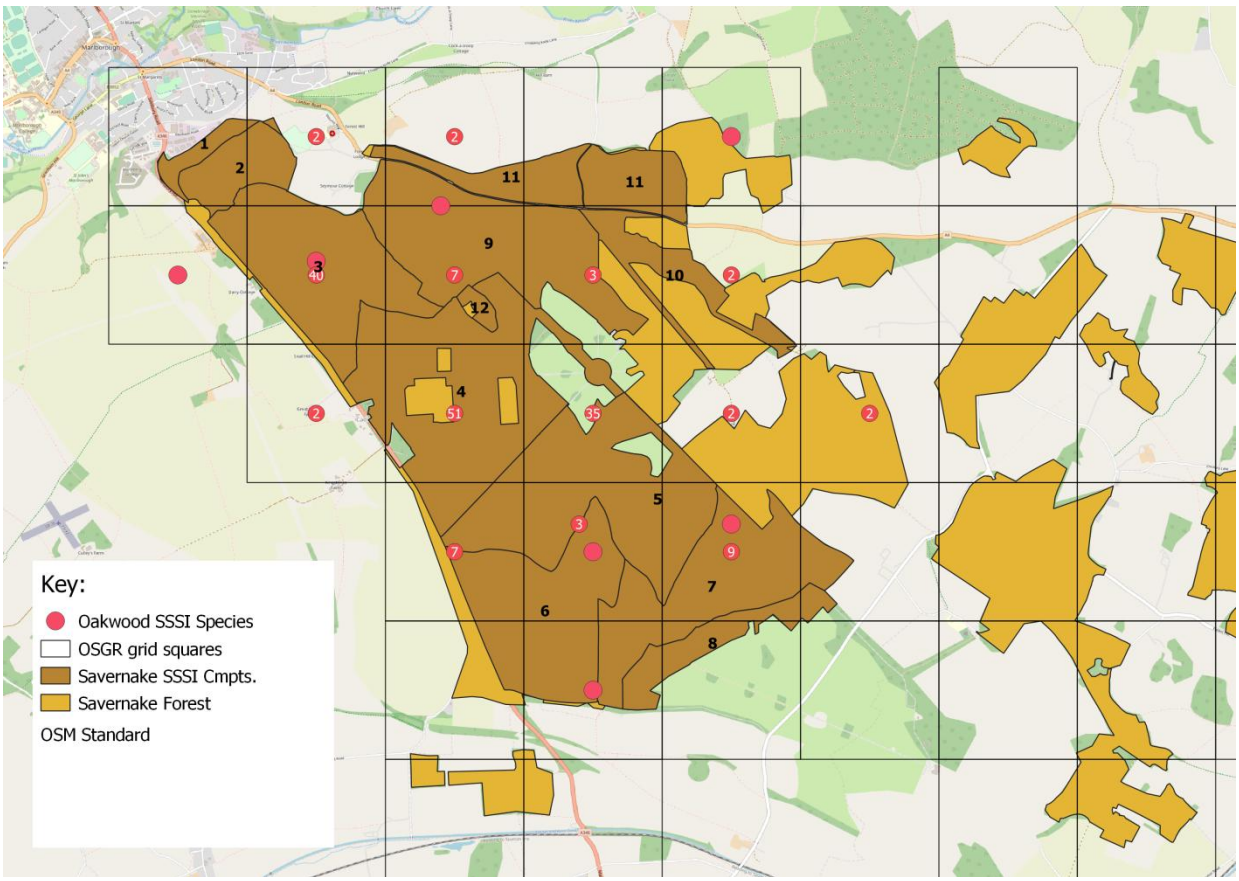


Figure 11. Distribution of the Oak Deadwood assemblage

According to the available data, this assemblage was distributed across all of the central SSSI compartments, and some of the species were recorded in the surrounding forest.

Grassland fungi

(Nutrient-poor unimproved and semi-improved grasslands)

The grassland fungi assemblage was assessed against 5 groups of grassland species (divided by historic taxonomy) in the current guidelines for SSSI selection (Bosanquet et al, 2018).

Sites that meet or surpass the threshold for any one of these groups would warrant consideration for SSSI designation. The groups are:

Table 5. The genera and groups included in the grassland assemblage

Common Group name	Group name	Included genera
Clubs, spindles and corals	Clavarioid fungi	Clavaria, Clavulinopsis, Ramariopsis
Waxcaps	Hygrocybe sensu lato	Cuphophyllus, Gliophorus, Gloioxanthomyces, Hygrocybe sensu stricto, Neohygrocybe, Porpolomopsis
Pinkgills	Entoloma sensu lato	Entoloma sensu lato
Earthtongues	Geoglossoid fungi	Geoglossum, Glutinoglossum, Microglossum, Sabuloglossum, Trichoglossum
Crazed caps, fanvaults and meadowcaps	Dermoloma etc.	Dermoloma, Porpoloma (Pseudotricholoma metapodium), Camarophyllopsis, Hodophilus

Clubs, spindles and corals

25 species/species aggregates were used to assess sites for this assemblage. The threshold for SSSI selection was 7 of these species/species aggregates.

Assessed as a single site, Savernake Forest had 7 species present, meeting the threshold for this assemblage. (See Appendix O for species list).

Waxcaps

49 species were used to assess sites for this assemblage. The threshold for SSSI selection was 19 of these species.

Assessed as a single site, Savernake Forest had 11 species present, failing to meet the the threshold for this assemblage. (See Appendix O for species list).

Pinkgills

There were over 200 species of Entoloma, (though not all are grassland fungi). The threshold for SSSI selection was 15 of these species.

Assessed as a single site, Savernake Forest had 21 species present, although only 11 of these were relevant grassland species. Therefore the threshold for this assemblage was not met. (See Appendix O for species list).

Earthtongues
18 species/species aggregates were used to assess sites for this assemblage. The threshold for SSSI selection was 5 of these species/species aggregations.

Assessed as a single site, Savernake Forest had 1 species present, not meeting the threshold for this assemblage. (See Appendix O for species list).

Crazed caps, fanvaults and meadowcaps
The threshold for SSSI selection was 3 of these species.

Assessed as a single site, Savernake Forest had 0 species present, not meeting the threshold for this assemblage. (See Appendix O for species list).

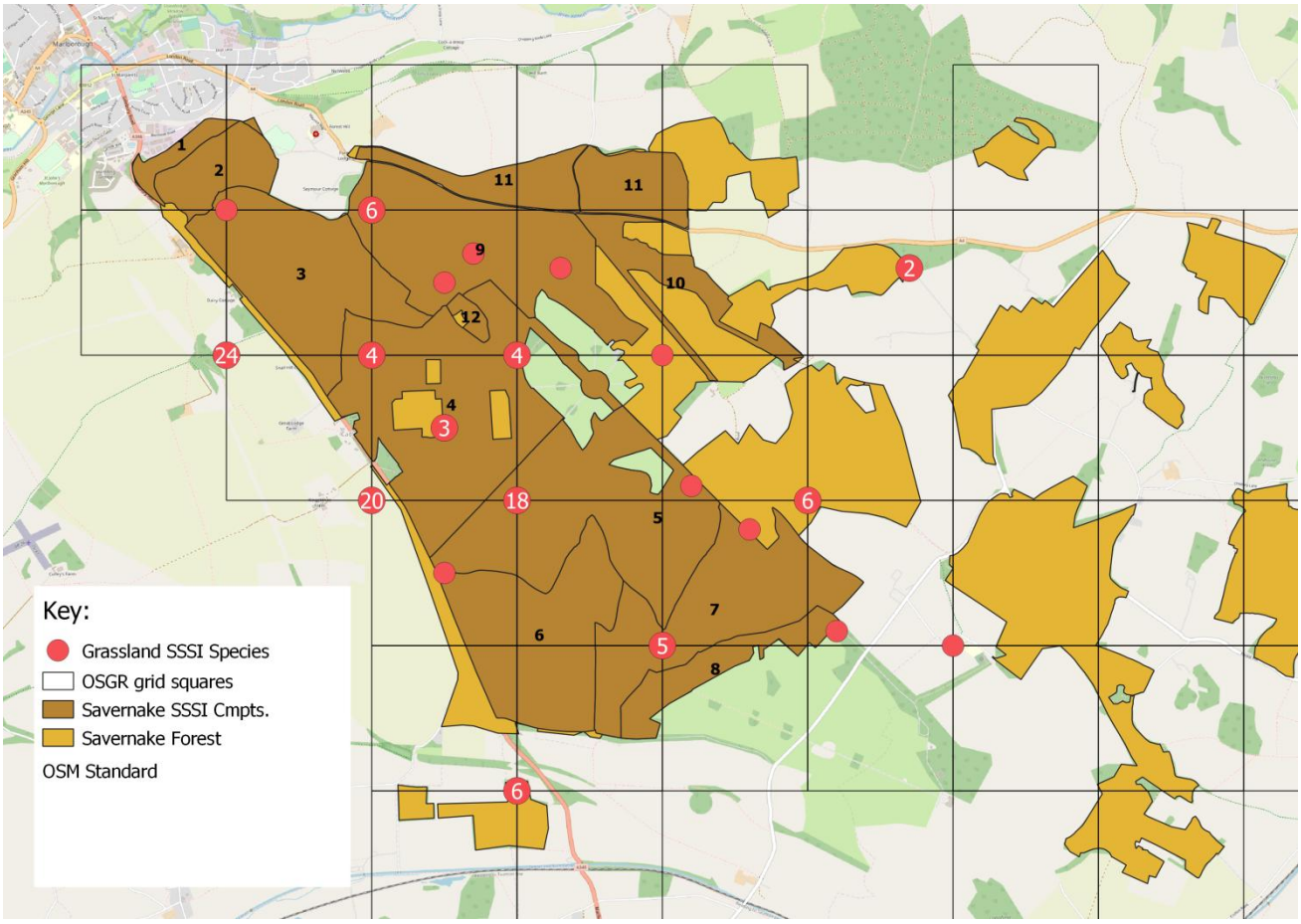


Figure 52. Mappable records of all grassland fungi in Savernake Forest.

Although there was not enough diversity in the 115 records of grassland fungi within Savernake alone, two churchyard locations immediately adjacent to Savernake (St. Katharine's and Cadley church) had considerably more records of species from this assemblage, and should be considered for inclusion for any future surveys of grassland fungi at Savernake.

Boletes of wood pasture and parkland

(Thermophilous boletes: species of Boletaceae in warm, open sites with short ground cover; these tend to occur in open woodland or parkland)

An assessment for this group of fungi was not included in the current guidelines for the selection of biological SSSIs –Chapter 14, Non-lichenised fungi (Bosanquet et al, 2018) as "Very few species rich sites were known and all confined to southern England. The best sites were already designated SSSIs. It was therefore not considered a priority for further work", (Knowles, 2017).

However a draft version, for this group was included as Appendix 3 in the Draft SSSI Guidelines for Thermophilous Boletes in England (Smith, 2012).

In these guidelines, 25 species were used to assess sites for this assemblage. The threshold to be considered a 'High Priority Site' was 8 of these species.

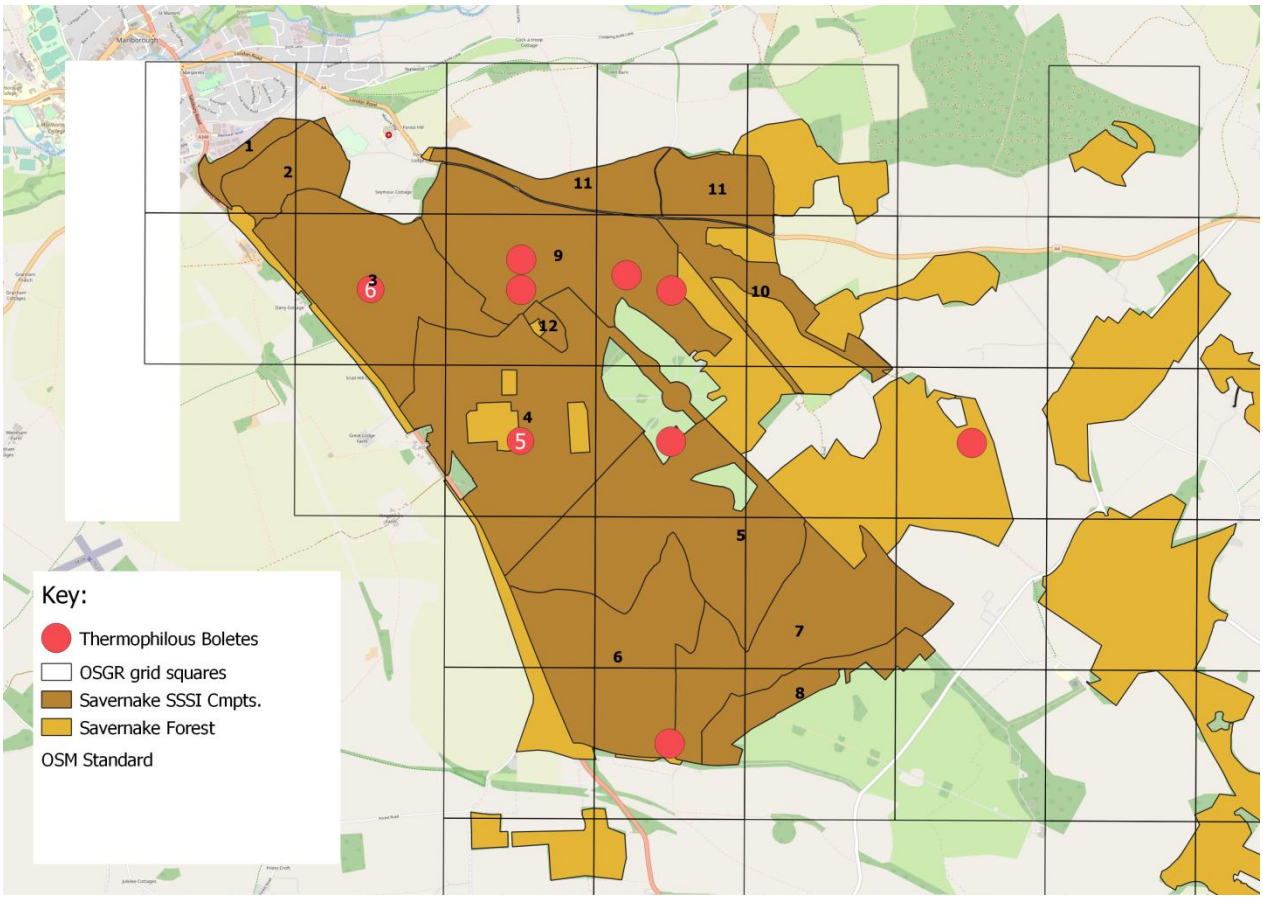


Figure 3. Distribution of Thermophilous Boletes in Savernake Forest.

Assessed as a single site, Savernake Forest had 5 species recorded as present, although only 4 since 1995, failing to meet the threshold for this assemblage to be considered a 'High Priority site'. (See Appendix P for species list).

Difficulties

The issues that hindered progress, or were beyond the scope of this project are listed here. They can be broken down into 4 types: Data quality, taxonomy, categorisation and mapping.

Data quality:

The quality of data in any given record was widely varied. Some were missing information from some or all important fields, others had all fields completed but with mistakes. Working through the dataset using filters could therefore only go so far, and much of the cleaning and correction had to be done manually, 1 record at a time.

Hundreds of erroneous and duplicated records were removed from the dataset provided with this project, however more could be done in a similar, manual way to find and remove more. Some particular issues were:

- Some sources had records with so little detail, that it was not possible to rule them out as duplicates, as there was not enough information to compare with.

- It was apparent that some areas of the forest have been a focus of more recording effort than others. Although this may have been caused by accessibility issues, habitat preference, recorder bias etc., the outcome is still an incomplete picture of the fungi of Savernake Forest.

Taxonomy:

Fungal taxonomy is in a state of upheaval as different groups and genera are examined more closely, and subjected to molecular studies. While this project updated names to those currently in use where possible, the filters had to be created to deal with a number of synonyms for many species and so some may have slipped through with recent synonyms ascribed as current names.

Categorisation:

- The categories into which species were assigned for this study were not true categories based on fungal taxonomy and there were many instances where a single species could have fitted into more than one category. The ecological habit of *Mycena hiemalis* for example is dependent on the mossy trunks of mature broadleaf trees, although it is not directly dependent on rotting the wood of those trunks, it was categorised under 'Basidiomycete saprotrophs'.

- The process of categorisation was open to subjectivity. However, the same subjective divisions were made consistently throughout the dataset. For example, records were assigned to 'Resupinate Saprotrophs' according to the definition of 'resupinates' given in the Corticiaceae of Northern Europe (Hjortstam, 1987).

Mapping:

- Due to the poor resolution quality of over 80% of grid references, a large number of records (and the records of entire species) would have been lost when creating accurate distribution maps. For the purpose of this study the use of 4 digit ($1km^2$) grid references was the best compromise between accuracy and exclusion of records.

- It will be possible to investigate the distributions of individual species using the data and shapefiles generated by this study, but the user should be aware of the acute loss of records in proportion to the accuracy of the location data.

- Some records were included as present, but not mapped. For example priority species records with no grid reference, but a local name like 'Chisbury Wood' were included as a species, but could not appear on any distribution maps. There was a very low number of records for Savernake for which this was an issue.

Conclusion

At the time of this study, Savernake Forest was host to a wide diversity of fungi, and featured some important, priority and protected species.

Although Savernake had a comparably high quantity of fungal records, many of these were of poor quality, giving little of the additional information that would be needed to assess or map them in greater detail.

Figure 6. Deadwood habitat in Savernake Forest. © Heather Newman

This desk-study found 1,058 species of fungus from 405 genera that were recorded in the forest over the last 50 years. Of these, 3 were priority or red-listed species and 313 species were the target, wood-rotting fungi.

By mapping these species to 1km2 grid squares, it could be inferred that compartments 3 and 4 had by far the highest number of records of target species within them. Compartments 5, 7 appeared to have the next highest number of records of target species (See Appendix Q.).

Fagus and Quercus were identified as the host tree species with the greatest amount of associated target deadwood records (Chart 4 and Appendix J).

This study reconfirmed the importance of Savernake Forest for fungi. The desk-study stage of assessments against SSSI thresholds was positive for the Oak deadwood assemblage, and some species were present in each of the other assemblages indicating the strong potential for other habitats at Savernake. The forest already had a designation to protect some of those habitats, but it would be advisable to compare the current management policies with those that would benefit the specific needs and habitat requirements of at least the four assemblages discussed here..

Further monitoring

The records compiled in this project for fungi in Savernake Forest betrayed a number of biases, and a lack of detail common to many fungus records across the UK.

It was only possible to create distribution maps with a minimum of 4 digit grid references (1km^2), as less than 15% of records found in this study had grid references to a suitable resolution. To adequately monitor scarce and priority species grid references of 8 digits (10m^2) or 10 digits (1m^2) are required to locate and relocate potentially lone specimens.

Almost as important, but often absent details are 'associated organism' and 'substrate', although there are others. Having information about the associated organism, (tree species for the purpose of this project) can be vital to correcting a misidentification, or resolving taxonomic changes.

The following list should be used as baseline for future recording surveys, and is to be encouraged in local amateur recorders to give their often hard-won records more value:

- A 6 digit grid reference minimum for all recorded finds
- An 8 or 10 digit grid reference minimum for species targeted for monitoring.
- The associated organism should be recorded for all finds

The following groups would particularly benefit from targeted or ongoing surveys as this study indicates they are either under-recorded or not recently recorded in Savernake Forest.

- Saprophytic ascomycetes (Pyrenomycetes and Discomycetes)
- Resupinate saprotrophs (Corticioid fungi)

Ideally, all red-listed and priority species should be resurveyed to get up-to-date and exact grid references, this will make future monitoring of those species more practical.

Appendix K lists specialised habitats for fungi that were considered to be important, but which did not yet have scoring systems for SSSI assessment. Any of these habitats that are present at Savernake should be surveyed for fungi. As with most fungal monitoring, a single autumnal survey should be considered a minimum, with repeat surveys at different times of year, over several years being the only way to get a true picture of the wider fungal community at any given site.

Compartments with no (mapped) records of fungi should be prioritised for surveys, before also surveying compartments with less than 100 records (Table 7).

Table 5. Number of fungi records per compartment. Red = 0, Orange = <100, Green = <500 records.

OS Grid Ref.	SU1967	SU1968	SU2066	SU2067	SU2068	SU2163	SU2164	SU2165	SU2166	SU2167	SU2168	SU2263	SU2264	SU2265
No. Of records	15	2	109	2525	173	0	1	185	2045	635	244	1	146	116

OS Grid Ref.	SU2266	SU2267	SU2268	SU2364	SU2365	SU2366	SU2367	SU2368	SU2465	SU2466	SU2467	SU2563	SU2564
No. Of records	1099	161	0	1	624	98	17	6	25	323	18	0	8

OS Grid Ref.	SU2565	SU2566	SU2567	SU2568	SU2663	SU2664	SU2665	SU2666	SU2667	SU2764	SU2765	SU2766	SU2767
No. Of records	8	6	2	0	0	0	2	0	0	0	50	0	0

Traditionally, surveys for fungi were carried out by trained mycologists who will have spent many years building up their identification skills both in the field and the lab. The fruiting bodies of the fungi are sought at the times of year they are expected to be produced by the fungi which is usually present in the substrate year-round.

This method can be hindered by many factors, but some key ones are: The skill-level of the field-worker, the cryptic nature of fungi, and the irregular fruiting of some species.

In recent years, a growing number of surveys have been completed by carrying out molecular work using environmentally sourced DNA samples (eDNA).

This method has had some proven success on grassland fungus surveys, where the eDNA studies revealed more species of notable fungi than traditional field studies had. (Griffiths et al, 2019).

There can be considerable appeal of a survey method that involves collecting a sample of the woody substrate of any target tree, then sending this 'to a lab where the eDNA can be separated, sequenced and identified before producing a list of all recognised species (even those which do not appear to fruit regularly/at all). However, there are some issues too:

- Many species of fungus (particularly microfungi) have no/no reliable sequences on record for comparison (Yahr et al, 2016).
- With an increase of eDNA surveys, the sequences of new, unnamed species are continually being discovered (Hibbert et al, 2011) It is possible that fruitbodies may not be found to match these species.

Both of these situations are likely to improve, or be countered over time making eDNA surveys increasingly viable. In the meantime, Frøslev et al, (2019) found that when comparing surveys of soil fungus communities, "The fruitbody survey was slightly better in finding red-listed species", and that although

"more species (OTUs) were detected by eDNA-metabarcoding than by the classic fruitbody survey. This could mainly be attributed to the detection of groups, which always go undetected in a fruitbody survey, e.g. diverse groups of moulds and yeasts".

This suggested that for the purpose of carrying out the surveys that will inform woodland management and gauge site condition; traditional fruitbody searches for rare and priority species will continue to be more valuable than eDNA surveys.

However, eDNA surveys of signature trees and deadwood in Savernake will reveal more species and cryptic species that may eventually prove to be priority species of the future, so these surveys should be taken opportunistically. In the meantime, the general management of vintage tree specimens and deadwood in the park will continue to protect these as yet unknown species.

All surveys proposed here should be repeated for monitoring purposes every 5 years for priority species, and every 10 years for other fungi, (except when habitat has become damaged or destroyed, at which point monitoring should be carried out at that time).

Management recommendations

The species of wood-rotting fungi that are noted and/or protected rely on the wood of large, dead boughs and trunks of standing and fallen trees, as well as the heartwood of standing, living trees. The most important trees for these fungi are usually the largest, and therefore the oldest specimens, although the next generation of these trees is also vital to the continuity of this fungal assemblage.

Maintaining veteran trees in wood and parkland should rely on low levels of practical management. However a baseline survey of the quantity and distribution of veteran trees (alive and dead) as well as fallen veteran trees and large pieces of deadwood should be conducted.

Maintaining a supply of deadwood may be vital to these populations of saprophytic fungi, but the felling of veteran trees should be avoided at all costs. Naturally occurring damage and death will provide enough resources and habitat, so long as the site is not allowed to shrink in size and that trees of a range of ages are always available to become recruited as the new veteran specimens.

Existing veteran trees should therefore be allowed to age and deteriorate naturally, including the dropping of limbs and hollowing of the trunk, all of which will extend the life of the tree and provide resources for the priority fungi.

Where possible, paths should be rerouted away from these trees so that they do not need to be felled for health and safety reasons. When this is not possible, the canopy should be reduced and/or offending limbs should be removed with all debris left in situ, or moved to a suitable location on site.

In areas of dense closed canopy (often typical of historical plantation, with trees of the same age), individual trees should be selected as 'future-veterans', and a ring of the surrounding trees should be removed to allow the chosen specimen to spread as it grows to fill the cleared space. All large debris should be left in situ or moved to a suitable location on site.

Where necessary and relevant, new trees should be planted in the park. While Quercus and Fagus should be prioritised, Appendix 10a and 10b should be used as a reference to identify other important tree species for saprophytic fungi.

Some ectomycorrhizal species of priority fungus also rely on ancient woodland habitats. To avoid the risk of damage or destruction of these fungal communities, care should be taken when working in these areas with heavy machinery (e.g. when removing non-native species). Where possible mats should be used to spread the weight of plant machinery which will avoid compaction of the ground, and the fungi within it. When it is necessary to uproot entire plants in these areas, soil should only be disturbed at each necessary location, (as oppose to scraping the surface away while working between several nearby locations).

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Appendix A

Location names associated with compartments used in this study.

Compt. ID	Local site names included in compartment
A	East Croft Coppice + Puthall Park
B	Knowle Hens Wood
C	Ashdale Firs
D	Horseleaze + Little Frith
E	Birch Copse
F	Belmore Copse + Knowle Hill + Cobham Frith
G	Round Copse
H	Noke Wood
J	Sicily Clump + Bedwyn Common + Bloxham
K	Chisbury Wood + Brimley Copse + Brondsons Copse + Park Copse
M	Leigh Hill Copse + Square Copse + Crooks Copse

Appendix B.

Associated tree species

Full range of hosts within species dataset	Hosts of target priority species
Acer	Castanea
Aesculus	Fagus
Betula	Larix
Buxus	Quercus
Carpinus	No Associated Organism Recorded
Castanea	
Corylus	
Crataegus	
Fagus	
Fraxinus	
Larix	
Picea	
Pinus	
Prunus	
Quercus	
Salix	
Sambucus	
Sorbus	
Taxus	
Thuja	
Tilia	
Tsuga	
No Associated Organism	
Other	

Appendix C.

A list of theBasidiomycete saprotroph fungi of Savernake Forest.

Abortiporus biennis
Antrodia pseudosinuosa
Antrodia xantha
Armillaria cepistipes
Armillaria gallica
Armillaria mellea
Armillaria mellea s.l.
Armillaria mellea s.s.
Armillaria ostoyae
Auricularia auricula-judae
Auricularia mesenterica
Bjerkandera adusta
Bolbitius reticulatus
Buchwaldoboletus lignicola
Calocera cornea
Calocera pallidospathulata
Calocera viscosa
Ceriporia reticulata
Ceriporia viridans
Ceriporiopsis gilvescens
Chondrostereum purpureum
Coprinellus disseminatus
Coprinellus domesticus
Coprinellus ellisii
Coprinellus micaceus
Coprinopsis atramentaria
Coprinopsis romagnesiana
Crepidotus applanatus var. applanatus
Crepidotus caspari
Crepidotus cesatii
Crepidotus epibryus
Crepidotus luteolus
Crepidotus mollis
Crepidotus variabilis
Dacrymyces stillatus
Daedalea quercina
Daedaleopsis confragosa
Dichomitus campestris
Exidia glandulosa
Exidia thuretiana
Fistulina hepatica
Flagelloscypha minutissima
Flammulina velutipes var. velutipes
Fuscoporia ferrea
Fuscoporia ferruginosa
Galerina marginata
Ganoderma applanatum
Ganoderma australe
Ganoderma lucidum
Ganoderma pfeifferi
Ganoderma resinaceum
Gloeophyllum sepiarium
Grifola frondosa
Gymnopilus hybridus
Gymnopilus junonius
Gymnopilus penetrans
Gymnopilus sapineus
Gymnopus inodorus
Hapalopilus nidulans
Hemimycena tortuosa
Hericium cirrhatum
Hericium erinaceus
Heterobasidion annosum
Homophron spadiceum
Hypholoma fasciculare
Hypholoma fasciculare var. fasciculare
Hypholoma fasciculare var. pusillum
Hypholoma lateritium
Inonotus hispidus
Ischnoderma benzoinum
Ischnoderma resinosum
Kuehneromyces mutabilis
Laetiporus sulphureus
Lentinellus cochleatus
Lentinus brumalis
Lenzites betulina
Lenzites betulinus
Lycoperdon pyriforme
Macrotyphula fistulosa var. contorta
Megacollybia platyphylla
Mensularia radiata
Meripilus giganteus
Mucronella calva
Mycena alcalina
Mycena arcangeliana
Mycena corynephora
Mycena crocata
Mycena galericulata
Mycena haematopus
Mycena hiemalis
Mycena inclinata
Mycena maculata
Mycena polygramma
Mycena pseudocorticola
Mycena sepia
Mycena speirea
Mycena stipata
Mycena tenerrima
Myxarium nucleatum
Oudemansiella mucida
Panellus mitis
Panellus stipticus
Panus conchatus
Parasola conopilea
Phaeolus schweinitzii
Phanerochaete velutina
Phellinus pomaceus
Phlebia tremellosa
Phleogena faginea
Pholiota adiposa
Pholiota alnicola var. alnicola
Pholiota aurivella
Pholiota gummosa
Pholiota highlandensis
Pholiota jahnii
Pholiota squarrosa
Pholiota tuberculosa
Physisporinus sanguinolentus
Picipes melanopus
Piptoporus betulinus
Pleurotus cornucopiae
Pleurotus dryinus
Pleurotus ostreatus
Pleurotus pulmonarius
Pluteus cervinus
Pluteus chrysophaeus
Pluteus cinereofuscus
Pluteus griseoluridus

Pluteus hispidulus
Pluteus leoninus
Pluteus luctuosus
Pluteus nanus
Pluteus petasatus
Pluteus phlebophorus
Pluteus plautus
Pluteus podospileus
Pluteus romellii
Pluteus salicinus
Pluteus thomsonii
Pluteus umbrosus
Polyporus badius
Polyporus ciliatus
Polyporus durus
Polyporus leptocephalus
Polyporus squamosus
Polyporus tuberaster
Postia caesia
Postia floriformis
Postia ptychogaster
Postia ptychogaster
Postia stiptica
Postia subcaesia
Postia tephroleuca
Postia wakefieldiae
Psathyrella cortinarioides
Psathyrella cotonea
Psathyrella laevissima
Psathyrella multipedata
Psathyrella piluliformis
Psathyrella pygmaea
Pseudoinonotus dryadeus
Ramaria stricta
Resupinatus applicatus
Resupinatus trichotis
Sarcomyxa serotina
Simocybe centunculus
Sparassis crispa
Sparassis spathulata
Tapinella panuoides
Trametes gibbosa
Trametes hirsuta
Trametes ochracea
Trametes pubescens
Trametes versicolor
Tremella encephala
Tremella foliacea
Tremella globispora
Tremella mesenterica
Trichaptum abietinum
Tricholomopsis rutilans
Tyromyces chioneus
Volvariella bombycina
Xerula radicata

Appendix D.

A list of the Resupinate saprotroph fungi of Savernake Forest.

Amylostereum laevigatum
Botryobasidium aureum
Botryobasidium laeve
Byssomerulius corium
Ceriporia excelsa
Coniophora puteana
Crustomyces subabruptus
Cylindrobasidium laeve
Datronia mollis
Eichleriella deglubens
Fibriciellum silvae-ryae
Fomitiporia punctata
Gloeocystidiellum porosum
Gyrophanopsis polonensis
Hydnoporia tabacina
Hymenochaete corrugata
Hymenochaete rubiginosa
Hyphoderma setigerum
Hyphodontia alutaria
Hyphodontia barba-jovis
Hyphodontia crustosa
Hyphodontia pallidula
Hyphodontia subalutacea
Hypochnicium cremicolor
Hypochnicium geogenium
Junghuhnia nitida
Leptosporomyces fuscostratus
Mensularia nodulosa
Mycoacia aurea
Mycoacia uda
Peniophora cinerea
Peniophora limitata
Peniophora lycii
Peniophora quercina
Peniophorella praetermissa
Peniophorella pubera
Peniophorella pubera
Phlebia radiata
Phlebia rufa
Phlebiella sulphurea
Phlebiopsis gigantea
Physisporinus vitreus
Radulomyces confluens
Radulomyces molaris
Resinicium bicolor
Schizopora paradoxa
Scopuloides hydnoides
Sistotrema brinkmannii
Skeletocutis amorpha
Skeletocutis carneogrisea
Skeletocutis nivea
Stereum gausapatum
Stereum hirsutum
Stereum rameale
Stereum rugosum
Stereum sanguinolentum
Stereum subtomentosum
Stypella subhyalina
Subulicystidium longisporum
Vuilleminia comedens
Vuilleminia coryli
Xylodon radula
Xylodon sambuci

Appendix E.

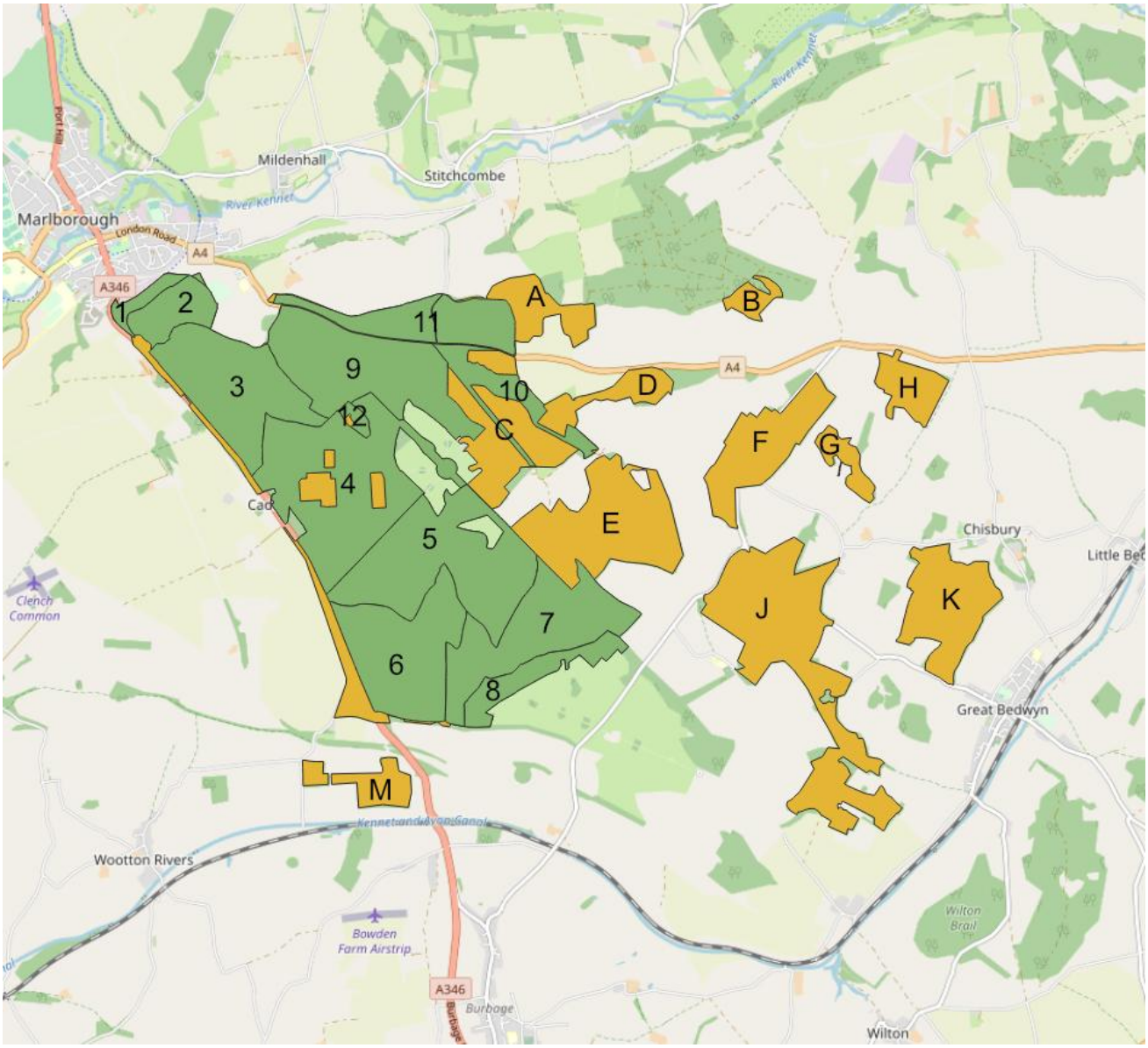
A list of the Ascomycete saprotroph fungi of Savernake Forest.

Annulohypoxylon multiforme
Ascocoryne cylichnium
Ascocoryne sarcoides
Baggea pachyascus
Bertia moriformis
Bertia moriformis var. moriformis
Biscogniauxia nummularia
Bulgaria inquinans
Calycina citrina
Calycina claroflava
Chaetosphaerella phaeostroma
Chaetosphaeria callimorpha
Chlorociboria aeruginascens
Colpoma quercinum
Daldinia concentrica
Dasyscyphella nivea
Dialonectria episphaeria
Dialonectria episphaeria
Diaporthe crataegi
Diatrype bullata
Diatrype disciformis
Diatrype stigma
Diatrypella favacea
Diatrypella quercina
Ditiola peziziformis
Euepixylon udum
Eutypa flavovirens
Eutypa spinosa
Eutypella prunastri
Gloniopsis praelonga
Glyphium elatum
Hyaloscypha hyalina
Hymenoscyphus calyculus
Hypocrea aureoviridis
Hypocrea gelatinosa
Hypoxylon fragiforme
Hypoxylon fuscum
Hypoxylon petriniae
Hypoxylon rubiginosum
Jackrogersella multiformis
Kretzschmaria deusta
Lachnellula occidentalis
Lopadostoma turgidum
Melanamphora spinifera
Melanomma pulvis-pyrius
Mollisia cinerea
Mollisia ligni
Nectria cinnabarina
Nemania serpens var. serpens
Neobulgaria pura
Neobulgaria pura var. pura
Neonectria coccinea
Orbilia coccinella
Orbilia sarraziniana
Orbilia xanthostigma
Peziza micropus
Polydesmia pruinosa
Quaternaria quaternata
Rosellinia aquila
Rutstroemia firma
Ruzenia spermoides
Sarcoscypha austriaca
Tapesia fusca
Trichoderma viride
Xylaria hypoxylon
Xylaria longipes
Xylaria polymorpha

Appendix F.

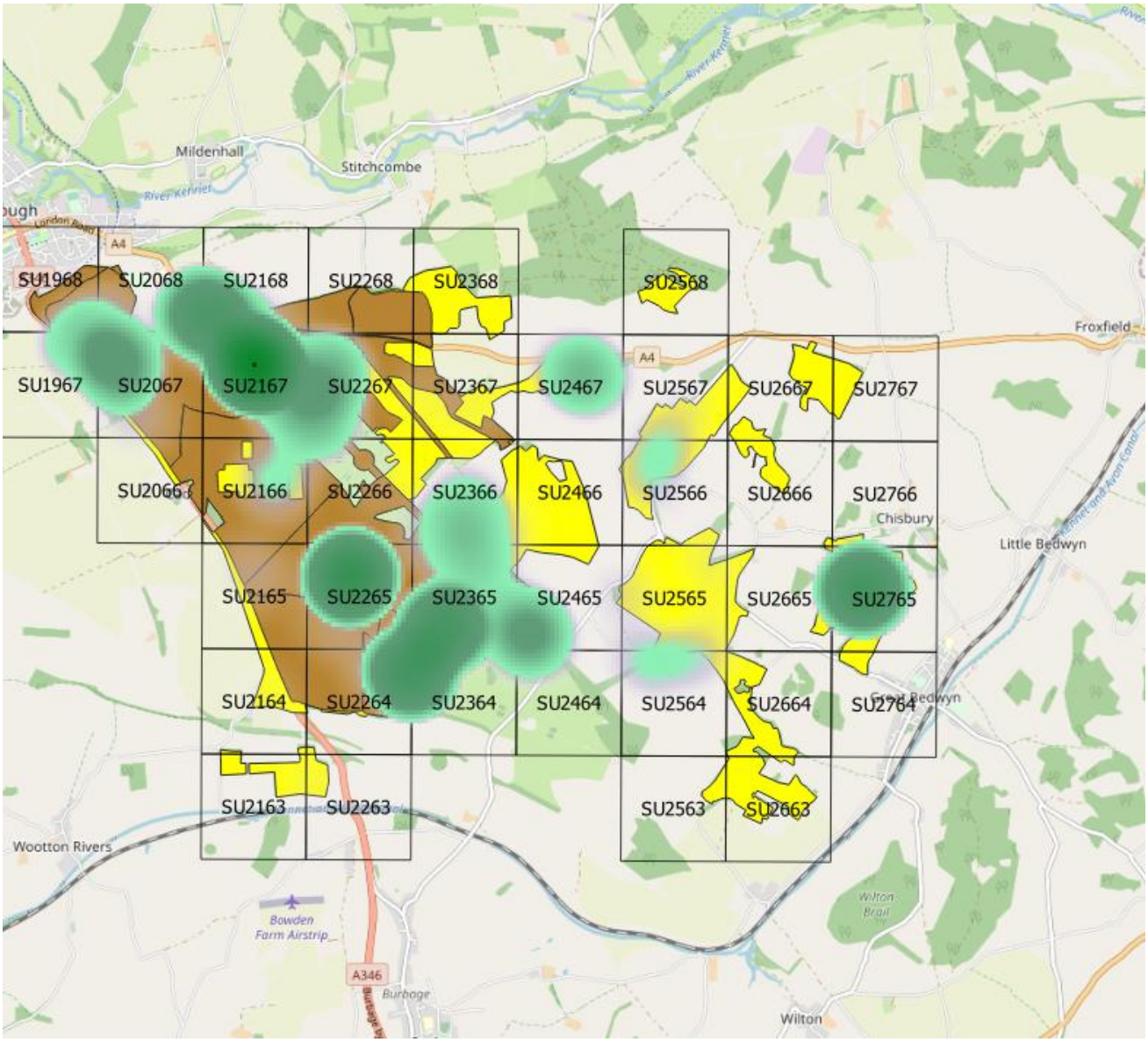
A Map of compartments in Savernake Forest.

Green compartments follow the shape and numbering of the SSSI units.



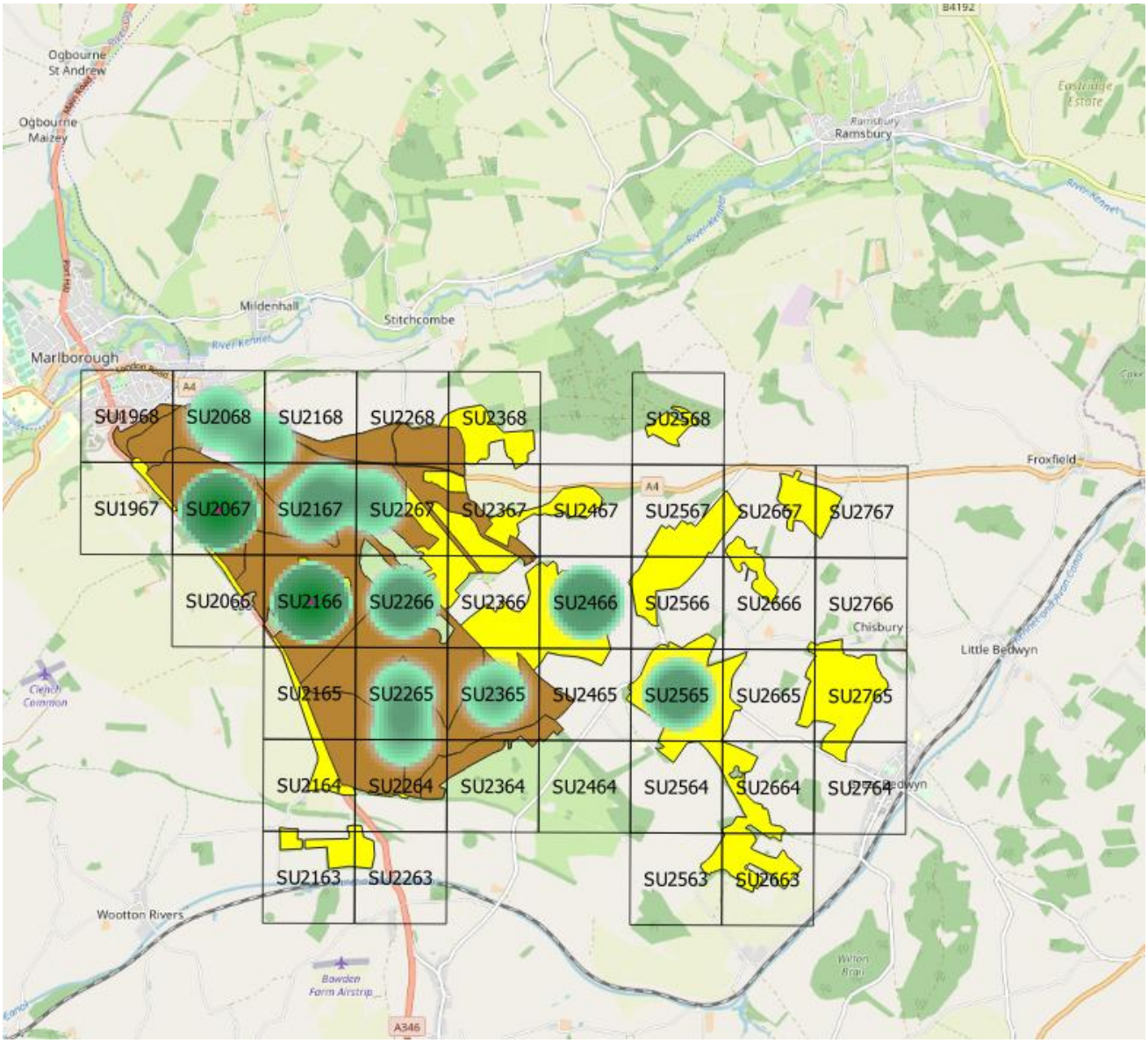
Appendix G.

A heatmap generated by all fungus records with a precise grid reference .



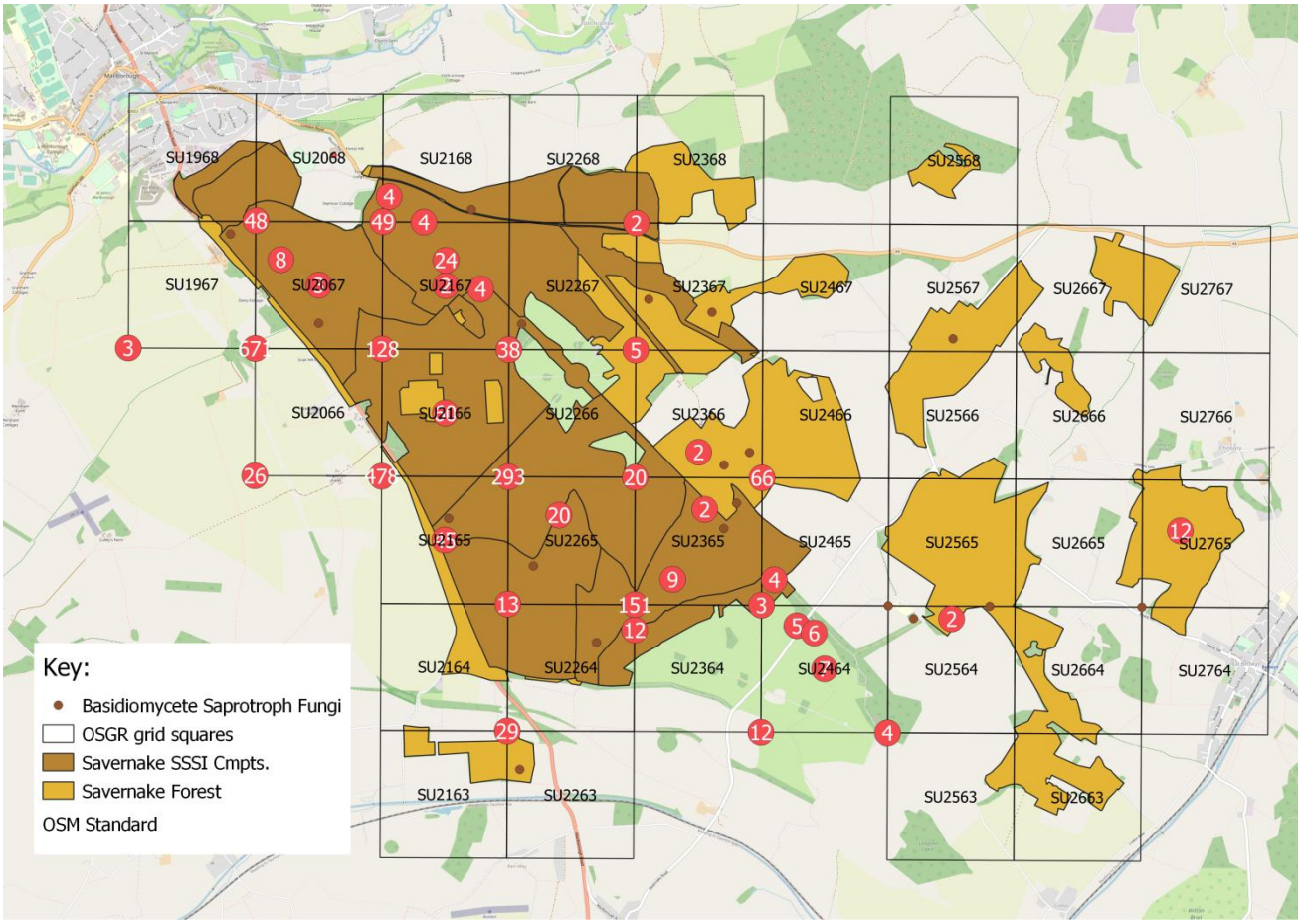
Appendix H.

A heatmap generated by all priority fungus species records with a precise grid reference.



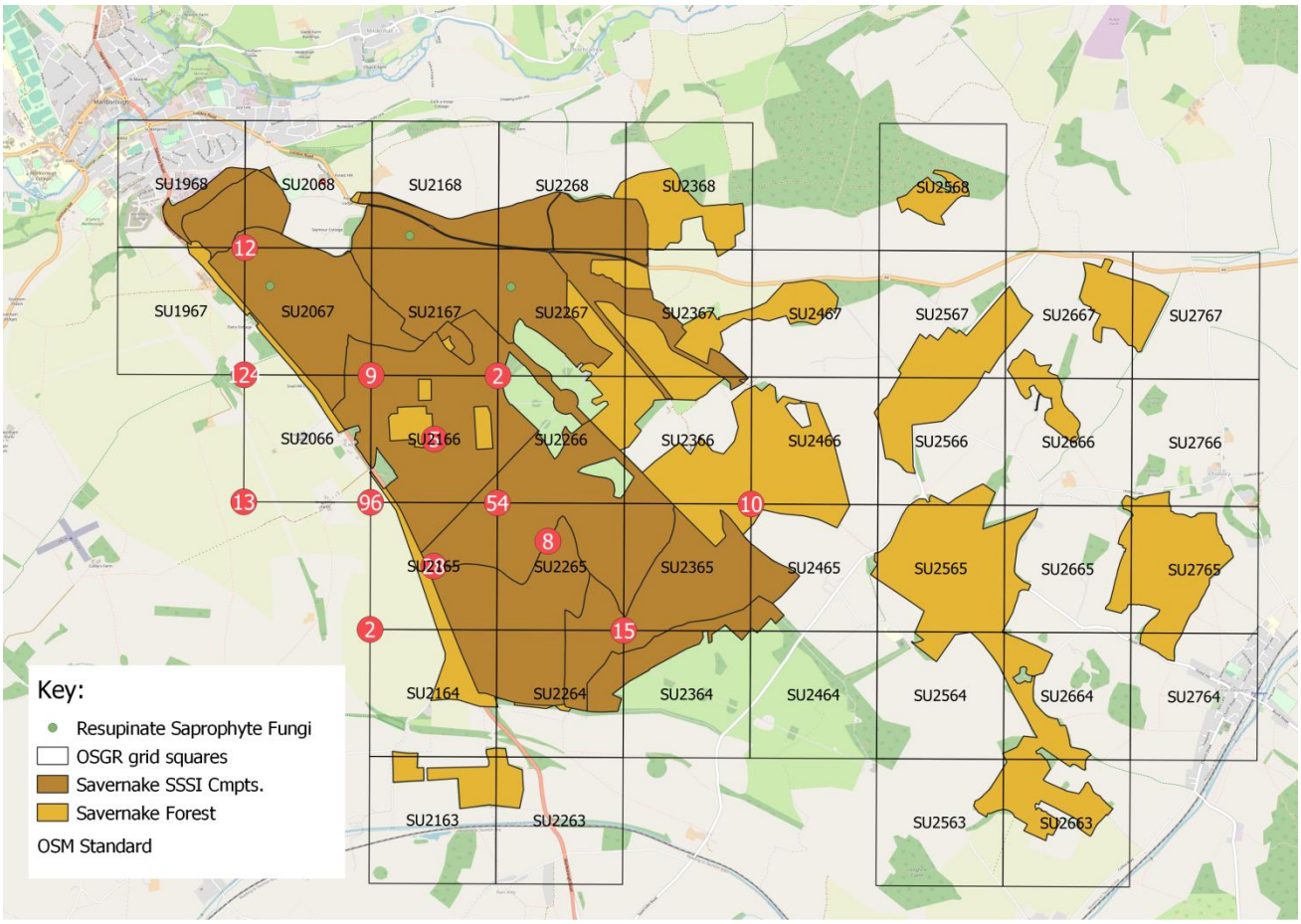
Appendix Ia.

A map indicating all wood-rotting basidiomycete fungus records with a precise grid reference.



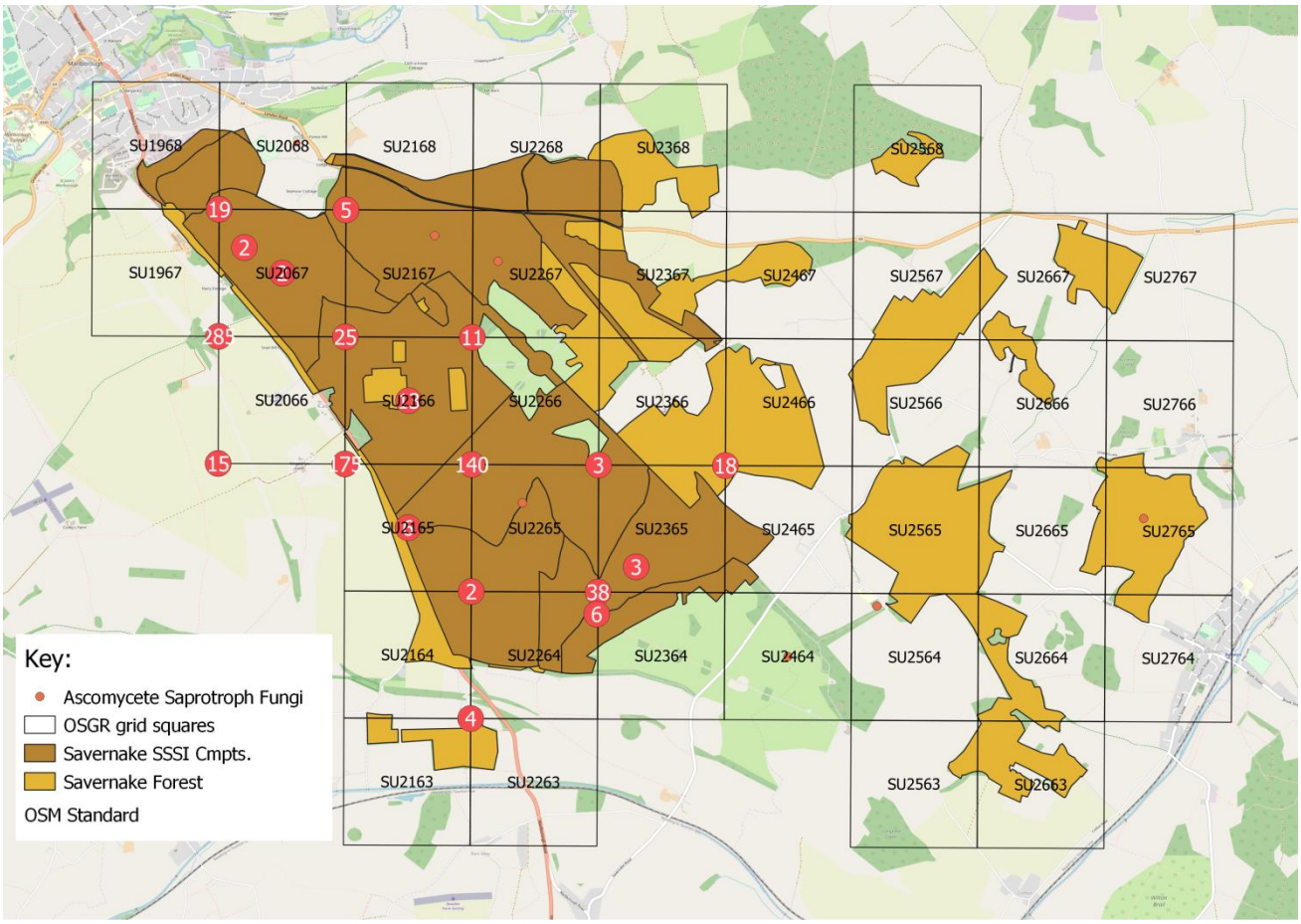
Appendix Ib.

A map indicating all wood-rotting resupinate fungus records with a precise grid reference.



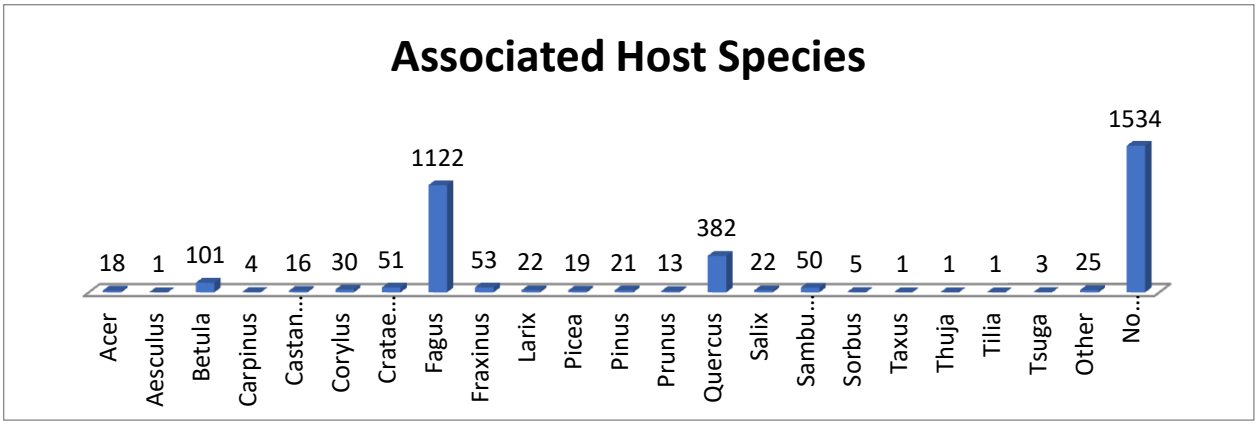
Appendix Ic.

A map indicating all wood-rotting ascomycete fungus records with a precise grid reference.



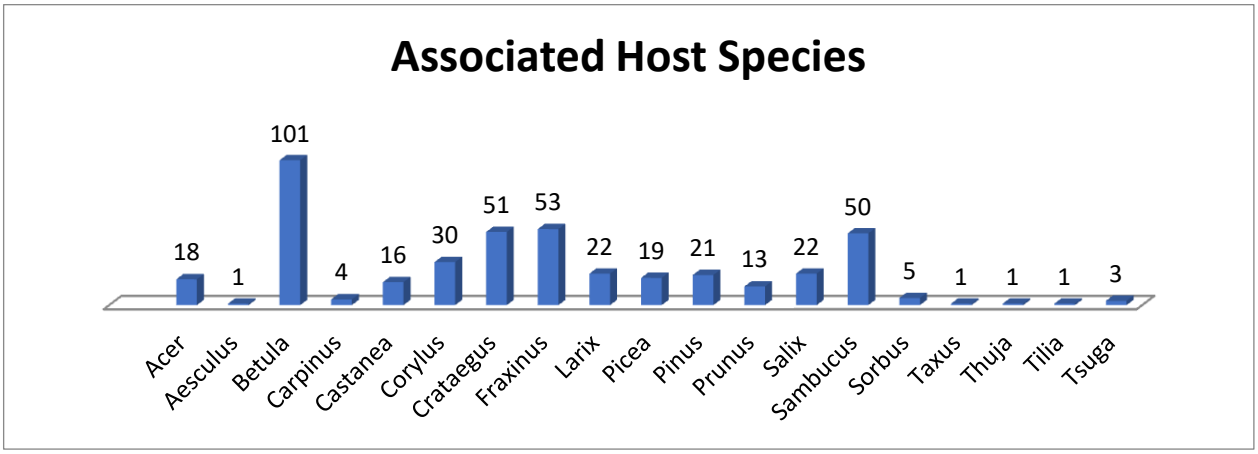
Appendix Ja.

A chart plotting the number of records of target fungi by host association.



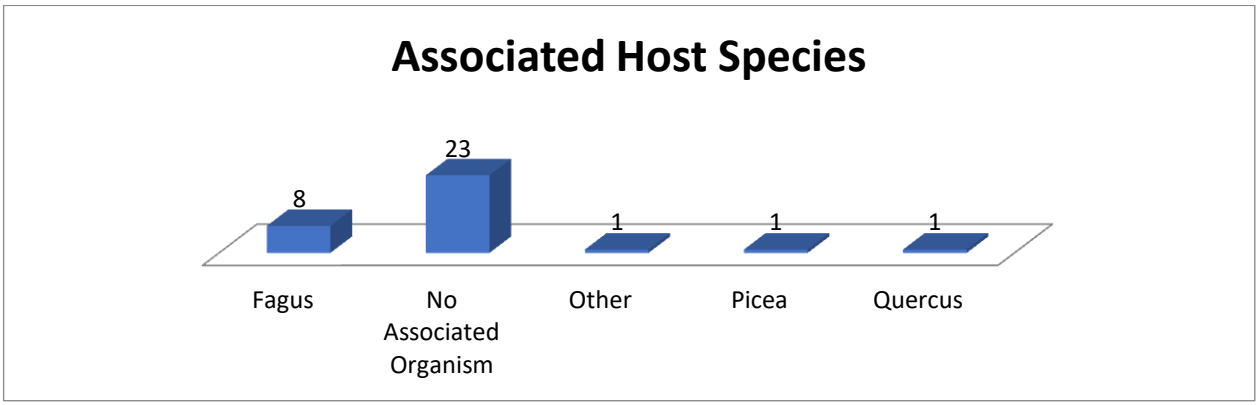
Appendix Jb.

A chart plotting the number of records of target fungi by host association. (Excluding hosts with more than 200 associated records).



Appendix Jc.

A chart plotting the number of records of priority fungi by host association.



Appendix K.

Fungal assemblages that were considered important, but did not yet have scoring systems for assessment.

Atlantic woodland fungi	Includes fungi of Quercus, Corylus and other woody plants in coastal, predominantly western, habitats under strong Atlantic influence
Inland dune/sandy soil fungi	Steppe-like/Breckland grassland and sandy soil assemblage, particularly gasteromycetes
Upland birch woodland fungi	Mycorrhizal and saprotrophic associates of Betula in upland Britain
Alder woodland fungi	Mycorrhizal and saprotrophic associates of Alnus in wet woodland
Willow woodland fungi	Mycorrhizal and saprotrophic associates of Salix in wet woodland
Calcareous beech woodland fungi	Diversity of ectomycorrhizal fungi: Cortinarius (subgenus Phlegmacium), Inocybe, Tricholoma and other relevant genera, including hypogeous fungi
Calcareous woodland saprotrophs	Diversity of saprotrophs: Lepiota spp. and allies
Base-rich fen fungi	Fungi associated with vascular plants and bryophytes in fen
Reedbed fungi	Fungi in Phragmites beds
Montane heath fungi	Mycorrhizal species on Arctostaphylos spp., Salix spp. & Betula nana
Dryas fungus communities	Mycorrhizal species on Dryas octopetala
Boletes of wood pasture and parkland	Thermophilous boletes: species of Boletaceae in warm, open sites with short ground cover; these tend to occur in open woodland or parkland

Appendix L.

SSSI guidelines for tooth fungi associated with oak, beech or sweet chestnut

		Present	
Hydnellum concrescens	agg		
Hydnellum scrobiculatum			
Hydnellum spongiosipes			
Hydnellum ioeides			
Phellodon confluens			
Phellodon melaleucus	agg		
Phellodon niger	agg		The British species with Fagaceae is probably not P. niger in the original sense
Sarcodon scabrosus	agg		The British species with Fagaceae probably do not include S. scabrosus in the original sense

Appendix M.

SSSI guidelines for Beech deadwood fungi

Beech deadwood	Type	Present
Camarops polysperma	asco	
Eutypa spinosa	Asco	x
Flammulaster limulatus sens. lat.	Gilled	
Flammulaster muricatus	Gilled	
Hohenbuehelia auriscalpium	Gilled	
Hohenbuehelia mastrucata	Gilled	
Lentinellus ursinus	Gilled	
Lentinellus vulpinus	Gilled	
Ossicaulis lignatilis sens. auct. Brit.	Gilled	
Phyllotopsis nidulans	Gilled	
Volvariella bombycina	Gilled	x
Aurantiporus alborubescens	Poroid	
Aurantiporus fissilis	Poroid	
Ceriporiopsis gilvescens	Poroid	x
Coriolopsis gallica	Poroid	
Fomitiporella (Phellinus) cavicola	Poroid	
Ganoderma pfeifferi	Poroid	x
Gelatoporia (Ceriporiopsis, Gloeoporus) pannocincta	Poroid	
Inonotus cuticularis	Poroid	
Mensularia (Inonotus) nodulosa	Poroid	x
Oxyporus latemarginatus	Poroid	
Spongipellis delectans	Poroid	
Spongipellis pachyodon	Poroid	
Gloeohypochnicium (Hypochnicium) analogum	Other	
Hericium cirrhatum	Other	x
Hericium coralloides	Other	
Hericium erinaceus	Other	x
Mycoacia nothofagi	Other	
Phleogena faginea	Other	x
Scytinostroma portentosum sens. auct. Brit.	Other	

Appendix N.

SSSI guidelines for Oak deadwood fungi

Oak Deadwood		Present
Buglossoporus (Piptoporus) quercinus		
Daedalea quercina		x
Fistulina hepatica		x
Fomitiporia (Phellinus) robusta		
Fuscoporia (Phellinus) torulosa		
Fuscoporia (Phellinus) wahlbergii		
Ganoderma lucidum		
Ganoderma resinaceum		x
Grifola frondosa		x
Gymnopus (Collybia) fusipes		x
Hymenochaete rubiginosa		x
Laetiporus sulphureus		x
Mycena inclinata		x
Podoscypha multizonata		
Pseudoinonotus (Inonotus) dryadeus		x
Riopa (Ceriporia) metamorphosa		

Appendix O.

SSSI guidelines for Grassland fungi

CHEGD - Hygrocybe group	High Diversity Indicator	Present
Hygrocybe acutoconica var. acutoconica (excl. H. aurantiolutescens, a sand dune sp.)		
Hygrocybe acutoconica var. konradii (incl. f. subglobispora)		
Hygrocybe aurantia		
Hygrocybe aurantiosplendens	Y	
Hygrocybe calciphila		
Hygrocybe calyptriformis	Y	x
Hygrocybe canescens	Y	
Hygrocybe cantharellus		x
Hygrocybe ceracea		
Hygrocybe chlorophana		x
Hygrocybe citrinovirens	Y	
Hygrocybe coccinea (excl. H. marchii s. Boertmann, 1995)		x
Hygrocybe colemanniana	Y	
Hygrocybe conica var. Conica		x
Hygrocybe constrictospora		
Hygrocybe flavipes (excl. H. radiata)	Y	
Hygrocybe fornicata var. fornicata		
Hygrocybe fornicata var. lepidopus		
Hygrocybe glutinipes		x
Hygrocybe helobia		
Hygrocybe ingrata	Y	
Hygrocybe insipida		
Hygrocybe intermedia	Y	
Hygrocybe irrigata		
Hygrocybe lacmus	Y	
Hygrocybe laeta		
Hygrocybe marchii (s. Boertmann, 1995)		
Hygrocybe miniata		
Hygrocybe mucronella		x
Hygrocybe nitrata	Y	
Hygrocybe ovina	Y	
Hygrocybe phaeococcinea		
Hygrocybe pratensis var. pratensis		x
Hygrocybe pratensis var. pallida		
Hygrocybe psittacina var. psittacina		x
Hygrocybe psittacina var. psittacina unnamed form		
Hygrocybe psittacina var. perplexa		
Hygrocybe punicea	Y	x

Hygrocybe quieta		
Hygrocybe radiata (s. Boertmann, 1995)		
Hygrocybe reidii		
Hygrocybe russocoriacea		
Hygrocybe spadicea	Y	
Hygrocybe splendidissima	Y	
Hygrocybe subpapillata	Y	
Hygrocybe substrangulata		
Hygrocybe turunda	Y	
Hygrocybe virginea		x
Hygrocybe vitellina		

CHEGD - Entoloma group	**Type**
Entoloma clypeatum	Grassland
Entoloma conferendum var. conferendum	Grassland
Entoloma exile	Grassland
Entoloma juncinum	Grassland
Entoloma longistriatum var. sarcitulum	Grassland
Entoloma papillatum	Grassland
Entoloma plebeioides	Grassland
Entoloma porphyrophaeum	Grassland
Entoloma sericellum	Grassland
Entoloma sericeum var. sericeum	Grassland

CHEGD - Clavaria group
Clavaria acuta
Clavaria fragilis
Clavulinopsis corniculata
Clavulinopsis fusiformis
Clavulinopsis helvola
Ramariopsis subtilis
Clavaria tenuipes

CHEGD - Dermoloma group

CHEGD - Geoglossum group
Geoglossum cookeanum

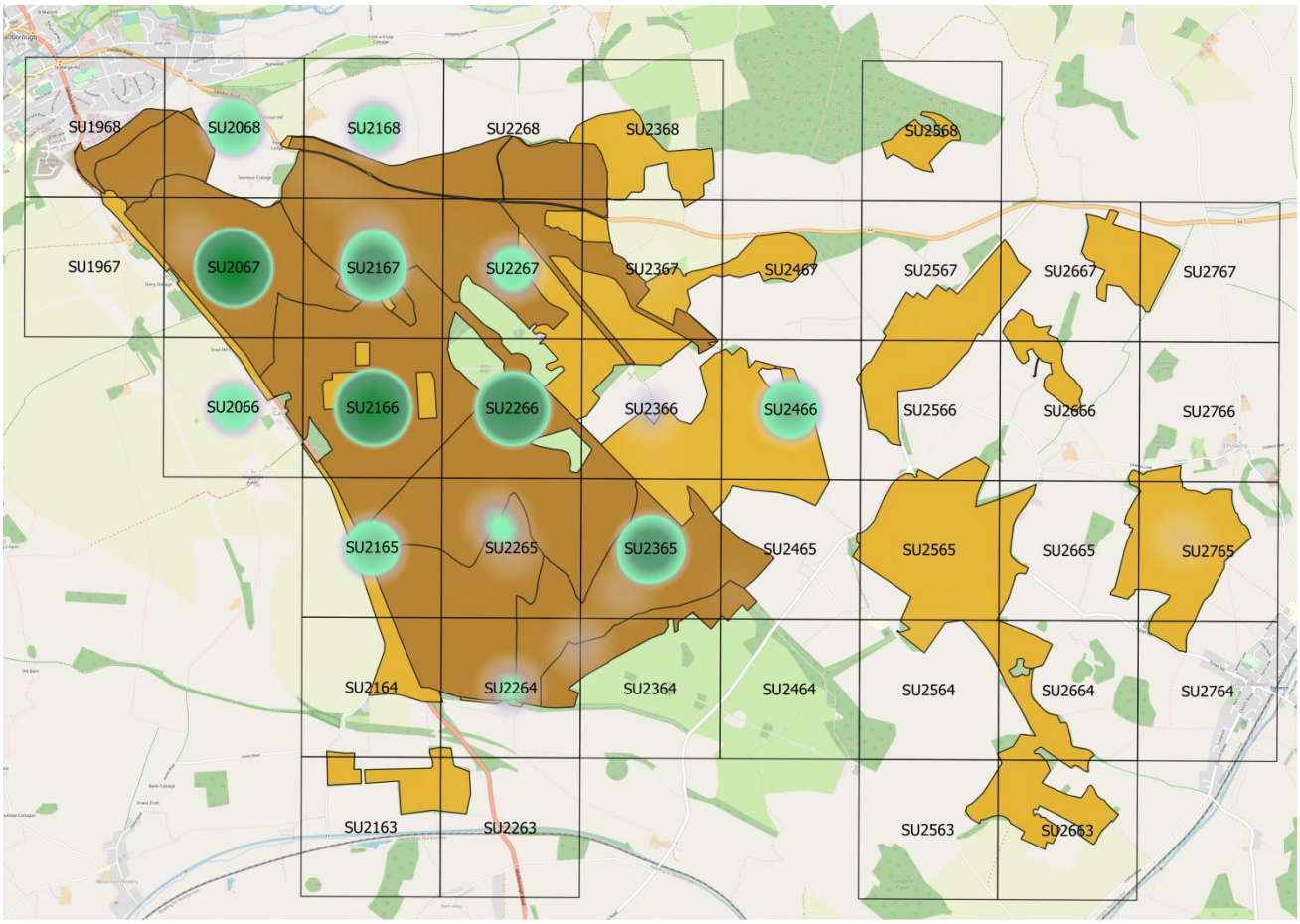
Appendix P.

Draft guidelines for Thermophilous Boletes

Thermophilous boletes	Schedule 8, BAP or Section 41 (NERC Act) species	Present (last 50 years)	Present since1995
Aureoboletus gentilis			
Boletus queletii		Y	Y
Boletus aereus			
Boletus radicans (albidus)			
Boletus appendiculatus			
Boletus regius	x		
Boletus fechtneri			
Boletus reticulatus (B. aestivalis)		Y	
Boletus fragrans			
Boletus rhodopurpureus/torosus	x		
Boletus immutatus	x		
Boletus satanas			
Boletus impolitus			
Boletus xanthocyaneus			
Boletus legaliae (B. satanoides, B. splendidus)			
Gyroporus castaneus		Y	Y
Boletus luridus		Y	Y
Gyroporus cyanescens			
Boletus luridiformis (B. erythropus)		Y	Y
Leccinum pseudoscabrum			
Boletus luridiformis var. discolor			
Leccinum crocipodium			
Boletus pseudoregius	x		
Rubinoboletus rubinus			
Boletus pseudosulphureus (B. junquilleus)			

Appendix Q.

A heatmap and record count of wood rotting fungi by km² grid squares.



OS Grid Ref.	SU1967	SU1968	SU2066	SU2067	SU2068	SU2165	SU2166	SU2167	SU2168	SU2263	SU2264	SU2265	SU2266
No. of records	5	1	54	1097	80	82	843	193	64	1	36	45	487
OS Grid Ref.	SU2267	SU2364	SU2365	SU2366	SU2367	SU2368	SU2465	SU2466	SU2564	SU2565	SU2567	SU2765	
No. of records	54	16	220	27	7	2	7	94	8	2	1	14	

Appendix R.

A table with all of the priority fungus species alongside a note of which red lists etc. they appear on. Wood-rotting species are highlighted in green)

Category	CurrentName	IUCN	UK BAP	S41	Schedule 8	Red Data List 2006	Red Data List 2016	Red Data list Boletaceae
Basisio. Sapro.	**Hericium erinaceus**		Yes	European concern	Yes	Annex		
Basisio. Sapro.	**Buchwaldoboletus lignicola**	Vulnerable						Vulnerable
Resupinate Sapro.	**Mensularia nodulosa**					Near Threatened		
Asco. Other	**Spathularia flavida**					Near Threatened		
Basidio. Other	**NeoBoletus luridiformis**							Not evaluated
Basidio. Other	**Boletus luridus**							Not evaluated
Basidio. Other	**Entoloma porphyrophaeum**	Vulnerable						
Basidio. Other	**Porpolomopsis calyptriformis**	Vulnerable				Annex		
Basidio. Other	**Cortinarius camphoratus**					Near Threatened		
Basidio. Other	**Mycena latifolia**					Near Threatened		
Basidio. Other	**Volvariella reidii**					Vulnerable		
Basidio. Other	**Russula lilacea**					Near Threatened		
Basidio. Other	**Hygrocybe punicea**	Vulnerable						
Basidio. Other	**Ramaria botrytis**					Near Threatened		
Basidio. Other	**Entoloma dichroum**					Vulnerable		
Basidio. Other	**Tricholoma focale**					Near Threatened		