Wytham Woods

Management Plan 2021-2025

Wytham WOODS

the natural place for science

Compartment Map for Wytham Woods (basemap @ Ordnance Survey)

Preface

This document has been prepared for the Wytham Management Committee and consists of:

- A statement of where and what Wytham Woods are;
- An overall 'vision' for what the University wants out of the Woods;
- A short account of the potential management for different areas or types of habitats in the Woods;
- Short accounts of different issues and opportunities that could usefully be addressed.

The details of the work to be carried out will be covered by the next forestry grant scheme, stewardship agreement etc.

We cannot allow for unforeseen events or opportunities: while some may be easily fitted into the existing framework; others might require a complete plan review. There is an element of 'future-proofing', but the framework should be revisited on a five-yearly cycle to check it is still appropriate or after any major events/opportunities become apparent

Any queries about this plan or Wytham Woods more generally should be addressed in the first instance to the Conservator (nigel.fisher@admin.ox.ac.uk)

Wytham Management Committee.

February 2015

Preface to the 2020 revision

We consider that the overall philosophy and approach set out in 2015 remain sound. However, some changes are considered desirable in the light of subsequent management and research, in particular the arrival and spread of ash dieback through the Woods. A summary of activity in the Woods over the last five years is provided before the revised plan proper.

November 2020

Contents

A review of activity in Wytham Woods, 2015-2020

Management

Despite some challenging weather conditions (from prolonged heatwaves to sodden soils) the main management activities were carried out.

- The major programme of thinning through the 20th century plantations was completed with the thinning of the beech and ash in compartments 14, 15, 17 and 34.
- Old oaks south-east of the main road to the Chalet were thinned around ('haloing') to reduce their shading by younger growth.
- Deer control was maintained through shooting by Woods staff and through organised closed weekend shoots. This effort will need to be continued (see Annex 1).
- The ride widening programme was maintained.
- 10 young oaks were planted in tubes in open spaces by rides.
- Getting the grassland areas grazed at the right intensities and seasons at times proved difficult but is now under control.
- New ponds were created for Great Crested Newts using funds from the Freshwater Habitats Trust Biodiversity Off-setting Scheme in the recent woodland below the coach drive in Marley Wood and along the stream below the Lower Pond on Radbrook Common. These remained dry for a long while but filled after the rains in autumn 2019.
- Conifers which were significantly affecting the water supply to Marley Fen were removed from plantations in Pasticks; encroaching broadleaved trees at the upper end of the Fen were cut back and scrub coppiced on the southern edge. The aim is to raise and maintain spring and summer water levels encouraging continued peat formation and preservation despite the effects of climate change.
- A major refurbishment of the Chalet took place to provide proper meeting rooms, laboratory space and potential overnight accommodation for researchers.
- The canopy walkway and flux tower were refurbished and their safety certificates renewed.

The management over the next five years will focus on:

- Necessary safety felling following on from Ash Dieback in particular;
- A possible second round of 'haloing' of old oaks;
- Possible thinning of oak and beech plantations that lack ash – if ash is present then some self-thinning may occur anyway through dieback;
- Maintaining wide ride management and widening rides in Pasticks;
- Maintaining grassland grazing;
- Feasibility of restoring second area of Marley Fen;
- Replacing the old deer fence around the woodland perimeter.

Profile of the Woods 2015-2020

The profile of the Woods within the University and with the public has been substantially increased.

- The Wytham Website was relaunched in 2017. Pageviews have gone from 28,000 in 2017 to 110,000 in 2019.
- Wytham has 2,504 followers on Twitter, 1688 Instagram, 6779 on Facebook.
- There were more public walks/talks, in particular, in 2018 to celebrate 75 yrs of research at Wytham.

- Various events have taken place in partnership with the Museum of Natural History, including new exhibitions in the Wytham Room (roughly every 6-9 months).
- The contribution of the ffennells was acknowledge in public events unveiling plaques at Hill End Camp and in the Sawmill Carpark.
- The suite of short videos in the Laboratory with Leaves series has increased to 16 with more on the way.
- The Woods have featured several times on Countryfile and were the focus of an hour-long documentary on a year in the life of an oak tree, fronted by George McGavin.
- The number of permits issued has gone up to 14,000 and there is increased visitor use, particularly at weekends. This does not however appear to be led to any serious conflict with research activity in the Woods.
- The artists-in-residence ran various exhibitions in the City featuring Wytham-related work and also during Oxford Arts Weeks at the Sawmill; the kiln-firings there attract attention.
- The annual 'Woodland Words' residency was introduced in 2019, with the first Writer in Residence writing commissioned poems and running public workshops.
- The Woods are regularly used by Forest Schools as well as the educational activity centred on Hill End Camp and Bean Wood.

For the next 5-year period activities will include

- Continuation of public engagement via walks/talks;
- The centennial of the ffennell purchase of the Wytham Estate is in 2020 and various events, organised through Hill End Camp;
- Preliminary discussions underway about a second Wytham book to be published c.2025

Research

The major programmes of long-term research and monitoring have continued to produce a steady stream of papers and theses. A number of these have involved an element of citizen science. Highlights are set out below.

- Research on bird populations, particularly tits, continues in Wytham, with three major strands relating to (i) social behaviour and information transmission, (ii) population and evolutionary biology; (iii) ecology of seasonal timing, which increasingly focusses on birds as part of a multi-level trophic system
- Work on the European badger is being used to model how mammal populations respond to selection pressures, and how these in turn govern their society. The work has focused recently on the effects of weather (changing mean and greater variability) and oxidative stress. It has also involved looking at senescence, both endocrinological and genetic (telomere shortening).
- Since 2014, small mammals have been live-trapped on fortnightly basis. Initially this research focused on understanding population dynamics and ecology. Current research involves studying gut microbiome ecology, and the development of novel technology to trap and track rodent movements.
- The Smithsonian plot was established in 2008 and has had two recensuses, the last being in 2016. These recensuses would be expected to be continued roughly every five years.
- A substantial research programme on ecosystem processes at Wytham has been developed. These include measurements of carbon, water and energy fluxes from the flux tower, microclimate and light environment, carbon and nutrient flows within the system, soil biology and processes, ecophysiology of leaves and wood from the canopy walkway, extensive three-dimensional laser scanning of woodland structure, and trace gases including isoprene and methane. Beyond the tree-focussed work, this work has expanded to research into multitrophic energy flow.
- Earthwatch have completed 10 years of carbon stocks and flux measurements across Wytham Woods, with the assistance of over 800 volunteer citizen scientists. We are now working on the data to understand what can be learned from this wealth of information.

- CEH – ECN monitoring continued, albeit at a reduced level (see Annex 10).
- A new initiative has been the creation of a database of past research materials that will enable future researchers to access the original observations from past studies. This will be reporting in 2020.
- The Gibson-Brown grazing experiment on Upper Seeds was reviewed and will go forward with an amended set of grazing and management treatments that are affordable and meet changing logistical constraints.
- A new long-term grassland experiment was established nearby under the RAINDROP programme to look at the effects of droughting on grassland communities in the context of climate change.
- An experiment was established in Common Piece/Thornycroft to compare litter breakdown and soil processes in plots where litter amounts were reduced by raking or increased through litter additions. The recording was ended after 3 years, but the treatments are being maintained.
- Various modelling studies looked at the potential effect of Ash Dieback on the composition of the Woods and the surrounding countryside. With the arrival of the disease work was undertaken to improve the baseline information on the state of the Woods at the start of the outbreak. Major funding has now been secured to track the changes across trophic levels for the next four years.
- Funding has been secured to collect species from Wytham for genome analysis as part of a large project funded by Wellcome Trust which aims to obtain complete genome sequences for a major part of the UK flora and fauna.
- Development and implementation of a woodland wireless mesh system to control or extract low rate real time data such as small mammal activity and spatial movement, weather station, skyglow and water levels thus allowing the remote monitoring of experiments, improved data recovery and aid in equipment maintenance.
- Investigation of the widespread sudden death of oak trees of all ages using aerial infrared photography and cores taken from dead and dying trees to try to identify possible long-term causes such as prolonged spring or summer periods of drought.
- The Dawkins plots were re-recorded in 2018 and a sub-set will be recorded annually over the next four years to look at the spread of Ash Dieback.

For the next 5-yr period a particular focus in many of the long-term studies will be on the impacts of Ash Dieback.

Issues, opportunities and challenges for the next plan period (2021-2025).

There will continue to be changes in the Woods from stand growth, climate change, nitrogen deposition etc. In addition, the following seem likely to remain/become more important.

Impacts from deer (see Annex 9), because the burst of regeneration from when numbers were first strongly reduced seems to have stalled and, being largely ash, is now dying off anyway.

- Culling efforts must be maintained.

Ash dieback, confirmed in the Woods in 2017, but probably present earlier, has spread rapidly through the site. We expect to see serious decline in canopy cover of ash and tree deaths over the next few years.

- This could lead to major changes in the composition, structure and functioning of the woodland system in parts of the Woods.
- Increased death of branches and whole trees will also have health and safety implications with respect to both public and researcher use of the Woods.

The last plan period saw increasing use of Lidar and remote sensing to investigate aspects of the woodland system. Drones and other technological innovations are likely to open up other avenues of research that may have management implications.

- Should there be a focus on using new techniques across research interests?

Land-use patterns are likely to start to change as a consequence of the review of agri-environment schemes following Brexit and concerns about the sustainability of current farming practices. There is a need for research that looks at the consequences of such changes.

- Future work that looks not just at the Woods but also potential changes across the wider Estate could be a priority.

The funding environment is likely to alter – involvement in European programmes will become more complicated; UK government priorities are likely to change. There has already been increasing difficulty in maintaining some long-term recording programmes in the Woods. The difficulties with the Gibson-Brown experiment provide one example; the reduced input from CEH to the Environmental Change Network recording is set out in Annex 10. Reliance of other schemes on particular individuals, such as Lionel Cole's winter moth surveys, leaves them vulnerable when those individual move on or retire.

- Alternative/back-up ways of resourcing key data collection and maintenance management need to be considered.

There is now a requirement that all data collected will be deposited in the Wytham Database.

- Resources will be needed to maintain and develop the Database if it is not to become just a one-off collation.

The public and teaching use of the Woods is likely to increase. The new 4-year Biology course will generate more demand on the Woods both for class practicals and for project work. Raising the public profile of the Woods leads to more visitors.

- Some zoning of the Woods for different uses might be needed if they start to impact on the vegetation structure and composition.

1. Introduction to the revised plan 2020-2025

Wytham Woods consist of 400 ha to the north-west of Oxford, located in a bend of the River Thames (National Grid Reference SP462083).



image @ Google Earth

The Woods are renowned for the long-term research studies that have been carried out there; they are important in nature conservation terms as a Site of Special Scientific Interest and are popular as somewhere to walk (under permit) by the people of Oxford. They are also a prominent feature in the landscape particularly from the major roads to the east (A34) and north (A40).

1.1 The ffennell bequest

Since 1943 the Woods have been owned by Oxford University, who were given them by Raymond ffennell with the request that:

"Every care should be taken to preserve the woods in their present state of natural beauty.... the University will take all reasonable steps to preserve and maintain the woodlands and will use them for the instruction of suitable students and will provide facilities for research..... it is in the hope and expectation of the grantor that the character of the lands included in this agreement and the buildings thereon will remain as far as possible as at present.....".

However, the state at that time was a consequence of centuries, if not millennia, of interactions between human activity and natural processes. The Woods have evolved over the last 70 years and will continue to do so in the 21st century. Change rather than stasis was and will continue to be the normal state.

1.2 Guiding future management

The aim of this document is to provide an agreed framework for guiding future management. It should give:

- those responsible for managing the Woods the long-term context within which year-to-year work sits;
- researchers an indication of what works are likely to take place in different areas;
- funders and regulatory bodies confidence that individual proposals are part of a broader strategic view of the Woods.

It sets out

- a vision for the Woods and how different sections of the woodland will be treated (and why) in order to deliver that overall vision; and
- proposals for how certain key issues affecting (or likely to affect) the Woods might be addressed.

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2. Wytham Woods – the next 100 years

The University will meet the requirements of the ffennell bequest by ensuring that Wytham Woods will continue to:

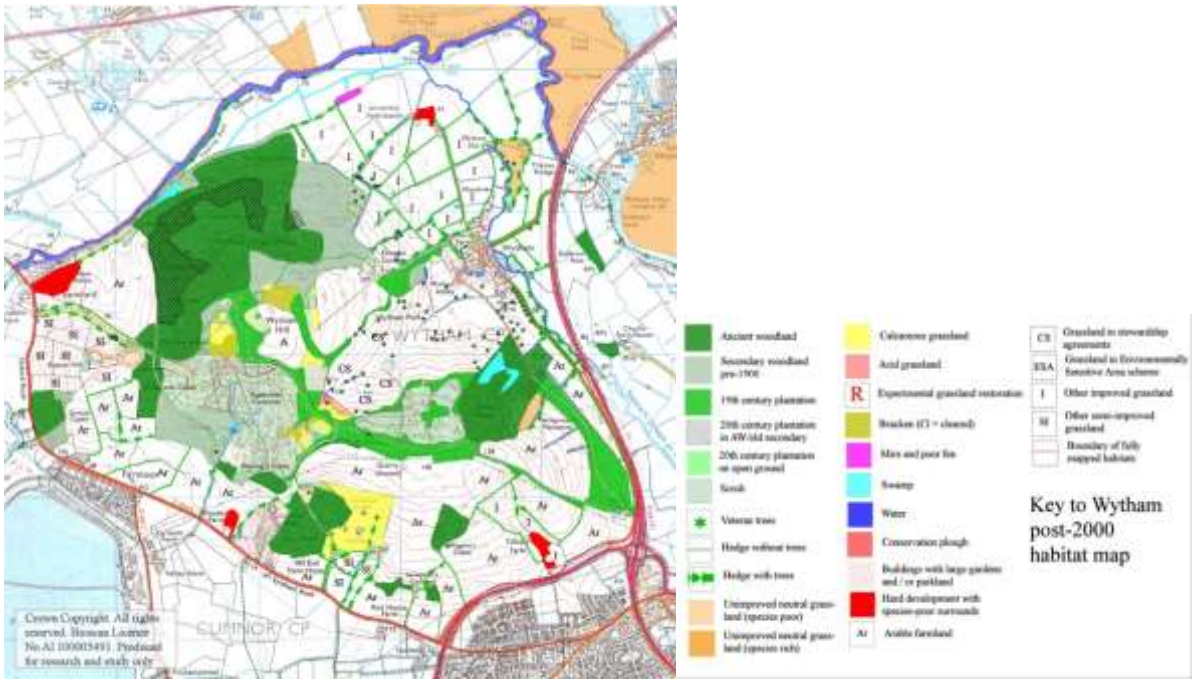
- *be a rich tapestry of woodland, grassland and wetland,*
- *demonstrate through research the impact of natural processes and sustainable management on species, habitats and ecological dynamics;*
- *be internationally known and respected amongst the academic community for the research carried out there;*
- *be loved and used by the people of Oxford and its surroundings;*

through a commitment to maintain:

- *the extent of the Woods;*
- *at least the current extent of open grassland and wetland;*
- *a predominantly native/long-established broadleaved canopy, with a diverse structure;*

in accordance with its responsibilities as an owner of a site of national importance for conservation.

The Plan deals primarily with the Woods, including the outlying copses, but must also be seen in their wider context. For example the badgers forage out on to the adjacent farmland; the parkland contains veteran trees that contribute to the saproxylic invertebrate populations of the Woods; the Wytham Ditches and Flushes SSSI provides a mixture of open wetland and fen habitats not well represented in the Woods; the Summerford Mead floodplain grassland restoration project can be viewed as a counterpoint to the limestone grassland restoration experiment in Upper Seeds. Looking more widely, the Woods are part of a local biodiversity hotspot, including the River Thames, its tributaries and floodplain meadows and pastures. In the longer term there may be a case for exploring whether there is scope for greater integration of research and management across these various sites.



3. The past management of the Woods

3.1 Through most of history

Wytham Woods are a cultural landscape: for at least the last two thousand years (possibly more) the land has been worked by people.

- Some of Woods are ancient (believed continuity of woodland cover since at least 1600) but even these may overlie Roman clearances; they were cut over regularly as coppice-with-standards up until the Second World War and in places sporadically afterwards; parts of them have also been replanted at various times in the last two centuries.
- Another block represents apparently natural regeneration, particularly of ash, on to former common grazing in the last 200 years; other blocks have been planted on open ground in that period, most extensively in the period 1945-1963.

Other legacies of past management in the structure of the Woods include the following.

- The current prevalence of old oaks is in part a consequence of historic management creating large open areas in which it could regenerate, even if there were not active planting of oaks (which did almost certainly happen).
- The grassland areas would have been kept open in the past by livestock grazing, then by rabbits and deer, until the recent re-introduction of sheep grazing. The Fen areas again were probably kept open by cutting and grazing.
- Particularly during the late 19th and early 20th century shooting was a major feature of the estate and the Woods were heavily keepered and contributed to the absence/low levels of predatory birds such as buzzards (though these have now recolonized). Elements of this continued in the first part of University ownership.
- The irregular surface of much of the top of the hill is a consequence of extensive shallow quarrying
- The archaeology of the hill has been only partly documented, but various banks, ditches and other surface features suggest past human activity.

3.2 1943-1963

Wytham Woods, as it came to the University was a landscape very much shaped by active intervention. The initial (Anon 1950)) management plan philosophy reflected the idea that it would be run as model estate according to the lights of the time (and as the farm was indeed run until the 1980s).

"The woods are to be managed to improve, maintain and utilize the existing woodlands under an approved plan and in accordance with the practice of good forestry insofar as the special local conditions and conditions of ownership allow. The woods have a high amenity value which must be maintained and also their value for instruction and research."

The woods were "not to be regarded primarily as a financial asset". The bulk (277 ha) was to be worked so as to create an irregular mixed broadleaved high forest, not necessarily of uniform composition throughout, nor precluding the use of coniferous species on short rotations where their use would help to achieve the main objective. A further 34 ha were to be worked as coppice. Only about 20% was set aside as research reserves.

Anon (1950). *Working Plan for 1949/50 – 1959/60 for the Woods of Hazel, Wytham, Berkshire* . Oxford Forestry Institute Library, unpublished MS.

3.3 Developing natural woodland

In the early1960s concerns about the extent of felling and restocking of the Woods led to a change of policy. As yet we have not found any overall guiding statement as to how the Woods were then to be treated, although Elton in 1966 wrote:
"It is ….clear that Wytham Woods have not for many centuries been 'virgin', though if given the chance to do so they might well return to something resembling a natural woodland, even if this would be different in composition from the original Saxon forest. What could be more fascinating than to watch this happen and record its progress over a hundred years or more, armed with the methods of modern ecology?"
Elton, C.S. (1966). *The Pattern of Animal Communities* . Chapman and Hall, London.

However what sort of 'natural woodland' should we imagine Wytham coming to resemble: 'original natural' woodland which may once have existed (but long before the Saxon period) as suggested by the word 'return'; or 'future natural' woodland as it would develop from the existing state and with the species now present on site. To approach the first would imply seeking to remove non-native species, re-introducing missing key species, small-leaved lime for example, and hoping that the Woods are large enough for natural disturbance factors to maintain at least some open habitats. To approach the second would imply letting grassland scrub up, letting deer (any species) eat out the understorey layers, and accepting that if sycamore or any other species spreads, then so be it. Should we now take our ideas of what 'resembling natural woodland' means from a 'closed forest' perspective (which Elton would have done), or from the open wood-pasture landscapes proposed by Frans Vera?

In practice, even where the long-term aim is to allow natural development (perhaps in its modern guise of 'rewilding') this will not preclude interventions in the short to medium term to provide more appropriate starting conditions, e.g. by breaking up the even-aged nature of some of the stands.

A mixture of intervention types and levels will thus be needed across the Woods.

3.4 A mixture of intervention levels

Intervention, in this context, is primarily about the management of the woody vegetation and maintaining the open habitats, through for example felling, planting, grazing, but also includes deer management, squirrel control, etc. It does not cover activities specifically sanctioned as part of research projects such as tagging trees of birds, installation of equipment, unless these are of a scale that they will have a significant effect on the general structure and composition of the woodland.

Parts of the Woods should be left to minimum intervention (with what counts as 'minimum' clearly defined); in others relatively-intensive management will be carried out, e.g. to maintain the grassland or rides. Once an area has been assigned to a particular level of intervention this allocation should be maintained so that there is long-term continuity of its treatment. This may not always be possible: if circumstances change radically, but continuity should be the aim.

The main part of the plan deals with the treatment of different sections of the Woods, both wooded and open. In the past these have been called zones, but it may be more helpful to use the term *'working circle'* to cover an area (which may not be contiguous) that is to be treated in broadly a similar way. For each working circle there is a definition of what it contains, the rationale for defining it, and what sorts of interventions might take place within it.

A series of sections have also been included setting out broad approaches to dealing with specific risks and opportunities (deer management, invasive species, climate change, ash dieback etc); these can be added to as required/desired. It is impossible to predict what other issues/opportunities might come up but these examples provide a framework for dealing with the future unknowns.

3.5 Compliance with regulations

Whatever is decided for particular areas certain regulations/good practice need to be followed across the Woods and should be assumed in the accounts that follow, even if not specifically mentioned.

- Necessary Health and Safety requirements with respect to, for example, dangerous trees will be followed throughout the Woods; this will largely affect trees adjacent to rides (Annex 3).
- Any work undertaken must comply with the minimum requirements of the UK Forestry Standard where applicable.
- All work must be compliant with species-protection legislation and the obligations under the Wildlife and Countryside Act (as amended) following from the Woods being an SSSI (Annex 1). The plan itself (once approved by Natural England) will effectively replace the current Site Management Statement (Annex 2).

3.6 Governance, responsibility for and financing of the Plan

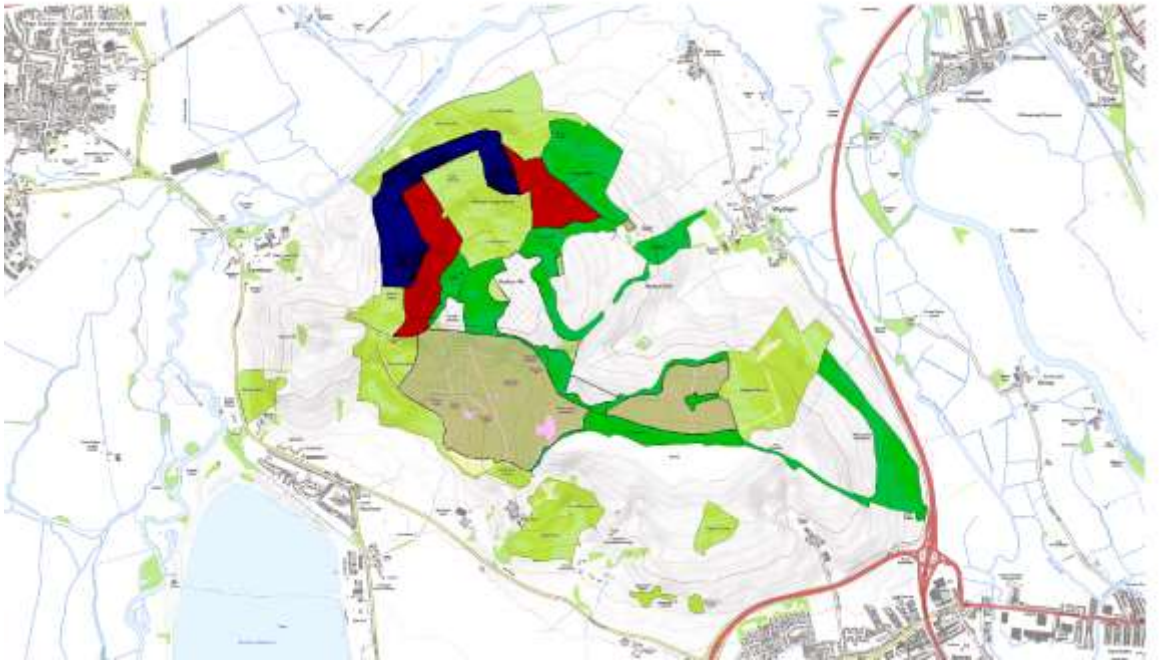
Responsibility for overseeing the management of the Woods was initially with the Forestry Department, but in the early 1960s this shifted to a management committee under the Estates Department. In the early 1970s this committee dissolved/was abolished and *de facto* the Scientific Advisory Committee became responsible for determining the management policies for the Woods, and hence, for this management plan. The composition of the Committee is somewhat informally defined; it is a mixture of representatives of the main research groups using the Woods and those directly responsible for the management.

The Committee has no control of the finance/budget for the management of the Woods (an indication of major sources of income and expenditure from 2015 is given in Annex 4). The Woods are supported by a block allocation from the University via the Estates Division. The Woods have also received grants the Forestry Commission, contributing to the oak haloing work, and from Natural England under Higher Level Stewardship to support the grazing management. The Woods are not run for profit (there is usually a deficit on the Woods account) but to provide the 'Laboratory with Leaves' for the various research projects. It is though expected that management will have regard to opportunities for generating income that are compatible with ongoing research and consistent with the terms of the ffennell bequest.

Research in the Woods is funded separately through individual research groups gaining grants from research councils etc. Sometimes there is provision within these for a contribution to maintaining the 'infrastructure' of the Woods, but this represents only a small part of the total expenditure. In addition, some of the smaller research projects, which may be self-funded, are not able to contribute in this way. In 2019 the Woods cost about £300,000 to run, partly offset by external grants of about £45,000, but hosted research work supported by grants worth several million pounds.

Day-to-day management of the Woods and implementation of the Plan rests with the Conservator of Wytham Woods and his team.

4. Future Management - Wooded areas (excluding rides and ride edges)



This compartment map shows the distribution of the various working circles, defined by the main type of management to which they are subject. All blocks contain areas of open ground or rides (not shown) that will be managed under a separate regime.

- Yellow – minimum intervention woodland
- Blue – disturbed ancient woodland, young stands
- Red – mainly disturbed ancient woodland, mature stands
- Green – recent woodland, both semi-natural and 19th C plantations
- Sage green– twentieth century plantations established on open ground.

4.1 Minimum intervention woodland working circle

(Compartments 20, 23, 24, 27, 28, pp30, 31, 38, 39,40,41,42: yellow areas on compartment map)

This comprises the bulk of the ancient semi-natural woodland and some of the oldest recent semi-natural woodland that has spread on to former common. Most of it has a relict coppice-with-standards structure. There has been little management within the stands in the last 40 years, apart from a couple of exclosures established in 1992. This woodland has a diverse structure already; is relatively free from non-native/invasive species; and has a relatively high level of mature timber and deadwood. They are the most appropriate areas therefore to try to develop something resembling 'natural woodland'. They provide a relatively-undisturbed surroundings for the ECN 1-ha monitoring plot.

Two other areas are included in this working circle, even though these fall within the disturbed ancient woodland. These are the Smithsonian plot and WES (Kitty Southern) plot by Three Pines Ride where we have long term records of canopy change and development.

Three of the outlying copses - Stimpson's Copse, Higgins Copse and Stroud Copse - are also placed in this working circle although in this last there was some recent thinning to promote natural regeneration (at the request of Natural England).

The rides and vegetation immediately adjacent to them are not counted as minimum intervention, but are treated separately (see Ride Working Circle), as are the Fens in Marley Wood.

Within the minimum intervention working circle:

- There will be no felling, planting, deadwood removal etc within the stands.
- Research that involves substantial manipulation of the vegetation will not normally be allowed. The emphasis will be on observational studies.
- Deer management will still take place since it would not be practical or desirable to exclude these areas (the deer would simply take to using them more frequently)
- New invasive species will be controlled when they first appear if this means that they can be stopped establishing, e.g. Himalayan balsam, but decisions will be taken on a species by species basis (see section on invasive species).

4.1.1 Some Implications

The composition and structure of these areas will change in potentially unpredictable ways with consequential effects on other groups (ground flora, birds, dead wood beetles, badgers etc). Such changes should be accepted as a corollary of the minimum intervention approach.

Elsewhere in the Woods ‘haloing’ is undertaken around large oaks (*Quercus robur*) to reduce the competition from younger trees. This will *not* be done in these areas. The old oaks will be allowed to die. It is unlikely that there will be oak regeneration within these areas under the current canopy densities. However new oaks might be established at ride junctions etc (see Ride Working Circle) and oaks in some of the nearby young plantations could be more heavily thinned around to give them more space so that they eventually develop large crowns (see section 4.2) to be replacements for those that may be lost in the minimum intervention areas.

As this section stands, for example, sycamore *Acer pseudoplatanus* will be treated as other species and if it spreads that will be accepted, although currently there is little evidence that it has increased significantly in the last 40 years. Nor is there any indication in Elton’s diaries that he saw this tree as a threat and in *The Pattern of Animal Communities* he speculates that left alone,

sycamore would probably settle down eventually as a part of our future deciduous woodland composition.

Minimum intervention could however represent a challenge to the Management Committee if less desirable species start to spread. These could be introductions such as Turkey oak *Quercus cerris*, but also native species such as holly *Ilex aquifolium* which is currently increasing: on some other sites it has formed dense impenetrable thickets in the last 50 years. If that happens in Wytham it could pose problems of accessing parts of the Woods. Issues such as this will need to be reviewed by the Management Committee if and when they arise.

4.1.2 The impact of ash dieback and our response

Ash *Fraxinus excelsior* is not that abundant through much of this working circle so the overall character of the woodland may change little. The gaps created will open up opportunities for future regeneration of other species, provided deer pressure is kept low. There are currently no plans to change the approach to planting in this working circle, even if large canopy gaps arise from the loss of ash.

In local pockets of ash, the disease may mean that researchers will need to take extra care as trees die (increased risk of branch drop/stem crack) particularly in windy or wet conditions; there will need to be increased inspection and possibly some pre-emptive fellings. Rideside tree safety work may need to intrude somewhat further into the stands than previously. The potential increase in ground vegetation, particularly bramble *Rubus fruticosus*, under any canopy gaps, may add to the problems for researchers working in this area and, again, increase the potential risk from trip hazards, hidden branches, holes etc.

4.2 Disturbed ancient woodland restoration working circle.

This covers those areas of ancient woodland which were disturbed by planting in the nineteenth century (often now sycamore high forest) or by planting in the 1945-63 period (other than those included in the Minimum Intervention working circle because they are part of the Smithsonian or the WES plot). The aim is to restore these towards a more natural structure and composition with the longer-term intention that they could then be moved into the Minimum Intervention Working Circle to expand the area of more-natural woodland.

The opportunity will also be taken to encourage oak establishment and growth in these areas. There is concern that many of the older oak trees are dying back. While this may simply be the natural consequence of succession following previous favouring of oak, the importance of oak as a keystone species for some of the invertebrate and much of the bird interest of the Woods means that special treatment is justified. Two approaches will be adopted: the establishment of young oaks on ride sides and naturally occurring gaps in the mature stands (where these are at least 20m across); and the favouring by heavy thinning in the young plantations.

Where there is already a mature woodland structure little action may be required, but the option of intervention is retained. (Compartments pp4, 5, 16, 22: red on compartment map)


- Rides through them are treated under the Ride Working Circle guidance.
- Sycamore will be treated in the same way as native trees.
- Large oaks may be haloed, as resources permit, to reduce the competition from younger growth.
- Any remaining large conifers may be gradually removed (assuming no raptors using them as nest sites), with the exception of mature Scots pine (*Pinus sylvestris*);
- Gaps will normally be left to be filled by natural regeneration, but if large enough planting of small groups (or individuals) of oak could be considered (see above).
- 'Alternative tree species for ash' (e.g. small-leaved lime *Tilia cordata*, aspen *Populus tremula*, birch *Betula* spp.) may be considered as a component of any planting. (Lime was probably a dominant species in the mid-Holocene; the other two species are still common in the Woods.)

In the young plantations more work will be needed to accelerate the restoration process. (Compartments pp4, 14, 15, 17, 19: blue on compartment map)


- Thinning will take place to remove any coniferous crop and more heavily around selected oaks (see above), beech *Fagus sylvatica* and ash that appear to have the potential to develop as large crowned individuals: this will increase the diversity of structure in these stands in the short term and in the longer term potentially provide future generations of veteran trees.
- Any surviving large oaks would also be haloed to improve their life-expectancy;
- No dead wood removal except of small material from plantation thinnings.

In both parts new invasive species will be controlled when they first appear if this means that they can be stopped establishing, e.g. small balsam, but decisions will be taken on a species by species basis (see section on invasive species).

4.2.1 Ash dieback and our response

This working circle includes small plantations of young ash as well as a more general scatter of mature trees. Several of the plantations have been recently thinned and it is to be hoped that regeneration of other species will take place in these. This may give an indication of what can be expected through ash dieback 'thinning' elsewhere. Some planting of oak and other potential replacements for ash can be considered in the larger gaps created. Where new haloing of oaks is to be done in this circle preference should be given to the removal of young ash to reduce future safety issues.

This circle includes some of the areas with most sycamore and it will be considered as part of the mix of species to replace ash where it regenerates.

4.3 Recent largely semi-natural woodland working circle

(Compartments 1, 2, 3,6,7,8,10, 36,37, pp60, 61: green on compartment map)

This comprises areas which grew up on former common land, largely in the last 150 years as mixed age high forest predominantly of native species (particularly ash) and the over-mature plantations of beech on the top of the hill, Brogdens Belt and Marleywood Plantations which have developed a semi-natural character. Unlike at many other lowland sites 'ancient woodland plants' have spread well into some of these areas; the old beech are also an important dead wood resource. Sycamore is present along with a scatter of other non-native broadleaves (common lime, sweet chestnut) often as mature trees.

The long-term aim is that these should develop as broadleaved high forest. Given their more recent history there is more scope for intervention fellings either for small scale manipulative experiments, such as the recent 'ash dieback' fellings, or for conservation reasons, such as the haloing of the old oaks to improve their survival chances (photos below). These areas tend to have a higher proportion of ash than elsewhere and hence could be particularly vulnerable to ash dieback: this may trigger a need for more intervention in future (see later section).

The main future management will be:

- Rides and open ground (e.g. Lords Common) will be treated as per the Ride or Grassland Working circles.
- Sycamore and other non-native broadleaves will be accepted.
- The current programme of haloing of old oaks south of the main road from the sawmill to Rough Common (compartments 6,7,8,10) has been more-or-less completed, but further work to maintain these 'halos' will be needed in future.
- Treefall gaps to be left for natural regeneration, but with the option of planting small groups or individual oaks where the gap is big enough (as in the Disturbed ancient woodland working circle, section 4.2).
- No dead wood removal, except for small amounts of small diameter material produced during haloing operations.
- 'Alternative tree species for ash' (small-leaved lime, aspen, birch) may be considered as a component of any planting.
- New invasive species will be controlled when they first appear if this means that they can be stopped establishing, e.g. small balsam *Impatiens parviflora*, but decisions will be taken on a species by species basis (see section on invasive species).

4.3.1 Ash dieback and our response

In any work along rides, or haloing old oaks, diseased ash will be preferentially targeted for felling. Natural regeneration will continue to be favoured as the means for restocking gaps but planting of alternative species will be considered where large gaps develop to complement any ash regeneration that does survive.

4.4 Twentieth century plantations working circle

(Compartments 25, 26, pp28, 29, 30, 32, 33, 34, 35, 55, 56, 57, 58: sage green areas on map)

Those plantations within the ancient woodland boundary have been discussed already. This section deals with the rest, mostly established on open ground between 1945 and 1963 (plus some enclaves of older growth along the Singing Way and Pasticks. Native species predominate, planted either pure or in mixtures with conifers. Most of the conifers have now been removed but locally some remain. The planting was dense (often just three-foot spacing) and there was little thinning in the 1960s and 1970s such that the trees grew thin and the stands dense.


It would be possible to clear some of the plantations to restore open grassland on Radbrook Common, consistent with the Government's Open Habitats Restoration policy, but there is little appetite for this amongst Committee members; it would not necessarily be that successful in conservation terms; and would impose a considerable future management burden to keep the areas open. Other plantations in were largely created on enclosed fields and there is even less of a case for restoring these to an open state.

The main long-term outcome is therefore development towards broadleaved high forest. This could be achieved by simply leaving the stands alone, but it would take a long time for them to develop a mixed age/height structure, understorey, or large trees. A short-term acceleration of the thinning programme speeds this process up considerably and provides the opportunity to remove more of the conifers (a particular priority in Marley Plantations where these are affecting the hydrological regime in the Fens). 60-70% of stems have been removed within compartments 26, pp28, 35, 58, with up to 30% of stems in others where there is insufficient regeneration. Any surviving veteran trees can be haloed at the same time.


The thinnings could just be left as deadwood, but small deadwood though valuable is not a particular conservation priority and is already abundant. Leaving them would also reduce ease of movement through the stands, particularly if they become overgrown with bramble. Loss of nutrients from the site is not likely to be an issue as the foliage and small twigs etc are not being taken, the soils are not particularly nutrient poor, and the site is becoming enriched by atmospheric deposition anyway. Removing the thinnings as firewood helps cover the cost of operations.

Future management:

- Sycamore, sweet chestnut *Castanea sativa* and other non-native broadleaved trees will generally be accepted
- Complete current WGS thinning programme through compartment 26.

- Selective heavier thinning around some young oaks and beech to encourage large crown development
- Halo any veteran trees present in the process
- All other mature broadleaved trees (plus yew Taxus baccata, pine) to be left
- Continue with removal of thinnings, but not larger deadwood.
- Gaps generally to be left for natural regeneration;
- Planting of oak and possible alternatives for ash (e.g. small-leaved lime, birch aspen) might be considered in any larger areas where conifers removed.
- Rides to be managed under Ride Working Circle. Wide rides to be encouraged on lower slopes where they add to the neutral damp grassland element of the Woods. Where plantations abut on to grassland or other open areas the edge of the plantation may be developed as a scrub margin to the grassland.

4.4.1 Ash dieback and our response

Stands of more-or-less pure ash will be identified and the following options considered:

- Continue with current stand, but encourage a greater diversity of species in regeneration, including if necessary by planting.
- Fell once the disease takes hold and re-stock with a range of species to minimise future management costs.
- Fell to restore to scrub/grassland if the stand is in a suitable locality, bearing in mind potential future management costs to maintain the open area.

4.5 Coppice working circle

Most of the ancient woodland has a coppice history of some sort and coppicing was still practiced through to WW2. Worked coppice is associated with particular groups of organisms that have declined as the majority of British broadleaved woodland has tended towards high forest structures over the last 60yrs. The first management plans for the Woods considered that there was still a local market for some coppice products such that about 30 ha would continue to be cut. Occasional blocks have been cut since, for example in Bean Wood and in the chestnut stand below Rough Common (457078).

Maintaining a small area of regularly worked coppice within the Woods would provide a demonstration of this type of management that might be useful for teaching/research as well as illustrating how the Woods were managed in the past.

Future coppice management:

- Continue to coppice the chestnut block at 457078, as opportunities permit, because it is easily accessible to visiting groups/students.


- Establish a more formal coppice rotation in Bean Wood with about 1 ha cut and regenerated every few years, ideally with some baseline recording of taxa such as plants, bats and selected invertebrates before management, to make the most of the experimental opportunity coppicing provides.

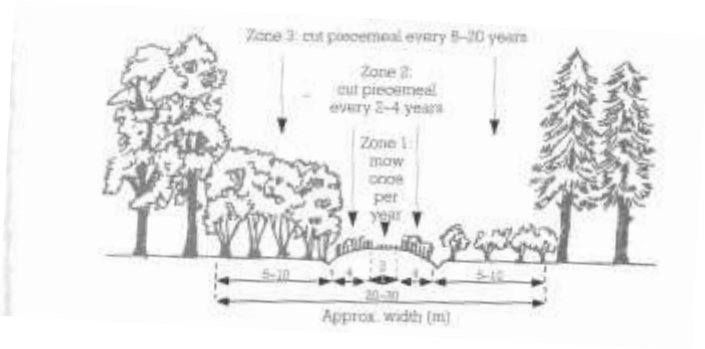
5. Future Management - Open habitats

5.1 Ride Working Circle

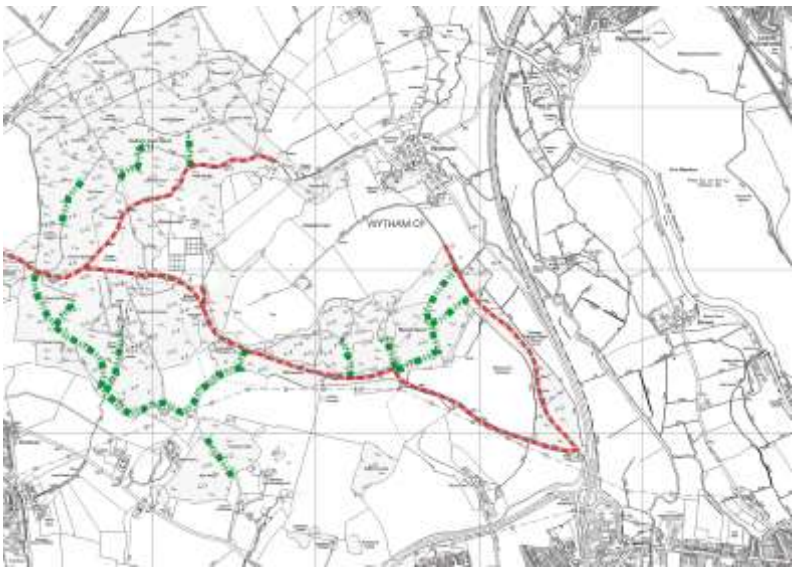
The 17 km of woodland rides form an important part of the infrastructure of the Woods allowing researchers to move equipment about for example; they are also an important habitat in their own right containing a wide range of woodland edge/non-woodland species. They bring in species of damp, neutral grassland on the lower slopes of the hill which complements the more extensive limestone grassland areas on the top of the hill; the herbs and flowering shrubs on ride edges can be important nectar sources for a wide range of invertebrates including those whose larvae feed in dead wood in shaded conditions.


- The normal ride maintenance regime consists of regular cutting of central zones.
- In selected areas the stand edge has been cut back to widen the rides to create more of a scrub edge which will be maintained by more irregular cutting (the ‘three zones’ approach, see diagram below). The aim is create a central short zone between about 3 and 6 m wide, with an outer zone (2-4 m wide) of taller herbs, scrambling plants and small shrubs (2-4 m wide) cut on a 4-7 year cycle. No new wide rides will be created in the minimum intervention circle, although the existing ones will be maintained.
- There is a requirement to check for dangerous trees particularly along ridesides, because this is where the highest risks to the public/researchers occur. The protocol for this is set out in Annex 3. Ash dieback will increase the felling required along rides.

- Occasional planting of oaks will be considered along ride edges or at junctions where they can develop wide crowns without compromising the open ride habitat or ride management itself.



From JNCC booklet *Rides and glades – their management for conservation*



Green square and bar - wide management

Triangle and bar length now in Smithsonian plot so not widened further.

Red where safety is key so tending to aim at coppiced edge to minimise potential issues.

5.2 Grassland Working Circle

The main grassland areas (excluding rides) are on the top of the hill – Lords Common, Rough Common and the Quarry, Sundays Hill and the Bowling Alley, The Dell, Upper Seeds, the Anthill Reserve at the top of the Park, and the grassland around Hill End Camp.

The main Upper Seeds block is grazed in spring and autumn according to the protocol given in Annex 5. This is currently under review by the project team and this Annex will be updated accordingly

when appropriate. Five Acre field (site of Raindrop experiment) is on a mid-summer and autumn cut, so as to be compatible with climate change experiments. Sundays Hill and the Bowling Alley are also grazed but have becomes somewhat overgrown in the last few years. Cutting of scrub is planned.

The other grassland areas have been managed under Higher level Stewardship by a mixture of cutting and grazing (where practical, eg The Dell, Lords Common south, main part of Rough Common) to maintain/restore limestone grassland assemblages, with a mixtures of short and tall vegetation to provide structural diversity for invertebrates. Lords Common (north of road) and Rough Common north of the road are cut by forage harvester once a year. Invading scrub is cut back around these and the Quarry. The Upper Seeds triangle is ploughed in autumn for arable weeds.

The long-term persistence of rabbit on the Quarry is interesting, creating lichen-dominant patches unique on the site, and rabbits should not be discouraged here. Sheep grazing would be used only as a last resort if the rabbits decline.

An issue under consideration is whether we should try to 'enrich' some of the recent grassland derived from 1980s arable in Five Acre field through strewing hay from richer parts of the estate or deliberate sowing/tranplants. The focus could be on those species that have been otherwise slow to spread into Upper Seeds through natural colonisation.

The relevant HLS prescriptions, with grid references to where they apply are:

- HB12 - Maintenance of hedgerows of very high environmental value (SP46590668, SP46720645, SP46730685)
- HF20 - Cultivated fallow plots or margins for arable flora (SP46180812)
- HK6 - Maintenance of species-rich, semi-natural grassland (SP46590668, SP46420786,
- SP46830676, SP46300738, SP45730809, SP46730685, SP46550761, SP46410747)
- HK7 - Restoration of species-rich, semi-natural grassland (SP46180812, SP46400824,
- SP46010825, SP46130839)
- HK15 - Maintenance of valuable semi-improved or rough grassland (SP46490660)

More details are given in Annex 6.

The next five years.

There has been concern expressed about the spread of scrub on Sunday's Hill and the Bowling Alley and a feeling that the grassland does not get as much management attention as it deserves. We will aim to address these concerns in the next 5-year period. We will also need to prepare for the shift from Stewardship to Environmental Land Management grants as a possible source of funding for the grassland management.

Separately there may be scope for expanding the area of scrub and open ground as part of the Ash Dieback response in some areas of the Woods.

5.3 Fens and Marshes Working Circle

The fens are a significant habitat feature in an Oxfordshire context as well as in terms of the Woods themselves. They are also important because of their palaeoecological research potential. They are thought to be drying out, becoming more wooded and losing species as a consequence of changes in the hydrology – particularly from the conifer plantations in their catchment – but also because of increased dominance by tall sedges and reeds, probably caused by less grazing disturbance than in the

past. However parts of the fen vegetation are very fragile so care is needed over any management works.


Future management would be:

- Try to trace and block any pipes/drainage from the fens
- Maintain relatively open broadleaved woodland in the plantations in the catchment
- Restrict any future spread of trees on to the fens
- Clear some birch off Marley Fen (2) to restore open conditions.

Elsewhere in the Woods are small marshy areas usually indicated by dense stands of *Carex pendula, Equisetum telmateia*. Some of these may be becoming dryer as a result of increased transpiration from the growing tree crops. Efforts should be made not to disturb them where they occur in areas where management is going on. Otherwise they are left alone.

Where felling for Ash Dieback is taking place there may be scope to expand the potential wetland area.

5.4 Ponds and streams working circle

Various springs and streams flow, sometimes intermittently, in the Woods. The basic presumption is that these should be left undisturbed, along with their associated marshy areas, even where they occur within areas where management is going on.

There are various small ponds, e.g. Deer Pond, (photograph bottom left) some of which were once in more open conditions but no management is currently proposed for these. They also hold populations of great crested newts which are the subject of periodic surveys; no active management is considered necessary for this species at Wytham, although care needs to be taken if other work is going on in the vicinity.

The Upper Duck Pond (bottom right) was recently restored, but some further work is needed on this. As it lies within the twentieth century plantations the extra disturbance is probably not that significant. The lower pond has had the marginal scrub cut back around the north side from time to time. The long term aim with both is to maintain significant areas of open water which is otherwise lacking in the Woods and is important for some of the foraging bats.

Several new ponds have been created for Great Crested Newts below Marley Wood and off the stream that comes out of the Lower Pond. Lack of rainfall in the autumn of 2018 and spring of 2019 meant that they were slow to fill.

Details of recent management are given in Annex 7.

It will be important to check that the new ponds fill and retain water, and to note what has colonised them.

5.5 Scrub working circle

Hawthorn *Crataegus* spp. and blackthorn *Prunus spinosa* scrub, with smaller amounts of other species is a significant element of the Woods, but young dense stands which tend to be of highest conservation value are often only transient habitats. Large areas of blackthorn developed after WWII in the gaps in the ancient woodland on the north and west of the hill, but most of these have now collapsed/been eaten out by deer. Hawthorn is common invader of the grassland and is periodically cut back. For the most part the scrub element is maintained as a by-product of other management priorities and natural processes operating across the Woods.

Brown hairstreak butterflies *Thecla betulae* have bred on Upper Seeds where low scrub occurs in some of the experimental plots and along fencelines. Scrub condition and abundance should be checked periodically in these areas to try to maintain this species. Other areas where scrub management is a priority are:

- At the western edge of Broad Oak for hairstreak butterflies, (around SP454074) in conjunction with the deer management area;
- to the south west of the lower pond

And if resources permit:

- On the northern edge of Marleywood Plantation where former open ground has scrubbed up in the last 40 years (north end of compartment 44);
- On the north edge of Common Piece where again a small field was recently incorporated into the wood (south-east corner of compartment 2).

5.5.1 Ash dieback and our response

There may be opportunities for developing new scrub-dominant areas where ash dies or is felled because of the disease.

6. Future Management - Issues and opportunities

6.1 Deer management

Deer were a part of the original natural woodland (red deer, roe, probably moose at one time), but for the last few hundred years have not been a significant part of the ecology of the Woods: they were largely eliminated outside parks from most of lowland England. The present populations include:

- Fallow *Dama dama*, a long-established introduction which probably escaped into the Woods during the Second World War from Wytham Park – small numbers are regularly recorded in Elton's Wytham notes from 1944 onward;
- Muntjac *Muntiacius reevesii* that have spread from escapes from Woburn and were first seen in the woods in the late sixties; Elton's notes for 3/3/67 "There is excitement at the arrival, recorded elsewhere in the Survey, of 4 muntjac deer, seen by Beale near the Chalet and heard barking, and H.N.S. has seen their tracks"
- Roe *Capreolus capreolus* - no specific references by Elton prior to 1970s, but 3/2/75 Elton notes that there may be 30 roe in Wytham.

As elsewhere in England, deer populations increased greatly during the 1980s and 1990s with consequential effects on the vegetation and regeneration. Management of the deer with the aim of reducing populations has been carried out for the last two decades and the vegetation and regeneration is 'recovering' – i.e moving back towards what it was in the 1970s/early 80s.

The levels of deer are now at the point where it is difficult to get precise population estimates. However, there are still deer in the Woods and control will continue. This will be done largely by Woods Staff shooting deer in season and short concentrated cull sessions where the Woods are closed (see Annex 9).

The aims are:

- Keep the Woods as muntjac free as possible;
- Aim to keep Marley Wood (and 1996 exclosures) completely deer-free as far as possible;
- Over the rest of the Woods maintain roe and fallow deer at levels, such that regeneration and vegetation recovery continue, which is likely to imply populations of the order of 20 roe and 20 fallow.

Some concern has been expressed about the spread of bramble with lower deer numbers making accessibility for researchers more difficult (though bramble levels are well below those in the 1960s and 1970s). It is likely that as the low cover (bramble and shrubs) spreads more the deer numbers will increase (less easy to see) leading to an increase in pressure on the vegetation. The situation will however be kept under review.With Ash Dieback the need to limit deer impact on tree regeneration becomes more acute, both to allow any ash that is resistant a chance to show itself (and not get eaten) and to allow regeneration of other species which has generally been much less frequent than ash in the past.

6.1.1 Exclosure fence maintenance

The fences round the existing exclosures have in places collapsed. All should be checked and repaired as necessary in the current five-year period.

6.2 Squirrel management

Grey squirrels *Sciurus carolinensis* established in the Woods in the last century (Elton's notes it as present in the 1940s) and there has been varying levels of control since, (mainly) because of their impact on young trees. Management was limited to use of Warfarin in hoppers in Marley Plantations and shooting elsewhere to try to get trees in the young plantations through the most vulnerable stage. Eradication is unlikely to be practical (given the potential for invasion from the surroundings) and beyond current resources anyway. This position may need to be reviewed if a national programme of grey squirrel control d (recently being talked up again by Royal Forestry Society) were to be instigated. Otherwise grey squirrel must just be accepted as part of the future composition of the Woods.

6. 3 Introductions//invasive species

Many management questions boil down to what to do with introductions/invasive species; the two are not synonymous since 'invasives' may be natives such as bracken *Pteridium aquilinum*, holly or wild garlic *Allium ursinum* in some situations, while not all introduced species get classed as invasives (little owl *Athena noctua*, hares *Lepus europaeus*).

If the template for what Wytham should be like were an original-natural one, then this would imply removing all introductions as a matter of principle, though inevitably concentrating on the most abundant/invasive ones first. However, this would be more extreme than typical international practice, and would be impractical technically and financially. One might define an arbitraty cut-off date with introductions to the country before this being deemed to have naturalised and to be acceptable: so if only pre-Roman species were acceptable brown hare would be accepted, but sycamore and fallow deer eliminated. The effort involved would be considerable and somewhat illogical since we cannot reverse easily other changes in the environment that have taken place since then. If 1500 AD were the cut-off, sycamore, fallow deer and sweet chestnut all become part of the native/naturalised mix. If we take a 'future-natural' perspective then any species currently in or invading the Woods could be accepted.

If we focus on the impact that species have then the question of their nativeness (and when that is judged to date from) becomes less critical, but we do need to be clear as to why we judge a particular species to be having an undesirable impact and hence subject to control. This can and does vary across the Woods. We already control scrub and tree invasion on to the grassland for example; we might choose to try to restrict the spread of sycamore in the ancient semi-natural woodland parts of the Minimum Intervention working circle (where it is currently scarce), but accept it in the Disturbed Ancient Woodland working circle because it is a dominant tree and would create too much disturbance to remove. If holly continues to spread we might choose to try to keep some compartments clear of it, but let others become dense thickets.

A focus on management of individual species as and when they are perceived to be a 'problem' would seem to be the better approach, not least because it would require the production of a clear rationale for action (by area or for the Woods as a whole) for a species that does need management without the need to bother with those that do not. The cost of the necessary control action can then be judged

against the likely species impact. This is illustrated in the following table. Other species can be added as desired.

Species	status	Action
Sweet chestnut *Castanea sativa*	Long-established in Britain, debatably native; in Wytham since 19th C. Minor component of the Woods. Provides a good coppice crop and deadwood. Not spreading.	No specific action needed.
Sycamore *Acer pseudoplatanus*	Long-established in Britain, early medieval, debateably native; in Wytham since at least nineteenth century. Mainly in the disturbed ancient woodland areas on the north of the hill where it is a major component. Any attempt at removal here would cause massive disturbance. Potential replacement in ash areas if this declines from disease. Little evidence for significant spread in the Woods in the last 40 years.	Monitor and review position if it starts to spread significantly but for the time being treat as native species, cf approach to holly below.
Deer *Capreolus capreolus* *Dama dama* *Muntiacius reevesii*	Span the spectrum from native but only recently recolonized, long-established naturalised, and recent introduction. All can cause major changes to vegetation and regeneration (documented for various lowland sites, not just Wytham) but provide a largish herbivore element to the system.	Populations of roe and fallow to be managed to keep at low level; muntjac shoot-on-sight approach.
Grey squirrel *Sciurus carolinensis*	19th/20th century introduction to Britain and in Wytham since at least 1940s. Probably contributed to loss of red squirrel and causes major damage to young trees. Impact on breeding birds frequently raised as issue but very limited evidence for this.	Control via hoppers has recently ceased. Shooting in most vulnerable tree crop areas to ensure future mature trees get away.
Small balsam/ Himalayan balsam *Impatiens parviflora/ Impatiens glandulifera*	Introductions to Britain. Have appeared at a number of points in last few years, mainly rides or by the river. Not currently a problem but spread vigorously by seed on suitable sites forming dominant ground flora.	Could probably be more or less eradicated if action taken now; aim to pull up main colonies when seen

Wild garlic *Allium ursinum*	Native plant, woodland specialist and in some places an ancient woodland indicator. Was rather localised in Wytham in the 1960s, but now forming large patches. Cause of spread unclear, but may be linked to increased nitrogen deposition and less disturbance through management.	Accept as one of the future changes in the Woods' composition; not practical to consider management.
Holly *Ilex aquifolium*	Native plant. Some signs from Wytham and elsewhere that holly is increasing in British woodland. Has potential to form dense thickets with as little below as rhododendron stands. Dense thickets would also have implications for researcher movement.	Watching brief; if substantial thickets start to develop that are significantly affecting research or woodland flora then consider management action.
Etc.		
Etc		

6.4 Re-introductions

There are species known from Wytham or other woods in the area which no longer occur here. Should these be re-introduced; and if so, should the criteria be based on conservation priorities or research potential?

As with other species management, decisions should be on a case-by-case basis with an appropriate rationale developed for each. Examples of how such an approach might work are suggested in the table below.

Small-leaved lime *Tilia cordata*	Known from pollen record to have been a significant component of Wytham and other lowland woods	Growth of hybrid limes suggests site remains suitable; it is a more southerly continental species so would potentially contribute to increased climate change resilience; could be one of the species used to replace ash if that suffers serious dieback.
Platycerus caraboides Blue stag beetle. A saproxylic (dead wood) feeding species.	Last British record from Wytham 1820.	Probably lost because of lack of dead wood (which is now increasing in the older parts of Wytham). So conditions might again be suitable.
Nicrophorus germanicus (a carrion-burying beetle)	Last British record from Wytham 1822.	Probably lost because of reductions in carrion. Depending on what type and scale of carrion is required so conditions might be suitable for its return.

6.5 Climate change adaptation

The Woods will change as a consequence of climate change, both natural and anthropogenic. In general, such changes will be accepted and are not expected to significantly affect the character of the Woods in this plan period.

The most likely impacts on the Woods and their management will be the following.

- Increased frequency and severity of droughts may increase the loss of old oaks and increase tree death generally through weakened trees being more susceptible to disease;
- Shallow ponds may dry out more often, water supply to the fens may become more critical.
- Droughting of limestone grassland may increase bare soil, allowing opportunities for greater richness of forbs.
- Young badgers may be more vulnerable in late spring/summer through fewer readily available earthworms
- Increased winter rainfall/more intense storms may restrict access through the Woods because of state of rides;
- Increased severe windstorms, with longer leafing periods, could lead to greater risk of windthrow;
- Warmer winters could increase winter survival of deer, leading to higher browsing impacts if culling not adjusted accordingly;
- The timing of various events (spring green-up, peak caterpillar biomass etc) will alter;
- Southern species expanding their range in Britain may be detected more often in Wytham.

The general guidance for woodland managers seeking to cope with climate change is to encourage a diverse composition and structure in their woods as being most likely to create resilient systems. The current approach to management in the Woods is in line with this.

Where tree planting is planned (only a very small part of the plan) there is currently debate as to the value of introducing more southerly species or provenances as part of climate change adaptation. This applies where planting trees is considered which is only a very small part of the plan but might be relevant to the choice of seed origin for new oaks or the introduction of small-leaved lime. This should be dealt with under the approach outlined in the previous section on introductions/reintroductions.

6.6 Tree disease response

The only major tree disease outbreak during the University's tenure up until 2010 had been Dutch Elm Disease. This had only a minor impact on the Wood as elm *Ulmus* spp. was limited as a canopy species. Ash dieback (now present) and Acute Oak Decline (not far away) are much more serious concerns. Ash is an increasingly abundant species in the Woods, particularly in the recent woodland developed on former common, while oak has a high proportion of old trees that already appear to be being weakened by drought.

A low level of disease incidence and impact can be absorbed into the normal management and dynamics of the Woods. However, if there were extensive and rapid death of trees a different approach would be needed and much of the plan might need to be revised.

The main action proposed at present is that there should be an annual sweep of the woods to check any establishment of new disease patches.

6.6.1 Ash dieback

The disease was confirmed in the Woods in 2017 and is now (2020) widespread throught the Woods. The main impact has so far been on patches of regeneration where patches of saplings have died off. Seedlings remain abundant, but most of these are a transient population that turns over each year. Individual mature trees show varying degrees of crown thinning and dieback, but as yet there have not been complete death of groups or stands of ash.

Management needs to

- Maintain the Woods as a safe environment;
- Minimise impact on existing programmes;
- Maximise opportunities for future research.

The proposals set out previously under the various working circle headings assume that there will continue to be a steady decline in ash health and increase in tree death but not necessarily sudden collapse of whole stands. If the latter happens additional actions may be required, not least because of the health and safety risks to the public and to researchers. There may need to be more closures of the Woods, particularly during high winds.

In response to the arrival of the disease various projects were carried out between 2015 and 2020 and a major integrative research programme is beginning led by Professor Yadvinder Mahli to follow the impact of the disease across a range of trophic levels.

6.6.2 Oak decline

There has been a long-standing concern about die-back of the larger oaks. As far as is known Acute Oak Decline is not yet in the Woods, although Oxfordshire is on the edge of the region where it has become common. Work by Curt Lamberth suggests that in many of the oaks decline started in about 2003 and that it may be linked to drought stress; the response to the heat-wave in 2018 is therefore awaited with some concern. Apart from the haloing programme it is not clear that there is anything specific that can be done to improve the condition of the old oaks. Limited planting of young trees scattered through the Woods has been undertaken to provide potential new recruits for the population in the absence of natural regeneration within the woodland blocks. However, if the cause of the decline is linked to higher summer temperatures and reduced summer rainfall – both expected to get worse under climate change scenarios - such new plantings may contribute little to the long-term survival of oak in the Woods.

6.7 Public use of the Woods

The Woods are open for 11 months each year, excluding compartments 48, 49, 50-54 and 69 where no access to the public is permitted. An access map is produced for visitors and will be updated as required.

Group/organised visits include Badger Watches, Education Group visits, Forest School use and use of compartments 49-51 by Hill End Residential Centre.

The current system of permits for individuals and guided group visits seems to work well and be compatible with the research and conservation objectives for the Woods. There seems no reason to change it. There are checks on permits from time to time.

It would be useful to have more information about levels of usage of the Woods since this is a valued service provided by the University. At some stage we could consider establishing some passive monitoring of use (e.g. automatic counters or cameras on gates) or encouraging a student project to look at 'people distribution' in the woods.

The use of the Woods for events involving the public has been increasing, including opera in the Woods, a 10K race and more organised walks etc. There does not seem to have been any increase in impact on research or other activity in the Woods as a consequence, but this does need to be kept in mind. As most public events do not go off the main rides to any degree there is likely to be little extra Health and Safety requirement with ash dieback over and above that required to maintain the safety of researchers.

6.8 Educational use of the Woods (other than research)

The education use of the Woods is high. Apart from the direct University activities there are those of Hill End Camp (concentrated on Bean Wood), the Earthwatch/WildCRU initiatives as well as from other individual school activities. They reflect the interest that was shown in such matters by Raymond ffennell and can be considered part of his legacy. However, there is the potential for some damage or interference with research if levels of use became too high in sensitive areas.

General educational/field study use of the Woods should therefore be limited to areas where it will not impact on research or conservation. This will usually be close to the main access routes because of time constraints. If such uses start to generate conflict then it may be necessary to apply further restrictions.

The ash cover in areas chosen for more intensive educational use needs to be reviewed and activity moved if necessary to less risky areas.

There may be opportunities for making more use of student or other volunteer work parties to help with conservation or experiment maintenance.

6.9 The road, deer fence and other hard infrastructure

The maintenance of these is a major service to the research use of the Woods, but are also major items of expenditure. Any improvements are likely to require new external sources of funding.

There could be increased risk of damage to fencing from ash trees and branches crashing on to the perimeter. However the creation of the new fence 5 m out has reduced the risk that this will be a problem and made it easier to pick up and deal with fence breaks as they occur.

A major refurbishment of the Chalet has taken place which has made it into the sort of field centre resource that Wytham has long needed. Further work will take place on the garage buildings.

7. Research management

A key reason for the University holding the Woods is their use for research. This is mostly by groups and individuals linked to University of Oxford but is not confined to those with such a link. The work includes long-running programmes, such as the work on birds and badgers, as well as shorter studies and student projects. Currently there are about sixty projects/groups active in the Woods.

Any new projects should not compromise the work of others or otherwise disrupt the management policies as set out in the preceding sections. Proposals need to be submitted to the Conservator for approval and considered by the Scientific Advisory Committee. The more disruptive the nature of the research, the stronger the scientific case that will need to be made for it to go ahead. Annex 8 provides a sample summary of one of the key projects.

Copies of the data collected, results and publications should be made available to the Conservator/Scientific Advisory Committee, within a reasonable period (normally less than 5 years and certainly less than 10 years) of completion of the study. The recommended route is via depositing material in the Oxford Research Archive (http://ora.ox.ac.uk/). Links can then be made to this via the Wytham website. Restrictions may be put on data use so as not to prejudice planned publication.

The responsibility for ensuring that the data are deposited rests with the individual researcher, but also with his/her supervisor or research group. Failure to comply may prejudice future applications to work in the Woods by these individuals/groups.

7.1 Wytham Research Data-base

A major step forward has been made with this through the work of Marc Bruard who has developed the basis for an interactive Wytham data-base. The aim is that existing data-sets with their meta-data will need to be deposited in the next year with a requirement that all future work will similarly need to be deposited.

7.2 Maintaining continuity of research

A key feature of research at Wytham is the continuity of various long-running data-sets. However, this continuity is increasingly difficult to resource. Typically research grants will support only 3-5 years of work; thereafter maintaining treatments or recording may be deemed a low priority because nothing much is happening. For example, the drought experiment in Upper Seeds established as part of the TIGER programme in the 1990s was abandoned. More recently recording of a long-term experiment on the effect of litter addition and subtraction on soil respiration was stopped after 3 years. In this latter case the treatments are being continued, but only through the use of volunteers. Recording or maintenance may depend on key individuals – when they move on, retire, die the observations may simply stop. The problems of maintaining the Gibson-Brown experiment on Upper Seeds illustrate this point; the winter moth recording carried out by Lionel Cole may similarly cease now that he will no longer be doing it. Even when the recording is part of an organisation's programme budget cuts and shifts in priorities may mean that the work is sidelined (see Annex 10).

7.3 Research across the Estate, not just in the Woods

The Woods are part of a wider landscape and if we are to make research relevant to the changing patterns of land-use in Britain it would be valuable to make more links between the work in Wytham and that on the rest of the Estate and in the surrounding countryside.

8. Promotion and publicity of Wytham and what goes on there

Opportunities will be taken to promote collaboration and dissemination of Wytham research through research workshops (bringing together different groups interested in a particular topic), seminars at which the range of different research projects are showcased. Consideration will be given to an annual research report and a pilot version produced in the next two years.

There is scope to promote Wytham through local and national media, e.g. local newspapers, Countryfile items, the displays in the Museum of Natural History. These are valuable in helping to increase Wytham's profile (and hence support) both within the University, the City, and more generally. However, this should not be done in a way that leads to future over-use or damage to the Woods or the research which is its prime output.

There has been an upswing in the publicity and information available about the Woods over the last few years. The video series has proved a great success; there was a lot of coverage of the 75th anniversary events. It is important that this is continued so that the depth and breadth of the 'Wytham outreach' is recognised.

9. Annexes

Annex 1 SSSI citations for Wytham Woods and Ditches and flushes

COUNTY: OXFORDSHIRE **SITE NAME:** WYTHAM WOODS

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authorities: Oxfordshire County Council, Vale of White Horse District Council

National Grid Reference: SP462083

Ordnance Survey Sheet 1:50,000: 164 **1:10,000:** SP41 SW/SE SP40 NW/NE

Date Notified (Under 1949 Act): 1950 **Date of Last Revision:** 1977

Date Notified (Under 1981 Act): 1986 **Date of Last Revision:**

Area: 426.5 ha 1053.8 ac

Other information: Site boundary revised in 1975. Formerly part of Wytham SSSI.

Description and Reasons for Notification

This site consists of a complex of ancient woodland, wood pasture, common land and old limestone grassland on a variety of soils. The site has a well documented history dating back to at least 1544 when it formed part of the lands of Abingdon Abbey. The ancient woodland copses are undoubtedly of greater age and were probably present in Saxon times. The site has an exceptionally rich flora and fauna. Over 500 species of vascular plants have been recorded. Many aspects of the bird, mammal and invertebrate fauna have been studied by Oxford University and have provided Wytham Wood with a volume of data probably unparalleled in this country.

The essential landscape features of the site are the outliers of Calcareous Grit and Coral Rag which form Wytham Hill (165 m) and Seacourt Hill (148 m). The Coral Rag is a rubbly limestone and together with the grit gives rise to a brown rendzina soil which contrasts with the pelo-stagnogley soils derived from the Oxford Clay surrounding the hills. A number of spring-fed streams rich in calcium radiate from the higher ground.

The different soil types are reflected in the vegetation pattern and ecological history of the site. Wytham Hill formerly had a cover of open grassland and scattered trees, partly managed as wood pasture and common which has since been afforested or has developed into secondary woodland. The free- to poorly-drained neutral clay soils support ancient coppice-with-standards woodland.

About half the former common land has been replanted with a mixture of deciduous and coniferous species. The remaining semi-natural woodland is dominated by pedunculate oak, ash and sycamore but in the ancient copses the largely derelict coppice structure is composed of two closely related stand types, wet ash-maple and the heavy soil form of acid pedunculate oak-hazel-ash. Underwood species present in the old copses are holly *Ilex aquifolium*, crab apple *Malus sylvestris*, spindle *Euonymus europaeus*, blackthorn *Prunus spinosa,* honeysuckle *Lonicera periclymenum* and two species of hawthorn *Crataegus monogyna* and *C. laevigata*.

The composition of the ground flora is very varied depending on soil, aspect and management. Species common throughout the wood are bluebell *Hyacinthoides non-scripta*, dog's mercury *Mercurialis perennis*, pendulous sedge *Carex pendula*, wood sedge *C. sylvatica*, bramble *Rubus fruticosus* and on the former common land, bracken *Pteridium aquilinum* and Yorkshire fog *Holcus lanatus*. There are over 60 species of plant strongly associated with ancient woodland; these include herb paris *Paris quadrifolia*, stinking iris *Iris foetidissima* and wood dog violet *Viola reichenbachiana* in the copses underlain by Oxford Clay. Where the soils are enriched by calcium from the overlying strata, more localised species such as autumn crocus *Colchicum autumnale*, and greater butterfly orchid *Platanthera chlorantha* occur. Adder's tongue *Ophioglossum vulgatum* is found in the more open habitat associated with rides.

There are a number of small ponds, and an area of fen vegetation with common reed *Phragmites australis*, lesser pondsedge *Carex acutiformis*, great horsetail *Equisetum telmateia* and meadowsweet *Filipendula ulmaria* has developed in one locality.

COUNTY: OXFORDSHIRE **SITE NAME:** WYTHAM DITCHES AND FLUSHES

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authorities: Vale of White Horse District Council

National Grid Reference: SP465098

Ordnance Survey Sheet 1:50,000: 164 **1:10,000:** SP40 NE, SP41 SE

Date Notified (Under 1949 Act): 1950 **Date of Last Revision:** 1977

Date Notified (Under 1981 Act): 1986 **Date of Last Revision:**

Area: 5.7 ha 14.0 ac

Other information: Formerly part of Wytham SSSI.

Description and Reasons for Notification

The ditches of Wytham support a species-rich eutrophic aquatic and fen flora, examples of which are rare in the county following widespread drainage, pollution and fertiliser enrichment. They contain flowering plants which are now uncommon in central southern England, at least one species of which has its sole Oxfordshire locality here. A wet neutral grassland included within the site is a small survivor of the agricultural improvements which have led to the biological impoverishment of virtually all other meadow land in the county south of the Thames.

The flat riverside land at the north end of the site has calcareous clay soils of the Thames Association, underlain by alluvium. The higher sloping land to the south has fine loamy soils of the Badsey 1 Association over river terrace gravels. The water table is permanently high and there is a seepage line along the lower slopes at the junction of the two soils, which helps maintain the ditches and keeps the small meadow partly waterlogged.

The main ditch is up to one metre deep and up to six metres wide near the eastern end. The banks are dominated by dense stands of reed *Phragmites australis*, reed sweet-grass *Glyceria maxima*, branched bur-reed *Sparganium erectum* and reed mace *Typha latifolia*. More open stands typified by a mixture of reed and common club-rush *Schoenoplectus lacustris* contain a rich flora including the only sizeable populations of greater water-parsnip *Sium latifolium* and greater spearwort *Ranunculus lingua* in the county, together with a number of other uncommon wetland species, notably brookweed *Samolus valerandi*, water violet *Hottonia palustris*, narrow-leaved water plantain *Alisma lanceolatum*, tubular water-dropwort *Oenanthe fistulosa* and creeping Jenny *Lysimachia nummularia*. The open water retains a diverse flora, among which yellow water-lily *Nuphar lutea*, whorled water milfoil *Myriophyllum verticillatum*, shining pondweed *Potamogeton lucens*, thread-leaved water crowfoot *Ranunculus trichophyllus* and fat duckweed *Lemna gibba* are prominent.

A small field of tussocky, unimproved pasture included within the site has a base-rich flush occupying its shallow, north-facing slopes. Here the bryophyte and vascular plant flora is rich and unmodified by ploughing or fertiliser treatment. Characteristic flowering plants include common spotted orchid *Dactylorhiza fuchsii*, fen bedstraw *Galium uliginosum*, marsh arrowgrass *Triglochin palustris* and marsh valerian *Valeriana dioica*. The very rare water germander *Teucrium scordium* was recorded from this area in the past.

Annex 2 Natural England Site Management Statement April 1999

Introduction
Wytham Woods is owned and managed by Oxford University as a Site of Special Scientific Interest. It also has an agreement with the NERC that Wytham is a NERC sponsored Environmental Change Network (ECN) Site.

History
Wytham Woods (also known as the Woods of Hazel) cover some 415 ha within the Wytham Estate which is c.980 ha in extent. Apart from the Woods, most of the land is farmland. The Estate was sold to the University by Raymond ffennell who also gave the woodland to the University in 1943. The donor stipulated that "every care should be taken to preserve the woods in their present state of natural beauty.... the University will take all reasonable steps to preserve and maintain the woodlands and will use them for the instruction of suitable students and will provide facilities for research..... it is in the hope and expectation of the grantor that the character of the lands included in this agreement and the buildings thereon will remain as far as possible as at present.....".

Nature Conservation Importance
Because of their size and the University's guardianship, the Woods are now exceptional in lowland England because they encapsulate the range of habitats both woodland and non-woodland that were formerly common prior to agricultural intensification. Consequently interactions between and within them can occur which are rarely possible elsewhere. Ever since it was acquired by the University, Wytham Woods have been used for scientific study, ranging from observational to experimental and this is what sets Wytham apart as a Site of Special Scientific Interest; the extent of the knowledge about the fauna and flora, resulting from five decades of scientific study by members of the University and others (bibliography available) is unparalleled.

Approximately one-third of the area is ancient semi-natural woodland, which was historically managed as coppice with standards; hazel (*Corylus avellana*) is the most common coppice species and pedunculate oak (*Quercus robur*) the most common standard. A characteristic of the Woods is that most of these oaks are large and old. Over the course of the last 100 years coppice management has been largely abandoned. Another third of the area is recent semi-natural woodland that has regenerated naturally on arable, pasture or wood pasture sites in the last two hundred years. Some areas have been coppiced, but most are high forest. The dominant species here are ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplatanus*). The remaining woodland area consists of a variety of plantations, some on ancient woodland sites, some on sites which were formerly open. The oldest plantations date from the period following the Enclosure Act in 1814 and are mostly of beech (*Fagus sylvatica*), many of which are now large veterans. Most of the rest of the plantations (21% of the Woods by area) are less than 50 years old and the most common species are beech and oak; many conifers were planted as nurse trees, but most of these have now been felled. Elm was common until the late 1970s when all the mature trees were lost due to Dutch Elm Disease; there is currently some regeneration of young trees from root suckers, though the stems are normally attacked again by the disease once they reach about 10 cm diameter.

Almost all of the woodland except the most recent beech plantations can be classified as W8, *Fraxinus - Acer campestre - Mercurialis* woodland under the National Vegetation Classification. The ancient woodland areas tend to be the *Primula vulgaris - Glechoma hederacea* sub-community (W8a), whereas the more recent woodland is more often the *Geranium robertianum* sub-community (W8e). Some of the old beech stands on the limestone cap of Wytham Hill are W12, *Fagus sylvatica-Mercurialis perennis* woodland while the post-war beech plantations are W14, *Fagus sylvatica - Rubus fruticosus* woodland.

Apart from woodland, the Woods are important for their grassland habitats which are situated mainly on the top of the hill. Small plantations of conifers are maintained for research purposes and a variety of marshy patches, small streams and ponds add to the diversity.

Objectives
The University's objectives have been in line with Raymond ffennell's wishes (see above) while at the same time attempting to maintain the nature conservation value of the site. Specifically, this latter involves the following aims:

- To restore and maintain broad-leaved high forest woodland.
- To maintain scrub habitats.
- To maintain and promote veteran trees.
- To restore and maintain grassland habitats.
- To maintain other minor habitats especially wetland features (fens, ponds, stream sides etc.).
- To maintain reasonable access to the various parts of the woods by keeping rides open and maintaining roads

Management
The general presumption is towards high forest development and non-intervention; however clearly defined, localised areas are or will be actively managed for conservation. These different areas are treated separately below.

Non-intervention high forest

Over most of the site, the maintenance of a closed canopy of mixed, deciduous, native tree species is based on a non-intervention management policy. In the main woodland areas, rides are kept open, but little else done. Fallen timber is left where it falls (unless blocking rides) with the result that Wytham has a useful amount of dead wood. A survey conducted in the summer of 1997 estimates the amount of dead wood to be $30m^3\ ha^{-1}$, a medium value for British broad-leaved woodlands. No large trees are felled unless considered hazardous. Non-intervention is an appropriate strategy for Wytham because (1) Active ongoing monitoring and research programmes are taking place, studying natural processes and large scale environmental change; these studies would be disturbed by intensive management. (2) Thinning and felling have not taken place for much of the twentieth century in some areas and the potential exists to allow old growth forest structures and substantial dead wood communities to develop. (3) It is a large varied area and it is not necessary to introduce variety artificially. (4) There are no nationally rare species present which require active management for their survival (though see later comments on Black Hairstreak and Nightingale).

Sycamore, a non-native species has become well-established in some parts of the wood, particularly recent semi-natural woodland. It has not significantly colonised the ancient semi-natural areas or older secondary woodland which tends to be ash-dominated. Where sycamore trees are now mature and forming an important canopy dominant they will be left and future development will be monitored. In sites where ancient grasslands or veteran trees are threatened or where there is a realistic chance of reinstating old grasslands, felling will be considered (see below).

In the event of any substantial increase in non-native species such as sycamore or loss of indigenous ones, the non-intervention policy would be reviewed.

(This applies to Compartments 1, 2, 3, 5, 6, 7, 8, 10, 12, 13, 20, 23, 24, 27, 28, 31, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 59, 60, 62, 63, 64, 65).

Thinning to non-intervention high forest

Some areas of post-war plantations still require more thinning, before the final crop of trees can be left to mature. Normal forestry practice will continue to this point; thereafter it is intended that these areas should become non-intervention areas. In some clearings, individual trees, mainly of native species which are scarce in the Woods, have been planted. Details of the thinning programme will be worked up in the management plan and as in the minimum intervention sections there may be some sub-compartments that are identified for special treatment, e.g. for reversion to grassland.

(Areas within compartments 4, 14, 15, 16, 17, 18, 19, 22, 25, 26, 29, 30, 32, 33, 34, 55, 56, 57, 58).

Veteran trees

Particularly large and old, "veteran" trees have been identified (Sarah Cleveland, MSc Thesis, Oxford Forestry Institute, 1997) and if necessary localised thinning will be carefully carried out to reduce competition from younger trees, in order to prolong the lifespan of the veterans. This will normally only be done in compartments to be defined in the management plan, where it does not conflict with monitoring of the natural responses of the Woods to, for example, climate change. In these defined compartments there may also be a small number of new pollards created to provide potential successors to the existing veterans and their 'internal dead-wood' for saproxylic invertebrates. This would be particularly appropriate in association with areas which are being opened up as grassland (see below).

Scrub and coppice areas

Areas of scrub are valuable for a number of nationally declining species, especially Black Hairstreak butterflies (particularly on blackthorn) and Nightingale. Actively maintained coppice is also valuable for some species. Control of deer is the first priority in order to allow understory development in non-intervention areas. Once deer numbers have been controlled localised areas may be identified for cutting to maintain scrub and prevent succession to high forest. The most likely areas for this include the edge of the old grassland areas around the top of the hill, such as Rough Common (Compartment 21) and known Black Hairstreak sites (e.g. in Compartment 28). Small areas may also be identified for the reinstatement of coppicing.

Grassland

In contrast to the woodland, the grasslands need active management. These areas have deteriorated as a result of the loss of rabbits through myxomatosis; scrub and bracken have to be controlled on these sites on a regular basis. Sheep grazing takes place on larger grassland areas and is the subject of an ongoing research programme. Because of the nature conservation importance of some of the remnant grassland areas (notably Rough Common, My Ladies Seat, the Bowling Alley / Sundays Hill) it is desirable to expand them where feasible and to re-introduce grazing where it does not occur at present. This raises potential questions (and costs) relating to the priority of work in different areas, fencing, type of stock (their supervision), water supplies, scrub retention, bracken control etc. which will need to be addressed in the management plan.

(Compartments: 1 (part), 11 (part), 21, 35 (part), 60 (part) 61 (part), 66, 67.)

Wetlands

Radbrook Pond will be kept as open water with willow carr at the edge, with maintenance carried out on its retaining wall and sluice gate as necessary. Marley Wood Marsh and other smaller wetland areas do not appear to require active management at present but will be monitored.

Roads and rides

Access to the various parts of the woods, by roads and rides, will be maintained. Rides are cut on annual or biannual cycles to maintain plant diversity. Given that these also provide grassland habitats there might be benefits in reviewing this once the grassland management programme has been determined to see if there are links that can be made between the two.

Pest control

The major problem for management of the woodland, affecting the ground vegetation, the understory and the regeneration of trees, has been the great increase in deer since the mid-1970s. A vigorous culling program is taking place to reduce the damage. In association with this (recognising that it could take some years to bring numbers down to an acceptable level) it is desirable to establish some large deer – free enclosures within the wood.
Grey squirrel damage, especially on young broad-leaved trees (particularly oak, beech and sycamore) is serious and a poisoning campaign is carried out each spring.

Management Structure
The Woods are managed on behalf of the University by the Committee for Wytham Woods, a group of senior staff of the University including some of the senior scientists involved with research in the Woods. This Committee is responsible, amongst other things, for managing the budget and the woodland staff. There is a Sub-Committee for the Co-ordination of Research and Management of the Woods, comprising mainly scientists involved in research in the Woods, but also the University Land Agent, technicians, the Warden and the Forester-Naturalist. Dr. M. Morecroft (Institute of Terrestrial Ecology) who manages the ECN programme at Wytham and Dr. C. Gibson (Bioscan UK Ltd.), an ex-member of the University and long standing researcher at Wytham, also sit on this Committee. Its main remit is to discuss the more detailed management of the woods, and the duties of the foresters etc. in relation to research and maintenance of the woodland. There are currently four Woodland staff: a Warden, a Forester-Naturalist and two woodsmen. Their line manager is the University Land Agent. (N.B. Management structure is likely to be reviewed in 1999).

Access
Wytham Woods are privately owned by the University and there are no rights-of-way. Access is by permit only. Two types of permit are issued, for research and for walking. In order to safeguard scientific equipment, study plots etc., walkers are restricted to the roads and footpaths and dogs are not allowed. They are also restricted in the hours in which they can visit the Woods, partly for safety reasons in connection with culling deer.

Annex 3. Tree safety risk assessment

The aim of the policy is to ensure the reasonable safety of all visitors to Wytham Woods. The University has a duty to identify apparent sources of danger and make the land sufficiently safe. Liability is determined on the basis of whether a danger posed by a tree could have been foreseen, and whether reasonable remedies could have been undertaken, which would have moderated any potential hazard.

The assessor for the woods will be the Conservator with the assistance of the forestry staff. It is important that these staff recognise the limits of their knowledge and understand when it is appropriate to obtain specialist advice.

Classifying risk:
The zonation of the woods into risk zones will allow a manageable system of assessment and practical work. The division is based on the potential risk to visitors.
• High risk: Car parks, kissing gates, vehicle access points, Tarmac road system, and the Singing Way
• Medium risk: Frequently used rides and Bean Wood.
• Low risk: Remainder of woodland
These zones may require adaptation, i.e. for special events, visits, demonstrations.

Frequency of inspection:
• High risk: Detailed tree by tree inspection at least twice yearly and immediately after storms.
• Medium risk: Yearly inspection
• Low risk: During the normal course of visits.

Tree risk assessment:
This is the potential of the tree itself to cause damage. A structurally unsound tree is only dangerous if there is a significant potential to cause harm. Thus if a large dangerous limb is found on a tree in a high risk zone immediate attention is required. Such a limb in a low risk zone may not require any management.

Tree inspection:
Inspections should ideally occur in early autumn before leaf fall in order to assess the state of the canopy and to allow the observation of fungal fruiting bodies.

Schedules and recording:
Inspections should be recorded if only briefly to be able to demonstrate that this element of the duty of care has been done.
Any programme of work to trees should also be recorded.

Constraints:
The major constraints are time and money. If an area cannot be made safe in the short term by active tree management then the area should be cordoned off. Other constraints are the ongoing research programmes within the woodland and the conservation importance of the veteran tree populations. Each tree will be treated according to its particular merits.

Annex 4. Major sources of income and expenditure for the Woods (rough breakdown, 2015)

Income		Expenditure	
Central Funding*	£197,000	Staff costs (including admin support costs, pension provision etc)	£130,000
Grants (FC, HLS, SPA) **	£27,000	Ground maintenance	£40,000
Sales (mainly firewood)	£7,500	Premises	£23,000
Research project contribution***	£5,500	Vehicles	£9,000
Chalet rent	£9,600	Publicity****	£4,000
The Appeal fund brings in about £6,000 a year but sits separately to the main account.		Running costs (energy, water, consumables)	£40,000

*Budgets cut by 15% in recent years; now on 1% inflationary increase.

** Future of grants uncertain; current WGS up for renewal.

Woodland felling operations have largely broken even over the last 5 yrs.

The deer fence renewal costs £10,000/km (80% covered by NE/FC grants)

Sheep grazing is at zero cost.

*** Nominal contribution sought of £1,000 per major project per annum; £150 for smaller projects; but no-one is excluded if they do not pay.

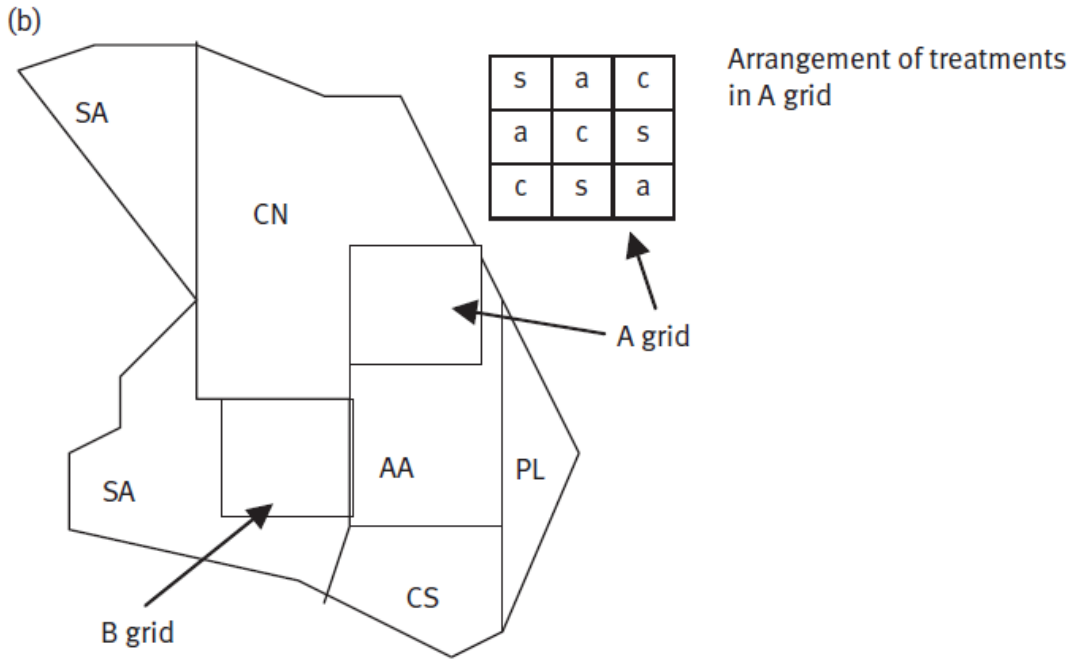
**** Increasing pressure for more outreach work.

Infrastructure – roads, rides, water supply – can all take major funding.

Annex 5 Grassland management

Upper Seeds

This experiment is in the process of being revamped as at November 2020.



Grazing in grid plots:
S 3 sheep per paddock 13-23rd April;
A 3 sheep per paddock 9-24th September
SA 6 sheep 13-23rd April, 24 sheep 23rd April to early June; 6 sheep 9-24th September,24 sheep 25th September to third week in November.
AA 6 sheep 9-24th September,24 sheep 25th September to third week in November.

Bowling Alley/Sundays Hill
10 sheep 13th April to early June
10 sheep from 9th Sept to early November.

More details are available on request to nigel.fisher@admin.ox.ac.uk

Annex 6. Higher Level Stewardship - Management of Environmental Features

HB12 - Maintenance of hedgerows of very high environmental value SP46590668, SP46720645, SP46730685

This option is aimed at the management of hedgerows specifically for the benefit of target species, and local historic landscape character. Target farmland birds, insects and mammals will benefit from an improvement in the structure of hedgerows through sympathetic trimming regimes and encouragement of the development of a diverse range of hedgerows at the holding level. Where appropriate in the local landscape, this option will also promote the development of a balanced tree population.

This management is intended to benefit the following features: Black hairstreak, Brown hairstreak, BAP hedgerow, Hedgerow.

The following rules apply across the whole area being managed under this option.
• Follow the agreed capital works programme produced by your Natural England Adviser on 1 November 2006.
• Allow hedges to reach and then maintain a minimum height of 2.5 metres and minimum width of 2 metres by year 3.
• Trim hedges between 1 August and 28 February only.
• Trim hedges no more than one year in three. Trimming of hedges should be rotated to avoid cutting all hedges in the same year – a maximum of two fifths of the total length of hedge should be trimmed in any one year.
• Leave hedges at southern boundary of fields 5968 and 7385 to grow untrimmed with a view to managing under a long-term laying rotation.
• Retain all standing deadwood unless it presents a genuine safety hazard.

Indicators of Success are:
• Each year, there should be some uncut hedgerows on the holding.
• By year 3, hedges managed under this option (excluding those parts that have been recently laid) should be at least 2.5m in height and 2m in width.
• By year 5, there should be evidence (eggs, flying adults) of black and/or brown hairstreak butterfly using these hedges.

Additional Management Prescriptions:

Brown hairstreak
• Lays eggs from August to early September on new low growth of blackthorn (often suckers). Blackthorn suckers should therefore be allowed to spread out from hedges. Trimming should be restricted to two-fifths of the total length of hedge in any one year, and should ideally be carried out in August to avoid destroying eggs.
• To achieve a range of blackthorn growth, short sections of hedge should be laid each year and then allowed to grow untrimmed to a height of at least 2.5m.
• Hedgerow trees, particularly Ash, should be retained, as these are used as 'master trees' where the butterflies gather during the flying season (July to September).

Black hairstreak
• Lays eggs on mature blackthorn, preferably more than 7 to 10 years old, in mid-June to mid-July. Sunny sheltered blackthorn thickets and dense blackthorn hedges are preferred.
• Rotational trimming and laying of hedges as outlined above will also benefit black hairstreak.

HF20 - Cultivated fallow plots or margins for arable flora SP461808 12

This option creates uncropped cultivated margin strips or in-field plots both within or adjacent to arable crops. This will provide suitable conditions for the germination and establishment of rare arable plants. These margins will also provide foraging areas in summer for declining farmland birds.

This management is intended to benefit the following features: rare arable weeds – slender tare, corn cleavers, slender bedstraw.

The following rules apply across the whole area being managed under this option.
• Annually create in-field cultivated fallow areas by producing a firm, fine tilth between February / April or August / November.
• Do not apply fertilisers, organic manures or waste materials (including sewage sludge).
• Do not disturb fallow areas before 31July.
• Control undesirable species under guidance provided by your Defra adviser.
• Treatments to, or management of adjacent land, must not affect or encroach onto the area under management.
• The area must not be used for regular access, turning or storage.

Indicators of Success are that at least two of the following target species should be present in the fallow: corn cleavers, slender tare, slender bedstraw.

HK6 - Maintenance of species-rich, semi-natural grassland (SP46590668, SP46420786, SP46830676, SP46300738, SP45730809, SP46730685, SP46550761, SP46410747)

This option is targeted at the maintenance and protection of areas of species-rich grassland. The importance of species-rich grassland is recognised by the UK Biodiversity Action Plan (BAP). The option can also contribute to protecting valued landscapes and archaeology, and the promotion of good soil conditions.

This management is intended to benefit the following features: species-rich lowland calcareous grassland BAP habitat; Barn owl, Kestrel, Brown Hare, Pipistrelle Bat, below ground historic feature – deserted mediaeval village site.

The following rules apply across the whole area being managed under this option.
• From year 1, manage the sward by grazing to achieve a sward height in May to July of 2cm-10cm over 75% of the area, with taller brome grass tussocks up to 20cm high covering a maximum of about 25% of the area.
• Manage the grassland to achieve the indicators and sward height by grazing with cattle and/or sheep. Grazing may be throughout the year but with sheep grazing largely concentrated in the autumn/winter. Stocking rates should not exceed 0.5LU/ha during mid-April to end of July to enable wildflowers to flower and set seed. Precise timings and stock numbers may need to be adjusted according to season.
• Do not install new drainage or modify existing drainage systems unless agreed in writing with your Defra adviser. This includes subsoiling and mole ploughing.
• Supplementary feeding is confined to the feeding of mineral blocks / mineral licks. Feeders and troughs should not be used. Feeding sites should be moved regularly and never placed on archaeological features.
• Control undesirable species such as Creeping Thistle / Spear Thistle / Curled Dock / Broad-leaved Dock / Common Ragwort / Common Nettle / Bracken / Brambles so that by year 3, their cover is less than 5% of the area. Agree all methods of control with your Defra Adviser.
• Ploughing, sub-surface cultivation and reseeding are not permitted. Chain harrowing or rolling are permitted except between 15 March and 15 July.
• Do not top, roll or harrow more than 30% of the total grassland area in any one year and always leave a minimum of 25% tussocks / longer grass.

• Field operations and stocking must not damage the soil structure or cause heavy poaching. Small areas of bare ground on up to 5% of the field are acceptable. Take particular care when the land is waterlogged.
• To protect the archaeological feature in field 5968 (deserted mediaeval village site), do not place anything likely to cause ground disturbance on or near the feature such as fences, feeders, water troughs.

Indicators of Success are:
• All SSSI land should be in favourable or recovering condition.
• The Soil Phosphate Index should be 0 or 1.
• By year 3, at least 4 indicator species for BAP calcareous grassland habitat such as Common Milkwort, Carline Thistle, Bee Orchid, Common Spotted Orchid, Pyramidal Orchid, Wild Basil, Wild Marjoram, Common Bird's Foot trefoil, Cowslip, Common Rockrose, Greater Knapweed, Lady's Bedstraw should be frequent, and 4 occasional in the sward.
• By year 3, cover of wildflowers in the sward (excluding undesirable species) should be between 40% and 90%.
• By year 3, cover of bare ground should be between 1% and 5%.
• By year 3, cover of Creeping Thistle / Spear Thistle / Curled Dock / Broadleaved Dock / Common Ragwort / Common Nettle / Bracken / Brambles should be less than 5% of the area.

Additional Management Prescriptions are
• Fencing around exclosures in field 7385 (Hill End) should be removed in year 1 and these areas grazed as part of the field.
• The wet fen area of field 8376 (Hill End) is to be grazed as part of field 7385. Care should be taken not to damage the fen vegetation during pollarding work.
• Timber resulting from the pollarding of willows in field 8376 should generally be removed from site, although one or two 'habitat piles' can be left on site.

HK7 - Restoration of species-rich, semi-natural grassland (SP46180812, SP46400824, SP46010825, SP46130839)

This option is targeted at grasslands that are potentially rich in plant and associated animal life. They are often on `difficult` ground and may have suffered from management neglect or they may have been selected for agricultural improvement. The botanical diversity of such grassland may be enhanced by simply amending existing management practices. The option can also contribute to protecting valued landscapes and archaeology, and the promotion of good soil conditions.

This management is intended to benefit the following features: Barn owl , Kestrel, Brown Hare, Pipistrelle Bat, Semi-improved grassland to be restored to lowland calcareous grassland - BAP habitat.

The following rules apply across the whole area being managed under this option.
• Field operations and stocking must not damage the soil structure or cause heavy poaching. Small areas of bare ground on up to [5%] of the field are acceptable. Take particular care when the land is waterlogged. From year 1, manage the sward by grazing to achieve a sward height in May to July of 2cm-10cm over 75% of the area, with taller brome grass tussocks up to 20cm high covering a maximum of about 25% of the area..
• Manage the grassland to achieve the indicators by and sward height by grazing with cattle and/or sheep. Grazing may be throughout the year but with sheep grazing largely concentrated in the autumn/winter. Stocking rates should not exceed 0.5LU/ha during mid-April to end of July to enable wildflowers to flower and set seed. Precise timings and stock numbers may
need to be adjusted according to season.
• Supplementary feeding is confined to the feeding of mineral blocks / mineral licks. Feeders and troughs should not be used. Feeding sites should be moved regularly and never placed on archaeological features.

• Control undesirable species such as Creeping Thistle / Spear Thistle / Curled Dock / Broad-leaved Dock / Common Ragwort / Common Nettle / Bracken / Brambles so that by year 3, their cover is less than 5% of the area. Agree all methods of control with your Defra Adviser.
• Do not install new drainage or modify existing drainage systems unless agreed in writing with your Defra adviser. This includes subsoiling and mole ploughing.
• Ploughing, sub-surface cultivation and reseeding are not permitted. Chain harrowing or rolling are permitted except between 15 March and 15 July.
• Do not top, roll or harrow more than 30% of the total grassland area in any one year and always leave a minimum of 25% tussocks / longer grass.
• Field operations and stocking must not damage the soil structure or cause heavy poaching. Small areas of bare ground on up to 5% of the field are acceptable. Take particular care when the land is waterlogged.

Indicators of Success are:
• The Soil Phosphate Index should be 0 or 1.
• By year 5, at least 2 indicator species for BAP lowland calcareous grassland habitat listed in the Farm Environment Plan Handbook should be frequent, and at least 3 occasional in the sward.
• All SSSI land should be in favourable or recovering condition.
• By year 3, cover of Creeping Thistle / Spear Thistle / Curled Dock / Broadleaved Dock / Common Ragwort / Common Nettle / Bracken / Brambles should be less than 5% of the area.
• By year 5, cover of wildflowers in the sward (excluding undesirable species), should be between 40% and 90%.
• By year 3, cover of bare ground should be between 1% and 5%.

Additional Management Prescriptions are:
• In year 1, areas of Bracken (particularly in field 1339) should be sprayed using Azulam. On an ongoing basis, areas of Bramble and re-growth of Bracken should be flailed.

HK15 - Maintenance of valuable semi-improved or rough grassland (SP46490660)

This option is aimed at existing semi-improved or rough grassland providing good conditions for particular target species such as chough or curlew or groups of species of interest such as wintering geese or scarce bumblebees. It may also be used to protect moderately species-rich grassland which is not BAP priority habitat, but which is identified as a priority in local targeting statements. The option will continue the successful management of the grassland. This option is only available on land outside of the LFA.

This management is intended to benefit the following features: Pipistrelle bat, Slow worm, grass snake, Habitat for invertebrates.

The following rules apply across the whole area being managed under this option.
• From year 1 onwards, manage the sward by grazing and/or cutting to achieve a variable sward structure with patches of shorter turf over 30% of the area (sward height 5cm-10cm), interspersed with taller tussocks and flowering plants over 70% of the area in April to July.
• Field operations and stocking must not damage the soil structure or cause heavy poaching. Small areas of bare ground on up to 5% of the field are acceptable. Take particular care when the land is waterlogged.
• Do not cut hay or silage before 31 July, always leaving at least 30% uncut in any one year (which need not be the same 30% each year). All cuttings that could damage the sward must be removed.
• Supplementary feeding is confined to the feeding of mineral licks / mineral blocks. Feeders and troughs must not be used. All feeding sites should be moved regularly to minimise damage to soils and vegetation and must never be placed on historic features. Care must be taken to avoid damage by vehicles.
• Do not top, roll or harrow between February and end of June. Do not treat more than 70% of the total grassland area in any one year, and always leave a minimum of 30% tussocks / longer grass.

• Ploughing, sub-surface cultivation and reseeding are not permitted.
• Do not install new drainage or modify existing drainage systems unless agreed in writing with your Defra adviser. This includes subsoiling and mole ploughing.
• Control undesirable species such as Creeping Thistle / Spear Thistle / Curled Dock /Broad-leaved Dock /Common Ragwort /Common Nettle / Bracken so that by year 3, their cover is less than 5% of the area. Agree all methods of control with your Defra Adviser.

Indicators of Success are:
• From 1 September to 28 February at least 30% of the whole field should have grasses that are allowed to go to seed and with the seed heads left undisturbed.
• At least 2 of the positive indicator species (slow worm, grass snake, pipistrelle bat) should be seen in the field every year.

Annex 7 Pond management protocol

<table>
<tr><td>SITE NAME</td><td>Wytham Woods</td></tr>
<tr><td>SURVEYS UNDERTAKEN IN 2013</td><td>Oxford University:
• Amphibians: routine monitoring of Great Crested Newt at all ponds (GCN)
Freshwater Habitats Trust:
• Wetland plants: standardised NPS method[1]
• Freshwater macro-invertebrates: standardised NPS method
• Water chemistry: pH, conductivity & nutrients using rapid field method</td></tr>
<tr><td>BAP SPECIES</td><td>• GCN
• Bats</td></tr>
<tr><td>ASSESSMENT OF POND CONDITION</td><td>All three ponds are Priority ponds – see criteria below.
<table>
<tr><th>Priority Pond Criteria[2]</th><th>Upper Radbrook</th><th>Lower Radbrook</th><th>Wormingstall</th></tr>
<tr><td>Habitat of high conservation importance</td><td>N</td><td>N</td><td>N</td></tr>
<tr><td>Species of high conservation importance</td><td>Y - GCN</td><td>Y - GCN</td><td>Y - GCN</td></tr>
<tr><td>Ponds with exceptional populations or numbers of key species</td><td>N</td><td>N</td><td>N</td></tr>
<tr><td>Pond of high ecological quality</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Other important ponds</td><td>N</td><td>N</td><td>N</td></tr>
<tr><td>Priority Pond?</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table></td></tr>
<tr><td>RATIONALE FOR PROPOSED WORK</td><td>All three ponds currently support breeding populations of GCN but the ponds are fed by streams/ditches and are silting up quickly (the ponds were restored by Oxford University c. 10 years ago). Scrub encroachment is also an issue due to lack of grazing. The proposed work seeks to address these issues to maintain good condition for breeding GCN and to help with future management of the ponds (see Appendix 2 for further details of the work planned).
Upper Radbrook:
• Increase the patchiness of freshwater habitats and help prevent siltation by creating a pond upstream of the existing pond. Pollution is not an issue as the whole of the catchment is woodland.
• Landscape the spoil heaps which remain from previous restoration work to improve access and facilitate management in the longer-term.
Lower Radbrook:
• Manage scrub encroachment in the pond and establish rotational management to maintain open conditions.
Worminstall:
• Manage scrub encroachment in the pond and establish rotational management to maintain open conditions.
• Manage dense homogenous stands of tall emergent plants to increase the diversity of habitats in the pond.
• Create silt traps on ditch line to slow down siltation and facilitate future management of silt.</td></tr>
</table>

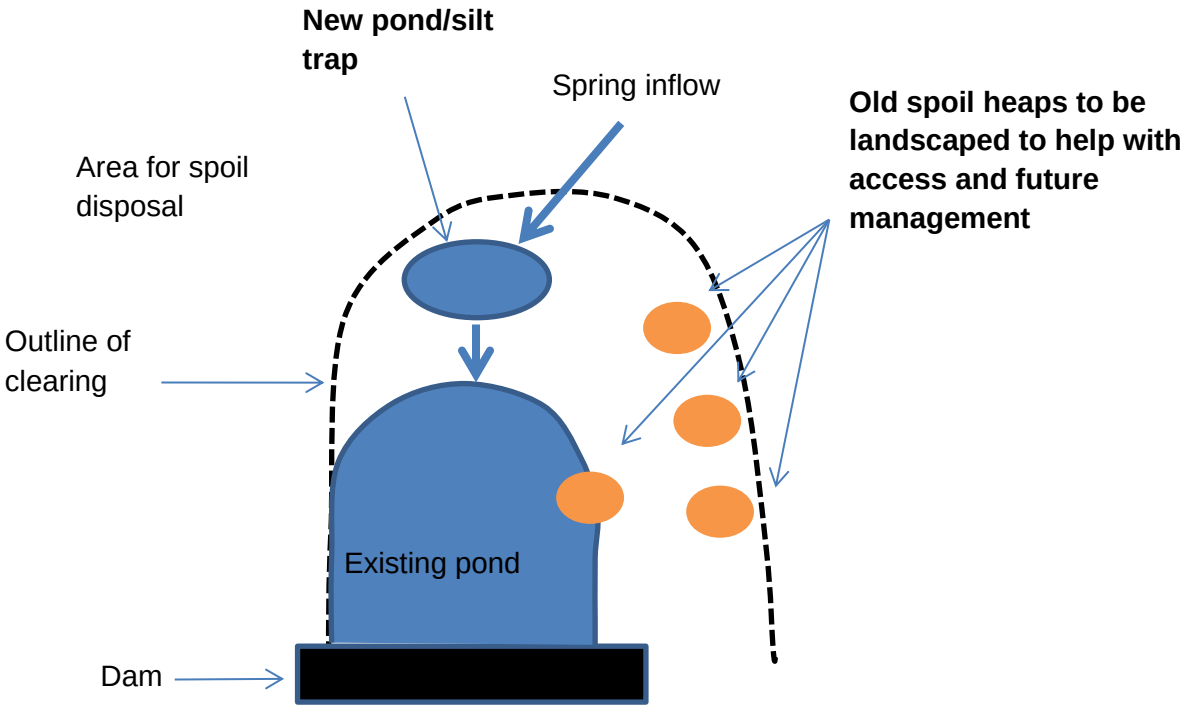
[1] http://www.freshwaterhabitats.org.uk/projects/surveys/nps-psym-methods/nps-method/

[2] See criteria at: http://www.freshwaterhabitats.org.uk/projects/pond-hap/priority-pond-criteria/

	• Replace sluice to maintain water levels.
TIMING OF MANAGEMENT	All works will be carried out outside of the amphibian breeding season (i.e. 1st November to 31st January), except for the spoil heaps landscaping at Upper Radbrook, which will be done during the breeding season, when GCN at Upper Radbrook are in the pond (i.e. from March onwards).
CONSTRAINTS	As Great Crested Newts may be present at the site, a method statement will be prepared by a Freshwater Habitats Trust (FHT) ecologist. The conservator of Wytham Woods or an FHT ecologist will also be present at various stages of the work, to ensure that the contractor is following best practice.

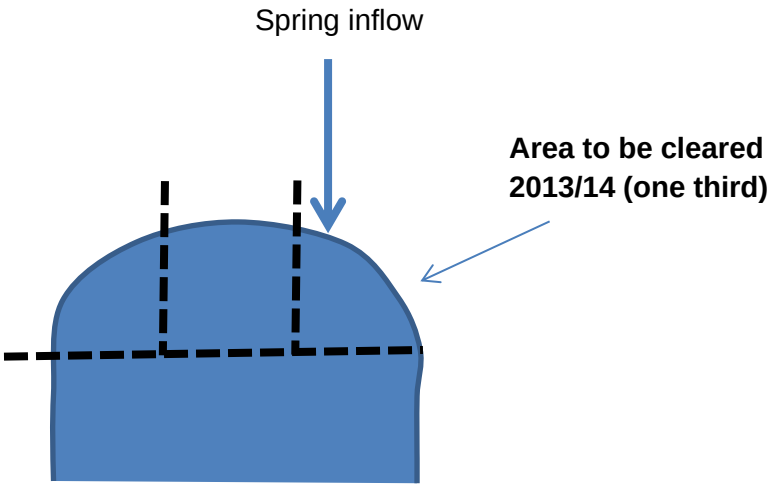
1) Radbrook Common Upper Pond

- Autumn/winter 2013: Create new pond basin c. 10-15m diameter and up to 1 m deep, upstream from pond. Spoil to be spread in surrounding woodland
- Spring 2014 (February onwards): Landscape 4 old spoil heaps to create access track



2) Radbrook Common lower

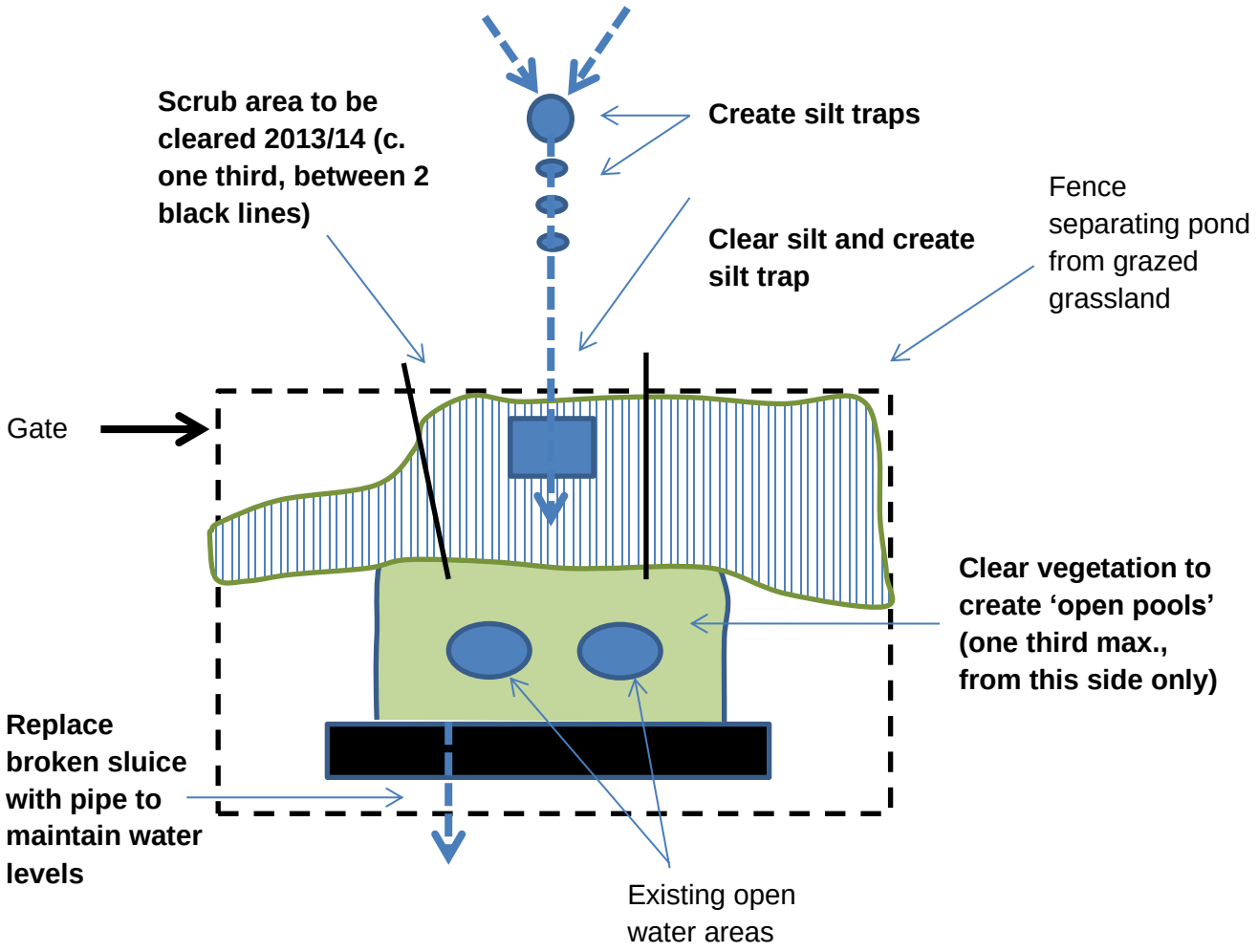
- Autumn/winter 2013: Clear 1/3 of scrub encroaching on the margin/area.
- Dispose of scrub on site – create habitat piles.



Dam → [redacted]

3) *Wormstall Pond*
- Clear 1/3 of scrub encroaching.
- Create pools in dense/homogenous sedge/sparganium/bulrush stands - remove up to 30% of total emergent cover, depending on access.
- Create silt trap within fence on ditch line.
- Repair sluice – keep at same level but replace with pipe.
- All scrub/spoil disposal within fence line.

4) *Ditch line upstream of Wormstall Pond*
- Clear silt on ditch line outside fence.
- Create a series of silt traps on ditch upstream outside fence (to be marked on site): 3-4 small ponds1-2m^2, and a larger pond up to 5m in diameter.
- Spoil disposal on grassland within the fence line.



Annex 8. Research Summary example

The Badger Project – The Wildlife Conservation Research Unit

Introduction

Directed by Prof. David Macdonald, the WildCRU's Badger Project began in 1987, initially to investigate the sociology of the species. With over 100 publications, our themes have expanded to embrace all aspects of ecology and ethology, often using the badger as a model with which to explore broader paradigm. We also collaborate extensively with groups researching badgers (and other mustelids) around the world.

Current Research

The Project is co-managed by Dr. Chris Newman & Dr. Christina Buesching, leading research into a range of portfolios:

- Population dynamics and Climate Change
- Territoriality, Movement patterns and Subterranean activity (led by current graduate student Mr. Mike Noonan).
- Olfactory Communication
- Foraging patterns and Energetic trade offs
- Mating systems and Genetics
- Immunology and Antioxidant ecology (Led by graduate student Miss. Kirstin Bilham)

Current Papers

Nouvellet, P., Newman, C., Buesching, C. D., & Macdonald, D. W. (2013). A Multi-Metric Approach to Investigate the Effects of Weather Conditions on the Demographic of a Terrestrial Mammal, the European Badger (*Meles meles*). *PloS one*, *8*(7), e68116.

Newman, C. & Macdonald, D.W. (2013). The Implications of climate change for terrestrial UK Mammals. Terrestrial biodiversity Climate change impacts report card Technical paper. Living with environmental change partnership.
http://www.lwec.org.uk/sites/default/files/Mammals.pdf

Bilham, K., Sin, Y. W., Newman, C., Buesching, C. D., & Macdonald, D. W. (2013). An example of life history antecedence in the European badger (*Meles meles*): rapid development of juvenile antioxidant capacity, from plasma vitamin E analogue. *Ethology Ecology & Evolution*, *25:* 330-350

Noonan M.J., Markham, A., Newman, C. Buesching, C.D., Ellwood, S.A. & Macdonald, D.W. (2014) Climate and the Individual: Inter-Annual Variation in the Autumnal Activity of the European Badger (*Meles meles*). *PloS one*, *9*(1), e83156.

Annavi, G., Newman, C., Buesching, C.D., Burke, T., Macdonald, D.W. & Dugdale, H.L. D.W (in press) Heterozygosity–fitness correlations in a wild mammal population: single locus, paternal and environmental effects. *Ecology and Evolution.*

Annavi, G., Newman, C., Dugdale, H.L. Buesching, C.D., Sin, Y.W. Burke, T & Macdonald, D.W (in press) Neighbouring-group composition and relatedness drive extra-group paternity rate in the European badger (*Meles meles*). *Journal of Evolutionary Biology.*

Macdonald, D.W., Newman, C. & Buesching, C.D. (in press) Badgers in the rural landscape – Conservation paragon or farming pariah: Lessons from the Wytham Badger Project. Book Chapter: In: Farming and Wildlife: Conflict in the Countryside (Vol 2) OUP.

Noonan M.J., Markham, A., Newman, C. Trigoni, N., Buesching, C.D., Ellwood, S.A. & Macdonald, D.W. (Subm) Den use by a fossorial carnivore: uncovering European badger subterranean activity patterns *Methods in Ecology and Evolution.*

Tinnesand, H.V., Buesching, C.D., Zedrosser, A., Rosell, F. & Macdonald, D.W. (subm). The role of anal gland secretion in mediating socio-spatial contact networks in European badgers (*Meles meles*): behavioural consequences of perturbation. *Ecology.*

For those interested in Wytham's wildlife more broadly, also see:

Buesching, C. D., Newman, C., & Macdonald, D. W. (2014). How dear are deer volunteers: the efficiency of monitoring deer using teams of volunteers to conduct pellet group counts. *Oryx*, 1-9.

Links

http://www.wildcru.org/research/the-badger-project/

Contact Details

Chris.newman@zoo.ox.ac.uk

Annex 9. Wytham Woods Deer Report

N F Ewart, October 2019

Background

Three species of deer are present in Wytham Woods and on the wider Wytham Estate. These are Fallow Deer (*Dama dama*) Roe Deer (*Capreolus capreolus*) and Reeves Muntjac (*Muntiacus reevesi*). Only Roe are native to the British Isles, Fallow being a long-established introduced species, while Muntjac are classed as an invasive alien.

Subsequent to the building of the deer fence in 1989 and prior to the mid-1990s control of deer was undertaken on an *ad hoc* basis by Wood staff. This strategy proved ineffective as it enabled the buildup of the Fallow population inside the fence, leading to grazing pressure, overpopulation and in turn to significant damage to the ecology of the woodland environment and a lack of natural regeneration. In 1998 a decision was taken by the Woods Committee to reduce the pressure being caused by deer through a program of targeted culling, and a contractor was engaged who in turn recruited an appropriately qualified group of deer stalkers to undertake this.

Population estimates were obtained from University staff in advance of the cull principally through the use of dung counting, an established tool used by deer managers, and initial cull numbers were determined. The initial population estimate was: Fallow >375, Roe >20, Muntjac Unknown.

The outset strategy agreed between the contractor and the University was to reduce the population to 30 of each species. This proved to be too ambitious a target. The key problem areas identified, ranged from an excessive number of Fallow Bucks and conflict arising from this around the period of the rut, to poor physical condition in the female group due to grazing pressure and a lack of available food sources.

Management Strategy 1998-2007

The Fallow population was initially targeted through this period leading to a systematic and very significant reduction. Roe were not shot, and Muntjac were shot in some years but not others. Records were maintained enabling an analysis of herd health, age profile, reproductive success, and food preferences to be built up. Conterminously work by a PhD student provided more detailed information on the structure of the Fallow group and its use of the Woodland.

Scientific samples were taken from each culled animal are listed below, and cohort analysis of culled animals was made through ageing by tooth wear. The samples were of***:*** Blood, Tissue (Lung, liver, bone), Rumen, Fecal, Reproductive Tract, Fetus

Extensive data sets were retained for each animal. These included the number of parasites carried by individual, as well as a record of each animal for condition, disease, and infectious conditions. Larder work is undertaken by suitably qualified and experienced members of the cull team.

Marley Wood was separately fenced in 2002 and has been managed to keep it deer free since then. This has proved to be a challenging task as both inward migration and human interference have enabled a regular buildup of deer in this enclosure. This has been dealt with in the main by the local deer manager and has been successful. However, in 2019 it was disappointing to find that Fallow does and young had got access to Marley through the deliberate cutting of the fence, and a failure to pass this information to the appropriate wood managers.

Management Strategy 2008-2015

The reduction in the Fallow population by 2007 saw visible regeneration particularly in the south side of the wood around Radbrook Common, where large areas of bramble (mainly *Rubus fruticosus*) became established. By 2008 it was apparent to the deer managers that there was a significant increase in Muntjac numbers across the wood. There are a number of explanations for this. Firstly, over southern England the Muntjac population continues to expand. Secondly, within the wood it is likely that the removal of Fallow has created opportunities for Muntjac to fill the vacuum. Lastly, the expansion of urban development is likely to have displaced many individual animals. It was also acknowledged that the numbers of Roe were much greater than the initial estimate, and so the decision was taken to selectively target both species during periods when the Woods were closed to enable culling to take place.

Up to four cull weeks per year took place, using teams of between 7 and 9 shooters. In addition, the Woods deer manager undertook specific culling both inside and outside the Woods when this was required, during the open season for males.

Regular night counts were introduced by the Woods deer managers, and a number of camera traps were established at strategic points to enable long term population assessment to take place. To address the issue of Fallow in difficult-to-access areas, some effort at establishing feeding areas close to deer lawns was made, but this proved to be ineffective. The outside copses of Bean Wood, Higgins and Stroud were fenced during this period and periodic trips are made to them by the deer manager and one member of the shooting team to assess and remove deer (always Roe or Muntjac) which have breached the barrier.

This period saw the withdrawal of the involvement of the contractor and his team, and the establishment of a smaller team under the management of Nick Ewart. In addition to culls resulting in the closure of the wood, Nick and his team have promoted a system of adaptive deer management which is able to react quickly to changing populations within the wood, the outlying copses and to incursions by deer into the Marley plantation.

Year	**Total Deer Shot**
2008	72
2009	58
2010	37
2011	78
2012	61
2013	49
2014	57

2015	77

Management Strategy 2015-2019

With the population of Fallow at historically low levels in 2015 (probably <20), the remaining animals have proved difficult to engage. This in part is a consequence of the acknowledged strategy Fallow adopt when under pressure, but also a reflection on the changing character of the wood from a deer perspective. Summer and autumn cover makes it very difficult to find animals during daylight. However, the use of new technology, particularly thermal imaging, has helped maximize culling opportunities while allowing for the targeting of individuals.

True Melanistic as opposed to common Fallow first appeared in Wytham in 2014. This may relate to the low numbers of deer now present in the wood, and the consequent limited gene pool in what is effectively a closed population. 2017 to date has seen increasing numbers of melanistic animals spreading throughout the wood.

Year	**Total Deer Shot**
2016	126
2017	146
2018	119
2019 to date	86

Going Forward

Currently there are a network of 33 fixed shooting positions in the main wood and in Marley providing safe shooting positions and observation points to allow for effective management.

Population estimates remain challenging, however going into the 2019/20 cull year a realistic set of numbers would be: Fallow <45, Roe <45, Muntjac >60

Key management recommendations would be to establish a range of deer lawns throughout the wood with a focus on the area bordering the Thames on the North Side and around Radbrook Common. If Marley Wood is to become deer free, investment in deer lawns within its boundaries needs to be facilitated. Communication from researchers and stakeholders around the number of deer they see could be improved and damage to barrier fencing whether accidental or not has to be made known. As inward encroachment by all three species has proved to be an ongoing problem consideration should be given to addressing the issue of subletting of sport stalking by tenant farmers. This is a potential area of difficulty due to sporting sub tenants having their clients target mainly male animals thus allowing the ever upward expansion of the active breeding population which eventually access the wood. This year there are three planned cull weekends, involving a team of seven qualified deer stalkers, three of whom have been part of the Wytham deer team since 1999.

The benefits of the reduced deer population in terms of regeneration can now be seen and felt. Deer however remain an important part of the wood's ecology and landscape, valued by permit holders and other wood users alike. While it is a distant hope that Muntjac can be limited to 30 animals as in the original strategy, the two larger species have the potential to be managed and sustained around this level.

Annex 10. Changes in recording data at Wytham as part of the Environmental Change Network

By Denise Pallet, CEH.

1992-2013

Up until the late 2000s Mike Morecroft and Michele Taylor were based at the University of Oxford Field Station at Wytham, although being part of CEH-Lancaster. It was relatively easy for them to get out to the woods and field station in order to carry out site maintenance and ECN monitoring activities that are somewhat weather dependent (such as walking the UKBMS butterfly transect) and do not have to be completed on a specific date. The ECN core sampling that was carried out in sync with the other 11 ECN sites across the UK was completed every Wednesday throughout the whole year.

For the ECN monitoring of fauna, butterfly recording (UKBMS) was carried out weekly (April-October) along the edge of the woods and back to the field station along the Thames path. Moth trapping (RIS) was carried out nightly through the help of Phil Smith (Site manager at Oxford University field station). The moths were sent off to an RIS expert for ID-ing and the Tipulid bycatch was sorted for archiving. If Phil was unable to empty the trap for any reason we had time to be able to go out and empty it. In June we carried out sweep netting to count the number of spittle bug nymphs found on monocots and dicots; approximately one month later we sweep netted for adults and these were taken back to the lab and split into the different colour morphs. From the end of March to the end of October we set out 30 pitfall traps to sample ground invertebrates, 10 at each of three sites (in a beech woodland, an ancient woodland and along a farmland hedge). These traps were emptied every two weeks and the catch sorted into three groups: carabids, spiders and other invertebrates. The carabids and spiders were sent away for identification, and the other invertebrates were archived. Twice a year we carried out an assessment of deer and rabbit numbers by counting their droppings along two transects. Dragging for ticks took place every 4 weeks. Finally, three times a year, roughly June, July and August, bat surveys were carried out through the wood and along the edge of the wood/Thames path.

In terms of monitoring of the flora at Wytham, vegetation surveys of 14 plots were carried out annually, with an additional three plots being surveyed every three years. There was a woodland survey every three years (38 plots) and additional “coarse grain” vegetation plots (2x2m) (45 plots) every nine years. We also spent time looking at and recording phenology, changes in the woodland as winter turned to spring/summer and as summer turned to autumn/winter.

Every five years a soil survey was carried out in our targeted sampling site within the Woods.

For the ECN core sampling, most protocols were carried out on a weekly basis (unless stated otherwise). We monitored four woodland streams, three for stream height and carried out chemical analysis for a range of ions along with pH and conductivity on all four. Automatic monitoring of the discharge of one of the streams was also carried out using a pressure transducer.

Meteorological data was downloaded and checked for accuracy on a fortnightly basis from our automatic weather station, although it was collected and stored on an hourly and daily basis on the data logger. Manual meteorological observations were collected on a weekly basis. These measurements were dry bulb, wet bulb, max and min temperatures in the Stevenson’s screen; grass minimum temperature; soil temperatures at 3, 10, 30 and 100cm depth; rainfall and the wind run. We monitored atmospheric NO_2 fortnightly and atmospheric ammonia with an ammonia denuder on a

monthly basis. We collected rainfall on a weekly basis and analysed this as for the stream samples, and we carried out sampling of soil water every 2 weeks as for the stream samples.

Work as part of the ECN contributed to several other networks; the Cimel contributing to the AERONET network, managed and run by NASA at the Goddard Space Flight Center, mercury in the air and rainfall and heavy metals in the air and rainfall as part of the CEH/Defra heavy metals project.

We took photos at two marked points in different areas of the woodland on a weekly basis to show weekly change.

Mike and Michele also undertook additional research on the impacts of drought on grasslands and woodland vegetation and stream water chemistry, canopy tree ecophysiology, forest microclimates, and the impacts of deer on woodland vegetation.

2013-2016

In 2013 the ECN employed myself, Denise Pallett and Stefanie Schafer to take over from Michele. Michele had worked with sandwich students since Mike left and we benefitted from having the extra help with the then weekly ECN core sampling, sample processing and sorting, submitting and archiving of data. By 2016 biological recording had reduced to butterflies, moths (which we couldn't do without the help of Phil Smith), spittle bugs, ground invertebrates, and bats.

In terms of vegetation, the annual vegetation survey of 14 plots was carried out, if it was not a woodland or coarse grain year. We also spent time looking at phenology, changes in the woodland as winter turned to spring/summer and as summer turned to autumn/winter.

For the ECN core sampling that had been carried out on a weekly basis (unless stated otherwise), we changed to fortnightly measurements at the start of November of 2016. We monitored four woodland streams, as previously and water discharge was automatically measured for one stream as previously described.

Meteorological data was collected on a 2 weekly basis from our automatic weather station as previously described along with atmospheric NO_2 atmospheric ammonia with an ammonia denuder on a monthly basis.

We took photos at two marked points at 4 weekly intervals.

We collected rainfall on a weekly basis (until November when it became fortnightly) and analysed this as for the stream samples, and we carried out sampling of soil water every 2 weeks as for the stream samples.

Additionally we carried out some time lapse photography of seasonal changes in the woodland, and our sandwich student carried out a project to look at carbon storage in soils under different agricultural and forest management practices.

2018 onward

Funding and staff time cuts meant that from April 2018 onwards we now only have one person to go out to Wytham every 4 weeks. Currently the long-term prospect for ECN is bleak. The plan for next year is to carry on with a skeleton sampling protocol.

The only invertebrate recording we will be carrying out will be recording the butterfly transect and running the moth trap. We would not be able to carry out either of these activities without the help of Phil Smith for the moth trap and volunteers (which can be a good and bad thing in equal measure) to help with the butterfly transect.

Our core recording will continue in the scaled down format from previous years. We will be monitoring two woodland streams for stream height and carrying out chemical analysis for a range of ions along with pH and conductivity. Automatic monitoring of the stream height at one of these streams has been discontinued as the, now unsupported, data logger has stopped working.

We will be collecting data on a 4 weekly basis from our automatic weather station, although this will be collected and stored on an hourly and daily basis, as it has always been. Manual meteorological observations will be collected on 4 weekly basis. We will continue to monitor atmospheric $N0_2$ on a 4 weekly basis and atmospheric ammonia (passively) on a monthly basis.

We will continue to take photos at two marked points at 4 weekly intervals.

In 2020 we hope to carry out some vegetation recording, the annual recording (mentioned previously) has now been downsized, so instead of all plots being recorded annually we are visiting a subset of the plots every year, meaning that the plots will be recorded every three years. 2020 is also the year in which the woodland plots (38) will be surveyed along with the coarse grain vegetation plots (2x2m) (45 plots) if we can negotiate time to carry this out.

We will continue with the permanent pasture experiment on Lower Seeds, where we measure yearly biomass production and also plant species diversity.