Hördalen Veteran Oak Survey
&
Arboricultural Management Plan

On behalf of

Länsstyrelsen in Hallands Län
30186 Halmstad
Sweden

Authors
Vikki Forbes, Luke Fay, Matthias Lindholm & Ben Rose

Surveyors
Vikki Forbes, Luke Fay, Lee Surey & Matthias Lindholm.

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Pro Natura
www.pro-natura.net

TREEWORK ENVIRONMENTAL PRACTICE
www.treeworks.co.uk

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Sammanfattning

Pro Natura har i samarbete med Treework Environmental Practice genomfört en inventering av gamla ekar i Hördalen. Syftet med trädinventeringen har bland annat varit att fotografera och lokalisera alla gamla ekar (s.k. "Veteran oaks") i området samt att samla in uppgifter om trädens tillstånd och mängden substrat och element som är knutna till träden enligt "English Nature Specialist Survey Method" (SSM). Denna metod innefattar även en bedömning av trädens tillstånd och när träden förväntas bli så försvagade att de dör eller kollapsar. I uppdraget ingick också att upprätta enskilda skötselplaner för varje inventerat träd samt att ge generella skötselrekommendationer.

I inventeringen noterades 63 levande och 11 döda gamla ekar. 66 % var ek (Querqus robur) och 20 % var bergek (Querqus petraea) medan övriga 14 % var Querqus sp. Det fanns en tydlig grad av hybridisering mellan dessa två arter i detta material. Trädens omkrets varierade mellan 196 cm och 487 cm. 98 % av ekarna har vuxit upp utan att de har blivit utsatt för ingrepp som hamling eller stamkvistning. Träden hade en varierad grad av kronreduktion. 73 % hade kvar nästan hela sin krona men samtidigt hade 26 % förlorat mer än halva sin ursprungliga krona. Vattskott har främst utvecklats i trädens övre delar men det är osäkert om det beror på beskuggning, abiotiska faktorer eller trädens genetiska uppsättning.

Mängden ärr, brottytor, grensprickor, avbrutna levande grenar, håligheter, hål, röta och död ved ger ett index på trädens värde som livsmiljöer åt andra organismer och detta kan användas vid jämförelser med andra områden. Hördalen har värdet 9,9 som är det högst uppmätta värdet jämfört med samtliga områden (merparten belägna i Storbritannien) som undersökts med samma metod. Särö Västerskog har som jämförelse 9,2. Skillnaden mellan Hördalen och Särö i detta avseende kan förklaras med att träden i genomsnitt är större i Hördalen än i Särö Västerskog. Det genomsnittliga antalet hål per träd (mellan 5 och 15 cm i diameter) var 2,6 och antalet större håligheter (> 15 cm i diameter) i kronan var 1,3. Storleken på stamhåligheterna är ungefär densamma för basen, mittsektionen och toppen. Brunröta var relativt vanligt och noterades på nästan 70 % av träden medan mulm fanns i ca 30 % av träden. Brunröta är ett första stadium i mulmbildningsprocessen och därför kan tillgången på mulm förväntas vara god i framtiden under förutsättning att merparten av de gamla träden inte dör. Mängden död ved i anslutning till träden (fastsittande och nedfallen) mättes i enheter. En enhet motsvarar 1 meter död ved som är grövre än 15 cm i diameter. Ett medelvärde på 17,3 enheter fastsittande död ved och 9,2 enheter nedfallen död ved per träd noterades. Mängden fastsittande död ved är vid jämförelser med alla andra områden som har undersökts med denna metod den absolut högsta. Den relativt låga mängden liggande död ved speglar gångna tiders markanvändning där nedfallna grenar och trädstammar kontinuerligt plockats bort. Dagens volymer av död ved är ett resultat av att träd och grenar under senare tid dött av och är inte att betrakta som en stabil framtida resurs.

Då man bedömer vitalitet samt sannolikheten för en gradvis försämring av träden och sannolikheten för att träden skall kollapsa får man fram uppgifter på trädens tillstånd och var man bör sätta in lämpliga skötselåtgärder. Tillståndet bedöms enligt en skala från 1 till 30 och 30 är det maximalt bästa tillståndet. En angivelse på 12 indikerar att trädet visar en tydligt nedåtgående hälsotrend medan 10 anger att trädet sannolikt kommer att dö inom en nära framtid. För 6,3 % (4 stycken) av de levande träden i Hördalen angavs hälsotillståndet till 10 eller mindre. Ytterligare 7,9 % (5 stycken) av de levande träden visar tydliga tecken på försämrat hälsotillstånd (angivelse mellan 11 och 15). Å andra sidan är hälsotillståndet för över 50 % av de levande träden så bra att de fått angivelser över 20. Den genomsnittliga angivelsen för hälsotillstånd var 19,3 jämfört med 18,6 i Särö Västerskog. Det finns ingen signifikant skillnad på träden tillstånd mellan dessa båda områden men vid jämförelser med undersökta områden i Storbritannien (Lords Bushes England, Dinefwr Wales, Richmond Park England, Ashton Court England, Hatfield Forest England) har alla, utom Lords Bushes där igenväxning är ett stort problem, ett signifikant högre medelvärde. Anledningen till de relativt låga angivelserna för hälsotillstånd kan bero på andra jordartsförhållanden, trädpopulationens genetiska sammansättning eller hög exponeringsgrad för salta havsvindar.

I Hördalen är det en relativt liten andel av träden som lider av kraftig konkurrens från omgivande vegetation. Detta till största delen som en följd av senare tiders skötselåtgärder. De största

anledningarna till försämrat hälsotillstånd är vind (15 %) och sammanpackning av jord (14 %) som har uppstått på och intill stigar som löper intill träden.

Vid inventeringen bedömdes ca 15% av populationen gamla ekar ha dött under de senaste 25 till 30 åren. Detta ger ett uppskattat mortalitetstal på 0,6 % per år (0,5 % i Särö Västerskog och 1,0% i Lords Bushes). Vid undersökning av de olika trädens hälsotillstånd bedömdes dock att 9 träd (14 % av den levande populationen) kan komma att dö inom de närmaste 10 åren om inga skötselinsatser sätts in. Detta ger ett mortalitetstal på 1,4% per år. Om denna populationstrend tillåts hålla i sig skulle hela populationen av gamla ekar i Hördalen vara försvunnen inom 75 år. Detta är för kort tid för att nästa trädgeneration ska ha hunnit nå lämplig ålder och utvecklat höga habitatkvaliteter. I frånvaro av lämpliga skötselinsatser kommer dessutom den kommande trädgenerationen att växa upp under skuggiga förhållanden och inte utveckla kvaliteter knutna till åldriga, öppet växande ekar. Åldersklassfördelningen ger en fingervisning om att det för närvarande inte finns tillräckligt många träd i mogna åldrar för att underhålla populationen åldriga träd men mer ingående undersökningar behövs. Målet bör vara att ha minst dubbelt så många mogna träd som åldriga träd innan den nuvarande generationen gamla träd dör ut. I området, speciellt de delar som är belägna på djupare jordar, bedöms därför inte gynnsamma förhållanden råda med tanke på framtiden.

Utifrån genomförd undersökning bedöms ideal skötsel för området vara en stängsling av områdets yttergräns och därefter återinförande av bete på en relativt låg nivå för att sedan kunna utöka detta till en passande nivå. 0,3 djurenheter per hektar föreslås som en lämplig nivå att börja med. Vid behov rekommenderas att en specialist på frågor rörande betestryck konsulteras. Bete bör kombineras med försiktiga röjningar runt de gamla träd där igenväxning är ett problem. Röjning bör även genomföras kring identifierade framtida "Veteran oaks - kandidater" så att dessa får tillräckligt med ljus och kan utveckla stora kronor med lågt ställda grenar. Gallring och röjning skall ske under kunnig ledning och man bör eftersträva att spara så många mogna träd som möjlig så att generationsglappet minimeras. Plantering av nektar- och pollengivande buskar har rekommenderats i vissa delar.

Två tredjedelar av de inventerade träden är i behov av någon form av skötselåtgärder inom den närmaste tioårsperioden. Merparten av föreslagna åtgärder utgör någon typ av beskärningsåtgärder i kronverket. Högst prioritet har givits träd som i dagsläget har ett vacklande hälsotillstånd eller hög risk att falla omkull eller brytas sönder. För dessa träd ska dock föreslagna åtgärder ha goda möjligheter att förbättra situationen för det enskilda trädet. Kondition och hälsotillstånd får inte vara så dåligt att trädet dör eller faller samman trots föreslagna åtgärder. Exempel på skötselplaner för individuella träd och förslag på arbetsgång återfinns i bilaga III respektive IV. Återbesök och uppföljning av samtliga vidtagna åtgärder är av största vikt för att i framtiden kunna finjustera områdets skötsel. Allt arbete som innefattar beskärning av åldriga träd bör genomföras av kvalificerade arborister och hänsyn måste tas till det faktum att åldriga träd har en lägre toleransnivå beträffande kraftiga förändringar i den närmaste omgivningen.

I rapporten rekommenderas även att fortsatta undersökningar avseende den generella vitaliteten hos de yngre trädgenerationerna (inklusive mortalitetstal för olika åldersklasser) och huruvida de båda Quercus-arterna skiljer sig åt när det gäller deras betydelse för biodiversiteten.

Summary

Pro Natura in co-operation with Treework Environmental Practice undertook a veteran tree survey of the old oaks in Hördalen. The aim of the project was to plot, photograph and record information according to the English Nature Specialist Survey Method (Fay & De Berker, 1997) for each oak. In addition information regarding the viability of each tree was recorded (based on an assessment of vitality and failure expectation) and recommendations for management on a tree by tree basis given. These recommendations were also interpreted into more general site management recommendations.

63 living and 11 dead veteran oak trees were identified of which 66% were recorded as Quercus robur and 20% as Quercus petraea, although there were significant signs of hybrids between Q. petraea and Q. robur. The largest tree had a girth of 487cms and the smallest 196cms. 98% of the trees showed no signs of previous management. 73% of the trees had a mostly fully canopy, whilst 26% had shed half of their crown framework. The majority of the epicormic growth was recorded from the upper parts of the crown, which may be as a consequence of the shading, other abiotic factors or the genetic make up of the trees.

An index which measures the habitat value of the trees gave an average of 9.9 for Hördalen (the highest was 19 and the lowest 4) compared with 9.2 for Särö Västerskog. Hördalen has the highest mean habitat score recorded from any site previously studied in Sweden and the UK. This index is calculated from information regarding habitat features on the tree including, hollowing, holes, decay and deadwood. The difference could be explained by the larger average size of the trees at Hördalen when compared with Särö Västerskog. The average number of holes (between 5 and 15cms in diameter) in each tree was 2.6 which is the same figure as was recorded from Särö Västerskog. There was an equal amount of hollowing recorded from all parts of the stem (not including the crown). Brown rot was the most commonly recorded rot and was identified from 70% of the trees and 30% of trees were recorded as having the rarest; black, soil type rot. Brown rot is the pre-cursor to the black soil type rot and therefore the likelihood of having good quantities of this habitat on the site in the future is high assuming the trees survive. Hördalen has the highest amount of dead wood attached to the tree, with an average of 17.3 units (1 metre lengths greater than 15cms in diameter) when compared to all of the other sites studied. The average fallen dead wood amounted to 9.2 units, which reflects the historical removal of fallen dead wood. The current volumes of dead wood are a result of recent rates of tree loss and are unlikely to be sustained in future decades assuming management takes place.

The arboricultural or viability assessment takes account of vitality, decline expectation and likelihood for collapse. In this system the maximum possible viability score is 30. A score of 12 shows a strong tendency to decline and a score of 10 is on the margins of viability. 6.3% of the living trees at Hördalen had a score of 10 or less. A further 7.9% of the living population are prone to advanced decline (scoring between 11 and 15): a total of 9 trees. However over 50% of the population scored over 20. The mean viability score for the trees at Hördalen was 19.3 compared with Särö Västerskog which was 18.6. Compared with the sites surveyed in the UK, this is significantly lower than all sites except one; Lords Bushes, which is suffering from significant competition. It is also possible that the situation is more complex and that the lower average score may be a reflection on different soil conditions, the genetics of the trees along with exposure to wind and salt.

At Hördalen a relatively small proportion of the population is suffering from extreme competition, due to recent management operations. 15% however, have been affected by wind and 14% are suffering from the effects of soil compaction, mainly due to the presence of footpaths within the crown drip line.

It is estimated that 15% of the population may have been lost in the last 25 to 30 years giving a mortality rate of 0.6% per year (c.f. Särö Västerskog 0.5, Lords Bushes 1.0%). However the viability score suggests that 9 trees (14% of the living population) would be lost within the next ten years without any form of management representing a mortality rate of 1.4% per annum. If this decline were to continue, the old oak population may be lost within 75 years, which will be well before the next generation is in a suitable condition with appropriate levels of habitat. In addition

without management it is unlikely that a future generation will have the open grown characteristics often associated with ancient trees. The age class distribution highlights that there are currently fewer mature trees than ideal to sustain the ancient tree population, but this does require further investigation. The aim should be to have at least twice as many mature trees as ancient trees before the current generation dies out. The site, particularly where the soils are richer is assessed to be in unfavourable condition and declining.

As a consequence of this study it is proposed that the ideal management for the site would be to perimeter fence and re-introduce grazing at a very low level (0.3 livestock units/ha to begin with). It is also recommended that a grazing specialist be consulted to help inform grazing levels. This should be coupled with sensitive clearance around the old oaks which are suffering from competition and around some younger oaks in order that they may develop a wide-open grown crown. Some planting of nectar and pollen sources in the form of flowering bushes has been recommended in places.

Two thirds of the population requires some form of management within the next ten years; the majority of this involves tree surgery. The highest priority treatments are scheduled for trees in danger of structural disintegration or accelerated physiological decline but are considered possible to save with intervention. Examples of individual tree management plans can be found in Appendix III and examples of a prioritised work programme in Appendix IV. Monitoring, re-inspection and recording of all work undertaken is essential for the full benefit of the management regime to be realised. All tree surgery work on ancient trees should be undertaken by suitably qualified arborists with due consideration to the likely intolerance of ancient trees to drastic changes in their environment.

It is recommended that further work is carried out to investigate the general vitality of the younger oaks (including mortality rates of different age classes) and the relative importance of both Quercus species in terms of their habitat value.

Conclusion

i. *This site is important for the conservation of decaying wood communities. This survey has identified that the ancient trees are in decline and that active intervention is required in order to maintain these trees and the associated species.*

ii. *It appears that an estimated 15% of the veteran oak population has been lost during the past 25-30 years. Without careful management this trend will continue. Many of the veteran oaks require crown reductions in order to avoid structural failure. Without intervention it is not too pessimistic to consider a complete loss of the ancient tree population within 75 years.*

iii. *The competitive tree growth around the veteran oaks requires thinning to reduce the pressures on the valuable old trees.*

iv. *Management of the younger tree generations should be aimed to ensure that future open grown ancient trees develop and the habitats associated with old trees persist over time.*

v. *It is believed that management for conservation could be compatible with the recreational aims of the site. However any form of management for nature conservation will appear dramatic to the public and therefore efforts will be necessary to educate and engage the public in the principles and practice associated with the proposed works.*

vi. *It is proposed that restoration to a wooded pasture with grazing animals would be the ideal management both for the individual trees and the site as a whole.*

vii. *If the nature conservation management proposals are implemented the Hördalen project could be used as a restoration model for other sites within Halland and more widely. This work would no doubt contribute to the development of an increased understanding of veteran tree populations in Sweden and the UK.*

viii. *Consideration of extension and expansion of Hördalen should be a priority when the opportunity arises, particularly concentrating on those areas which lie adjacent to the site to the north and south.*

Hördalen Veteran Oak Survey 2004

1.0 INTRODUCTION

1.0.1 Hördalen lies within and is owned by Kungsbacka Kommun. Västkuststiftelsen are responsible for the current nature conservation management that is carried out on the site. The area is open to the public (as is the majority of the countryside in Sweden) and is managed according to objectives laid down in the management plan. The site is a nature reserve and is of national importance for the lichen flora associated with the significant population of old oaks. This is partly due to the fact that it is situated close to the sea on the west coast of Sweden and has both continental and Atlantic species. It is also notable for the fauna and fungi flora associated with the old oaks.

1.0.2 Hördalen has a significant number of ancient oaks, which are currently surrounded by secondary woodland which has grown up since the cessation of grazing. The oaks are showing signs of poor health and there is concern about their long term future. It is vital that the longevity of these trees is encouraged due to the relatively large generation gap which exists on the site.

1.0.3 In order to secure the future of the old oaks and provide base-line data to inform management objectives and strategies Länsstyrelsen in Halland has initiated a targeted survey of the veteran oaks within the nature reserve of Hördalen. The key aspect of this project is the production of a series of management objectives for each tree (Individual Tree Management Plan), which if implemented should help to secure their long term survival. This work also provides some indication of mortality rates and therefore priority for management.

1.0.4 In May 2004 Pro Natura (in co-operation with Treework Environmental Practice) were commissioned by Länsstyrelsen in Halland to undertake this project.

2.0 BACKGROUND

2.0.1 The information from the maps dating from 1843-1844 suggest that Hördalen was less tree-covered than today. The area was once cut for hay and grazed and the wide crowned oaks are testaments to a long period with a more open character. It is likely that even the steep slopes were used for grazing indicated by the presence of juniper and the stone walls.

2.0.2 During the early 1940's it was grazed by cattle and also horses, however grazing had virtually stopped by the end of that decade. Some management took place during the 1960's and 70's when some of the aspen and alder was removed. More clearance of secondary woodland took place in the early 1980's (Fritz, 2001) and further work in 1996. The lack of grazing or regular cutting has resulted in the grassland becoming overgrown. There has been a history of fallen dead wood removal, however this has now stopped.

3.0 SITE DETAILS

3.0.1 Hördalen is 31 hectares in size and was established as a nature reserve in 1971. It is also a Natura 2000 site with five different habitat types (8230 – Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*, 91E0 – Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*, 9190 – Old acidiphilous oak woods with *Quercus robur* on sandy plains, 9180 – *Tilio-Acerion* forests of slopes, screes and ravines, 9160 – Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli)*. Despite its small size Hördalen contains three different Woodland Key

Habitat types and more than 40 Red Data Book species have been recorded. The grazing history has had a significant influence over the ground vegetation and there are still a number of juniper bushes on the slopes which bear witness to that time.

Figure 1: Number 53 - An oak typical of the richer soils which has grown up in an open situation

3.0.2 Hördalen consists of two oak (mainly *Quercus petraea*) dominated ridges with steep slopes and a valley with an overgrown oak wood pasture and alder carr which run through the middle of the site. The site is long and relatively thin and runs down to the sea. The alder carr also contains individuals of oak and ash in the drier areas and is of significant value for nature conservation. At least some of the 70 or so ancient oaks are thought to be more than 400 years old (Niklasson, 2003). The ground flora along the valley and the southern slopes is rich with species such as *Hepatica nobilis, Anemone sp., Mercurialis perennis, Lathyrus niger, Vicia tatrasperma, Campanula persicifolia* and *Primula veris.* The bird fauna is also rich and represented by many of the Swedish songbirds, tawny owl, and buzzard, black, greater and lesser spotted woodpeckers. The site has a rich fungus flora including *Inonotus dryadeus, Ganoderma resinacuem, Lecanographa amylacea* and recently the first European record of the fungus *Cordyceps stylophora (*Norden, *pers comm.).*

3.0.3 The bedrock consists of granite on the slopes and valley tops, however there are also areas of amphibolite which weathers more easily and contains more base-rich minerals. The latter together with lime rich clay gives rise to a relatively rich soil and thus flora in the valley bottom. Sandy soils are also found in some areas where the old oaks grow. The soils on the steep slopes are very thin and have many oaks that are *Quercus petraea*. Many of these oaks, although small have veteran characteristics as a result of the effect of wind and poor soils, which would indicate that they are older than their size suggests. It is likely however that few are older than 120 years of age (Niklasson, 2003). Other tree species include lime, aspen, birch and swedish maple which are mainly found on the slopes. The bush layer is dominated by hazel and some juniper on the slopes.

3.0.4 Hördalen lies on land with an east west aspect that runs to the sea. It slopes gently and fairly evenly from northwest (max ht. 79m O.D.) down to east (38m O.D.) within the valley.

3.0.5 The site is generally well drained except for the areas of alder carr where standing water gathers. There is a small stream which runs along the valley bottom. It also likely that some areas in the valley bottom become flooded during periods of high rainfall.

4.0 SURVEY INFORMATION

4.0.1 The area to be surveyed is within Hördalen nature reserve.

4.0.2 In Sweden wooded pastures and wooded meadows have been identified as Natura 2000 types. Ancient trees are also one of the woodland key habitat types, identified as part of a nationwide Woodland Key Habitat Survey. The habitat and the trees are considered important for the wide range of specialised and threatened species associated with them.

4.1 Survey Aims

The aims of this survey are:

a) To find and plot all veteran oaks (including standing and fallen dead oaks) within the survey area, using GPS and laser equipment (with an accuracy of less than 1 metre).
b) To tag all of the veteran oaks within the Hördalen survey area.
c) To survey these trees for habitat using the English Nature specialist survey method.
d) To carry out an arboricultural viability assessment for all trees in the survey.
e) To provide individual management plans for these trees.
f) To digitally photograph each surveyed veteran oak.
g) To record all survey findings in a database.
h) Provide an Excel spreadsheet with all the data that can be added to at a later date.
i) To produce a report outlining the key findings from the survey, providing a comparison with other populations of ancient trees that have been surveyed and site management recommendations.

4.2 Survey method

4.2.1 Tree data and habitat features were collected using the English Nature Specialist Survey Method (SSM). Treework Environmental Practice has further developed this method to incorporate a condition assessment of the viability of the veteran trees. This requires an assessment of vitality, and records failure expectation (from indications of decline in vitality and in structural stability).

4.2.2 Data was recorded on site, tree by tree, directly onto pen-notebook computers by means of the *Treework* SSM Tree Solutions System database. This incorporates the SSM plus veteran tree survey modules. The tree positions were located using a Geographical Positioning System (GPS) combined with laser plotting equipment and are digitally identified with their allocated tag numbers. Veteran trees are respectively plotted on

overlays superimposed upon aerial photographs supplied digitally by Länsstyrelsen in Hallands Län (see Appendix V).

4.3 Limitations

4.3.1 This survey represents the beginning of a comprehensive collation of information on the veteran oak population and as such the analysis of the survey is restricted by the lack of detailed previous comparative data. The current survey brief is restricted to an assessment of live and dead veteran oaks.

4.3.2 Throughout the fieldwork the weather was warm and clear, which meant that visibility on the whole was good. Difficult terrain on the steep, boulder clad slopes may have concealed a few, smaller veteran oaks from the surveyors and caused an understatement of ancient tree numbers.

4.3.3 It is emphasized that this report is not a safety inspection and is confined to assessment of habitat features associated with the survey population. Where recommendations are provided, these are made for the purpose of enhancing tree longevity and stability for the conservation and protection of the veteran trees themselves. The relative needs of the species associated with the old trees is therefore not considered in the first instance as there is a presumption towards stabilising the old tree which thereby secures the substrate with which the rare species are associated.

4.3.4 The survey system used was developed for UK conditions, which is not considered to be significant limitation in itself. By the fact that the surveyors who have carried out the viability assessments are the same for both UK and Swedish sites, makes the data less likely to vary due to user subjectivity. Growing conditions do differ between Sweden and the UK. The UK in general terms has a milder climate throughout the year particularly during the winter months and especially in the south of England, where the previous studies have been carried out. It is important to take these variations into consideration when drawing comparisons.

5.0 TREE DATA

5.1 Tree number [1]

The tree number provides a unique numerical identifier within this site. The sequence of tree numbers should not be taken to be an indication of position, status or continuity of data. Numbers run from 1-74. The tags were placed as high as could be reached from the ground, on the northern side of the tree unless this was adjacent to a footpath, when the tag was placed on the side out of view from the footpath. The tags (Latschbacher) and nails used are made from stainless steel. The nails were hammered in at an angle, leaving at least 1cm (usually more) protruding from the tree, thus ensuring that the tag rests on the tree and the tree is able to grow without damage.

Figure 2: An example of the Latschbacher tags used. They are attached to the tree with a single rust-proof nail.

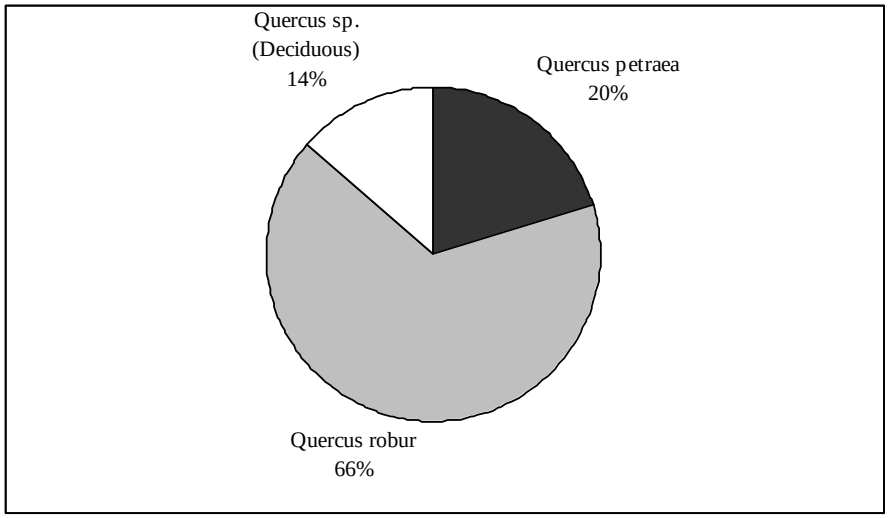
5.2 Grid Reference [2]

The positional data are recorded as fourteen figure grid references for all trees. The X-Y co-ordinates for these trees are held in spreadsheet form and may also be accessed through the GIS system.

5.3 Species and species composition [3]

5.3.1 The surveyors' observations indicate that the majority of the veteran oak trees are *Quercus robur.* It should be noted however that there were clear signs of hybridisation in the oaks. The species recorded was decided based on the number of specific features associated i.e. if the tree had more *Q. robur* features then it was recorded as such even if there were some *Q. petraea* features evident. The dead trees were for the most part recorded as non specific *Quercus*.

Figure 3: The species composition of the veteran tree population recorded at Hördalen by percentage (49 *Q. robur*, 15 *Q. petraea*, 10 *Quercus sp*.).



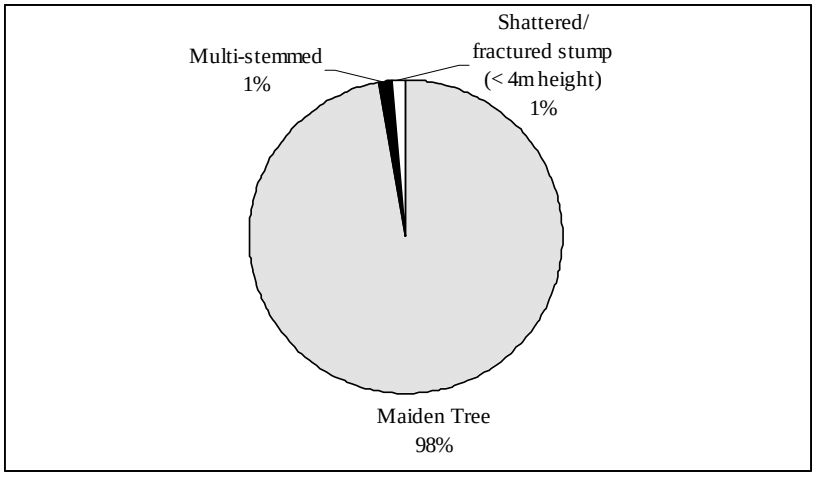
5.3.2 This survey identified 63 live veteran oaks at Hördalen. Eleven dead veteran trees were also identified and included in the survey.

5.4 Girth, Tree Form and Standing/Fallen [4], [6] & [7]

5.4.1 The measurement of tree girth can be a misleading factor in the evaluation of veteran tree status. There is a considerable range between the maximum and minimum girths recorded on the site. The largest girth of 487cms was recorded from tree 64 and the smallest was 196cms from tree 35.

5.4.2 Management of oak has been much debated in Sweden; whether it took place or not. It is clear, however from the tree form at Hördalen that significant tree management has not taken place, see figure 4.

Figure 4: Most of the trees are maiden or unmanaged in form.



5.4.3 All of the living trees were in a more or less upright position. The fallen trees of which there were 6 in number were all dead without any signs of layering.

5.5 Live growth and crown loss [8] & [9]

5.5.1 The assessment of crown loss and the proportion of live growth present in the crown are intended to provide indicators of past trends in tree condition with reference to crown mass and live foliar distribution. The study found that 73% of the veteran oaks had a mostly full canopy (a score of 1 signifies that live growth covers over 50% of current canopy outline and 5 signifies that the entire tree is dead). These results will provide valuable baseline material for future comparative surveys.

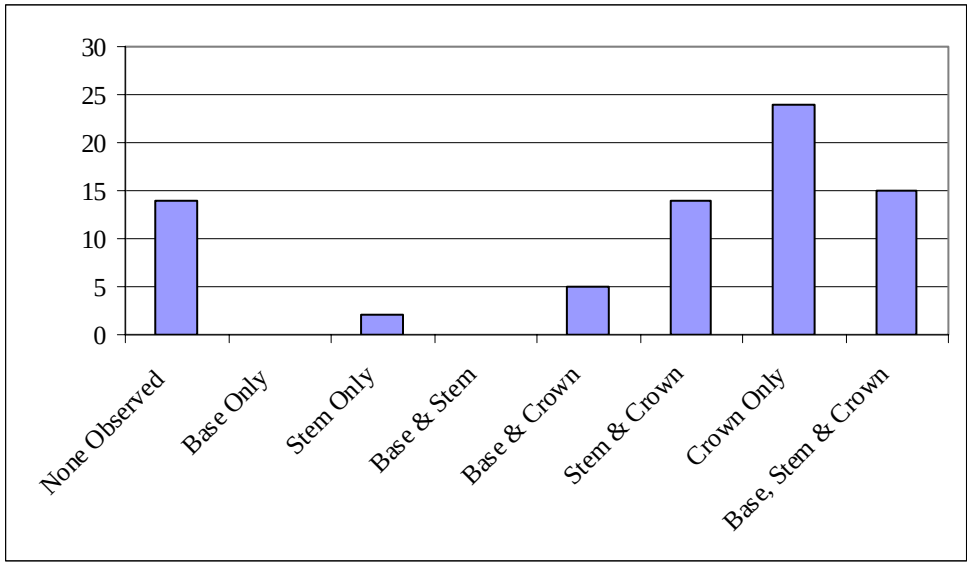
5.5.2 42% of the trees surveyed have a full crown outline. However 26% have lost over half of their peak crown outline. This appears to be mostly due to loss of crown branches. Once again these results will provide valuable baseline material for future comparative surveys.

5.6 Epicormic growth [10]

5.6.1 This is twiggy growth which is seen developing from the bark surface, often as a response to stress or environmental changes. In veteran trees a sustained, strong epicormic presence typically indicates an inherent predisposition of a specimen to readily produce and adopt regenerative or rejuvenation growth. Such a trait often characterises ancient trees. Its register can be a useful reference in an assessment of veteran attributes and can guide identification of candidate veteran trees. An epicormic response, which is expressed as a short-term flush of growth, may on the other hand, be symptomatic of an unsustainable, physiological reaction to trauma; a short-lived feature, preceding decline.

5.6.2 At Hördalen epicormic growth on the veteran trees is largely concentrated on the upper parts of the crown framework. When there is insufficient light reaching the lower parts of the trunk then epicormic growth may not be stimulated or viable in the long term. However this can also be due to a genetic predisposition of the oaks at Hördalen and may have little to do with shade. Without information about how this has changed over time it is difficult to draw conclusions at this stage. The fact that epicormic growth is present can indicate that there may be a more favourable response to tree work than if none was present.

Figure 5: Distribution of epicormic growth on the veteran trees at Hördalen.



CHAPTER 5 – TREE DATA - SUMMARY

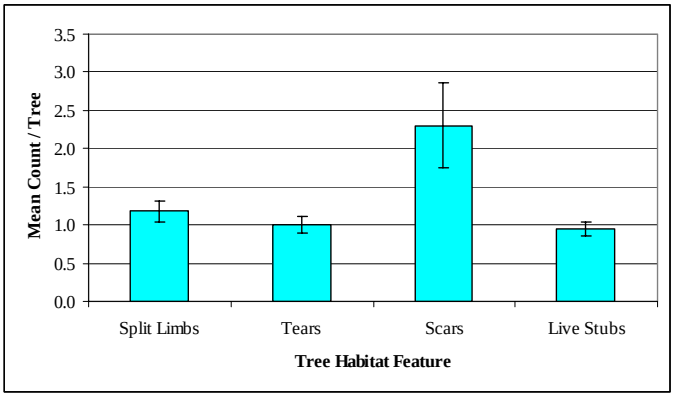
- 74 ancient oaks were surveyed of which 63 were alive
- Largest oak had a girth of 487cms and the smallest 196cms
- 49 of the trees were *Quercus robur* and 15 *Quercus petraea (the remainder were without determining characteristics and were recorded as Quercus sp.)*
- 73% of the trees have a mostly fully canopy
- 42% have a full crown outline remaining, whilst 26% have lost more than half of their full crown.
- Epicormic growth is most concentrated in the crown of the trees

6.0 TREE HABITAT EVALUATION

6.0.1 The assessment of tree habitats seeks to identify the quality of the saproxylic (decaying wood) resource in order to quantify the trees potential for supporting wildlife and offers a basis for comparative data for analysis. This quantification system results in a single score for each category. The system requires a special count of each habitat type as informed by the standard Specialist Survey Method and applies to fields [16], [17], [19], [20] and [21] inclusive. Species or signs of species were not recorded as part of this survey.

6.0.2 The mean habitat score was found to be 9.9 (c.f. Särö Västerskog 9.2, Lords Bushes 7.4, Ashton Court 9.5, Slindon 6.6, Hatfield 9.4), the highest of all sites surveyed. The highest score for Hördalen was 19 and the lowest 4.

Figure 6: Scars were found to be the most common habitat feature on the trees at Hördalen. Error bars show 95% confidence limits for the mean.

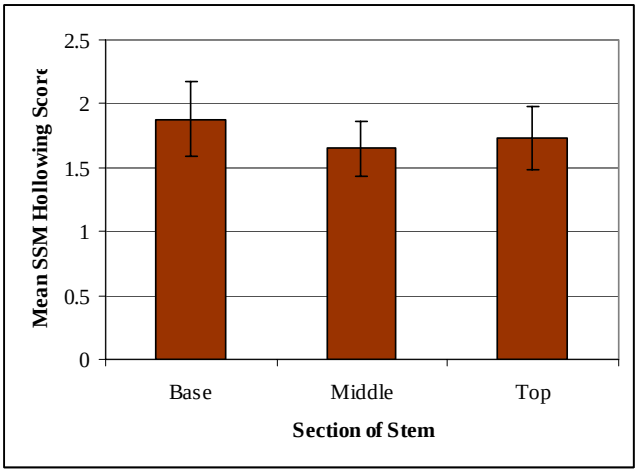


6.1 Trunk Hollowing [16]

6.1.1 The assessment of trunk hollowing (not including any part of the crown) is in three parts, (base, middle and top), with scores for the level of observed hollowing ranging from 1 to 5 as detailed in the survey codes where 1 represents minor cavities and 5 represents a remnant trunk. This gives an aggregated score range from 3 to 15. For the purpose of habitat scoring this aggregate is averaged and rounded to integer value.

6.1.2 The hollowing pattern, which was found to similar at all parts of the stem reflects the situation at Särö Västerskog and highlights the high habitat value of the trees at Hördalen.

Figure 7: The extent of hollowing was found to be similar at all parts of the stem (not including the crown). Error bars show 95% confidence limits for the mean.



6.2 Crown hollowing & holes [16.4] [17]

6.2.1 The habitat types are quantified and the following banding system generates the habitat value scores: For both the number of tree holes and the number of crown hollows the scoring system is as follows: none = 0; 1 to 3=1; 4 to 6 = 2; 7 to 9 = 3 & 10+ = 4.

6.2.2 The analysis revealed the average crown hollow (over 15cms diameter) count to be 1.3 per tree (c.f. Särö Västerskog 2.0, Lords Bushes 0.7, Richmond 2.5; Ashton Court 0.62, Hatfield 0.5) and 2.6 holes (between 5 and 15cms in diameter) per tree (c.f. Särö Västerskog 2.6, Lords Bushes 1.3, Richmond 4.4; Ashton Court 1.3, Hatfield 1.6).

Figure 8: Tree No.1 with extensive hollowing at all parts of the stem

6.3 Rot [19]

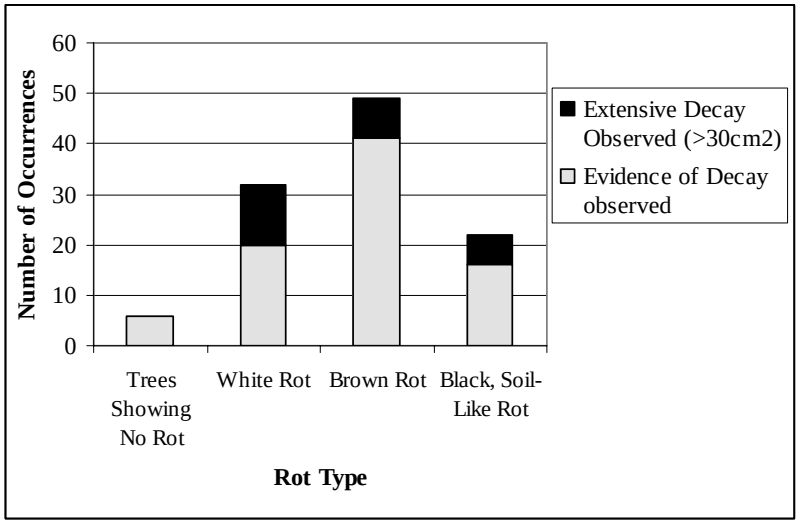
6.3.1 The survey of rot allocates a score of 1 to each rot type and a score of 2 where rot is identified as being significant in extent or type (marked with an asterisk on the recording form). The assessment applies to the specific site of veteran tree cover and may offer comparisons for other sites surveyed using this system. This results in a minimum score of 0 and a maximum score of 6.

6.3.2 The survey shows that brown rot is common on trees at Hördalen. In the case of brown rot cellulose is degraded. Brown rot is important for many of the saproxylic beetles associated with the oaks at Hördalen and is often created by fungi *Laetiporus sulphureus* and *Fistulina hepatica*, both of which have been recorded from Hördalen. It is also important because it is a pre-cursor to the black soil-type rot. *This has implications for limb loss as the strength of the affected wood is rapidly degraded and little or no reaction wood is formed resulting in a brittle fracture, often without warning.*

6.3.3 White rot is created when the lignin is degraded, leaving stringy white cellulose behind. Many of the fungal species which decay lignin can also decay the cellulose. The *Ganoderma* species are on the whole white rotting fungi.

6.3.4 Black soil type rot or mulm is a habitat type that is seldom found beyond sites with a high concentration of ancient trees (Alexander *pers comm.*). In the wood decay succession process this rot type requires a considerably prolonged period of time to become established and to accumulate within relatively undisturbed hollow trunk environments and therefore the majority of species associated with this habitat are rare. 22 trees were recorded as having some signs of black soil type rot (mulm), with 6 of those with extensive amounts.

Figure 9: Brown rot is particularly prevalent at Hördalen.



6.4 Deadwood attached [20], Deadwood fallen [21]

6.4.1 The habitat types are quantified and scores are generated by banding as follows: Number of deadwood units (1 unit = 1 metre of dead wood over 15cms in diameter either attached or fallen): none = 0; 1 to 5 = 1; 6 to 10 = 2; 11 to 15 = 3; 15 + = 4.

6.4.2 The survey found an average 17.3 units (1 unit = 1 meter greater than 15cms in diameter) attached to the tree (c.f. Särö Västerskog 11.6, Lords Bushes 5.9, Ashton Court 6.8, Slindon 13.4, Hatfield 12.7). This is particularly high as can be seen when compared to other sites that have been surveyed using this method, possibly due to the lack of surgical removal of dead wood at Hördalen.

Figure 10: Tree 59, which has a large quantity of dead wood still attached to the tree

6.4.3 An average of 9.2 units that have fallen from the tree and are present within its crown radius, on the ground (c.f. Särö Västerskog 10.9, Lords Bushes 3.5, Ashton Court 5.7, Slindon 5.6, Hatfield 10.3). This compares favourably with Särö Västerskog and Hatfield Forest and contributes to the high habitat values associated with the trees at Hördalen.

CHAPTER 6 – TREE HABITAT EVALUATION - SUMMARY

- ❄ The mean habitat score was 9.9 for Hördalen, the highest recorded from any site previously studied (highest scoring tree scored 19 and lowest 4)
- ❄ The extent of hollowing was similar at all parts of the stem reflecting the high habitat values
- ❄ The average number of crown hollows (over 15cms diameter) was 1.3 and holes (between 5 & 15cms in diameter) was 2.6 per tree (Särö Västerskog had 2.0 and 2.6 respectively)
- ❄ Brown rot was the most common type of rot recorded from the trees at Hördalen and 22 trees had the rarest type of rot: black, soil type rot (mulm)
- ❄ An average of 9.2 units of fallen dead wood and 17.3 units of attached dead wood were recorded (the attached dead wood is the highest score recorded from any site previously studied)

7.0 ARBORICULTURAL APPRAISAL

7.1 The Survey Approach and Inspection Notes

7.1.1 Treework Environmental Practice developed the SSM for English Nature in 1997 and has since developed advanced modules based on this system as a national standard for surveying and managing ancient trees. The current survey involves the application up to Level 7 of the SSM.

7.2 Method of Arboricultural Assessment

7.2.1 This is an arboricultural evaluation system used to assess tree vitality and failure potential in order to inform the future management regime and prioritised treatment programme. Each tree is assessed in relation to the expectation (estimated probability) of major

debilitation or total failure from radical decline in vitality or from collapse (mechanical failure) within an indicative period of 5 to 10 years from the survey date.

7.2.2 The vitality assessment ranges from 1=Dead, up to 10=exceptional vitality and takes into account indicators such as crown condition in the light of extension growth; bud size, the incidence of die back and evidence of effective wound wood/callus formation and epicormic growth.

7.2.3 The decline assessment takes a similar approach to the estimation of the tree falling into radical decline within a period of five years. Decline expectation ranges from 0=Dead, 1=extremely high decline expectation, up to 10=improbable failure and takes into consideration the context, tree species and surrounding environment, indications of physiological stress and recovery, incidence of random or systematic decline and the nature of fungal colonisation.

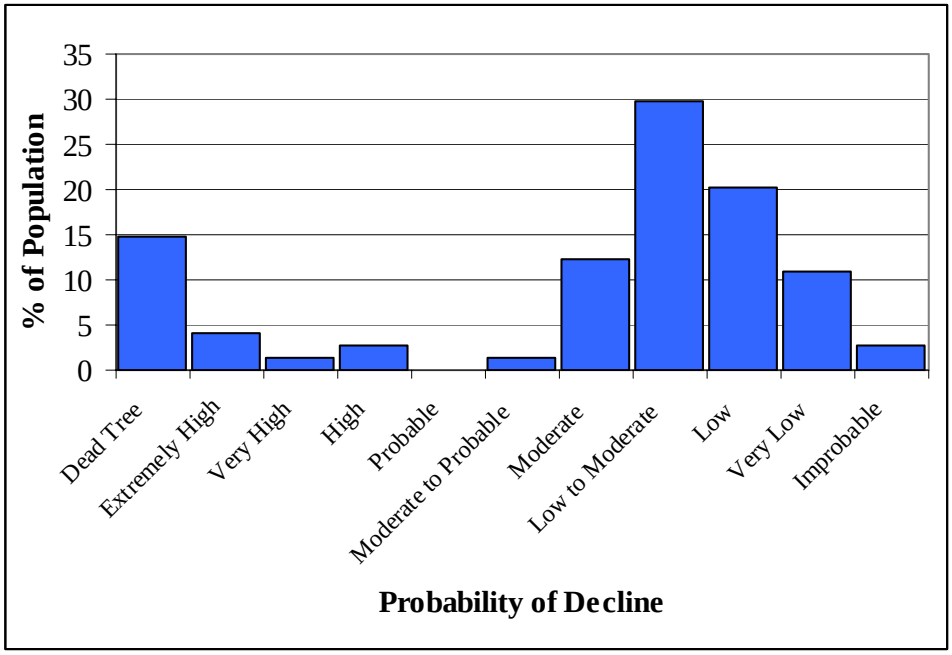
7.2.4 The structural failure/collapse assessment ranges from 0=Dead, 1=extremely high failure expectation, up to 10=improbable failure and takes into consideration - root, stem and branch stability; wood condition, embrittlement, end loading, character and pattern of decay in comparison to sound wood and the expected recovery from structural failure in the context of tree species and vitality.

7.2.5 These scores and assessments are aggregated to identify a quantified arboricultural or viability score for individual trees, giving a comparative appraisal of the viability of the veteran population on the site and help to inform future management

7.3 Tree Decline Assessment

7.2.6 Decline is expected in old trees and many of the symptoms of decline contribute to the habitat value of veteran trees. However as the range of saproxylic habitats offered by living trees is considerably greater than those associated with dead trees (Alexander, 1999), the management of any population of veteran/ancient trees should be targeted to enhance their longevity and sustainability. *Veteran trees should be monitored for signs of decline from either biotic or abiotic factors. This should inform future remedial management requirements to improve survival rates.*

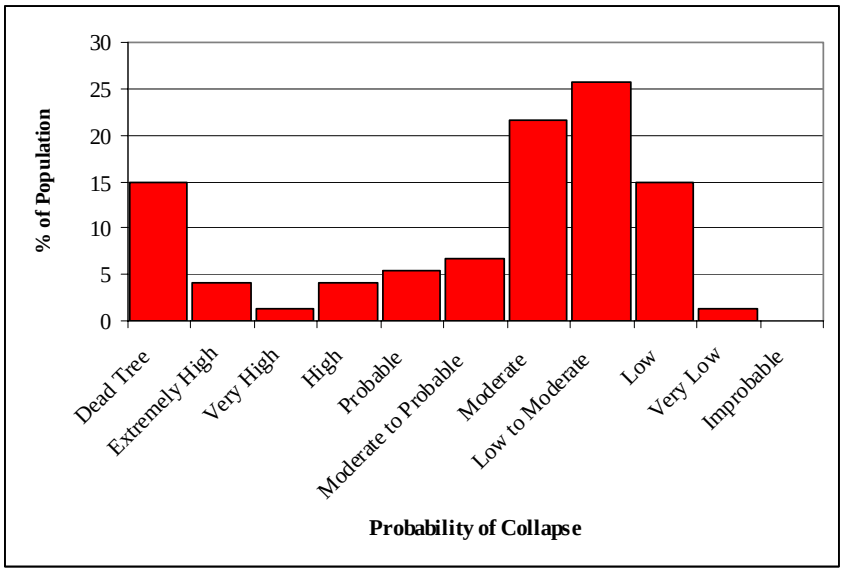
Figure 11: The likelihood of terminal decline within 5 to 10 years from the survey date. There is concern that six trees were recorded as have a high to extremely high likelihood of death through decline.



7.4 Tree Structural Failure/Collapse Assessment

7.4.1 There is a high risk of death following catastrophic structural failure. This can be avoided through targeted and often relatively minor limb reductions. Minor limb failure is less likely to result in death and is a part of the ageing process. In some cases limb failure can result in layering; however this was not seen at Hördalen. *The conservation aim should be to keep veteran trees alive for as long as possible.*

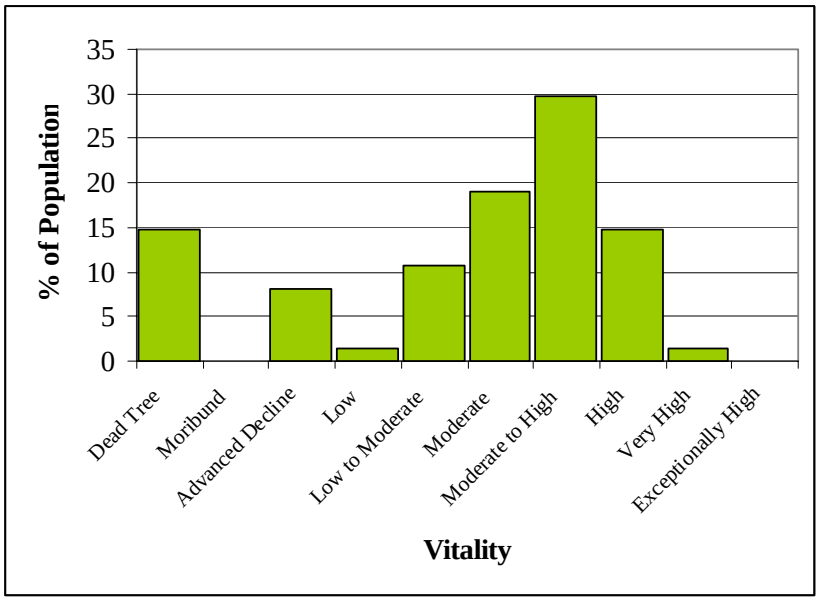
Figure 12: The likelihood of tree loss through collapsing within 5 to 10 years from the survey date. There is concern that eleven trees were recorded as have a probable to extremely high likelihood of loss through structural failure.



7.5 Tree Vitality Assessment

7.5.1 The evaluation of tree vitality considers characteristics such as extension growth, bud size, presence, degree and distribution of die back, evidence of callus response and epicormic growth. From analysis of these factors an impression is gained of the vitality of the tree and of its tolerance to stress, wounding, pathogenic attack or competition.

Figure 13: Eight trees were assessed to have low to moderate vitality and a further seven were low vitality or advanced decline.



7.6 Evaluation of Tree Viability

7.6.1 One of the most important long-term aims of the management of decaying wood ecosystems is to ensure a large quantity of sustainable habitat resource for the associated species. Living old trees with veteran characteristics provide an enormous contribution to the size and variety of decaying wood habitats in the landscape (Alexander, 1999). Through the protection of veteran trees natural communities are allowed to persist and ecosystem functioning may be supported and maintained. The viability assessment (arboricultural score in the data which is the total figure from the three assessments) aims to identify which trees are at greatest risk of failure, and thereby the implications that this may have for the population as a whole. Management that is informed by these results is typically intended to enhance current viability to extend the longevity of the veteran trees. The greatest impact on the overall population will be through treatment of those trees in the intermediate category, where intervention can significantly improve vitality, live growth and stability.

Figure 14: Tree 45 which has a high risk of mechanical failure, but is otherwise in good condition, so is a tree which would likely be saved by quick action

7.6.2 In this system, the maximum possible tree viability score is 30. A score of 12 shows a strong tendency to decline and a score of 10 is on the margins of viability. The 6.3% of trees (as a proportion of live trees) that have a viability score below 10, are either moribund or are considered likely to die following partial or total collapse. There are in

addition 7.9% of the veteran population prone to advanced decline (scoring between 11 and 15). However, the mean viability score for all trees (excluding dead trees) is 19.4, indicating that the majority of the population is above the threshold of 15 and show fair vitality and a relatively low probability of total failure through collapse or decline. Over half of the population of living trees have a score of higher than 20, i.e. have high viability compared with 34% of the population at Särö Västerskog.

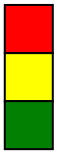
Table 1: This table indicates the condition of the veteran trees. It is a method of identifying trees that may be targeted for arboricultural works.

Viability Score	Number of Trees	% of Total Surveyed Trees
Dead Tree	11	14.9
6	2	2.7
9	1	1.3
10	1	1.3
12	2	2.7
14	2	2.7
15	1	1.3
16	2	2.7
17	5	6.8
18	5	6.8
19	8	10.8
20	2	2.7
21	9	12.2
22	8	10.8
23	9	12.2
24	5	6.8
25	1	1.3
Total	74	100.0

Table 2: Summary of viability assessment results

	Number of Trees	% Live Trees
High Risk of Failure	4	6.3
Remediable Trees	27	42.9
High Viability Trees	32	50.8

Key:



Trees with a high risk of failure within the next 5-10 years.

Trees with a moderate / remediable risk of failure within the next 5-10 years.

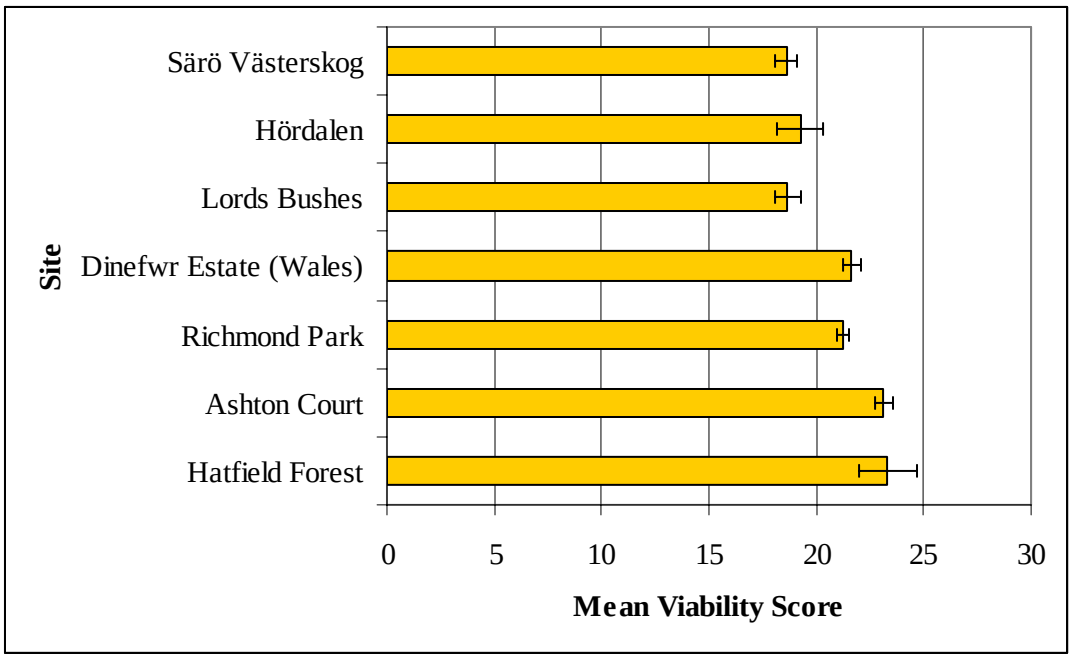
Trees with high viability.

7.6.3 The Specialist Survey Method has been used to survey other large populations of veteran trees. These surveys have produced data, which show general viability trends of the respective veteran populations. Since many key sites that have been surveyed contain significant oak populations these data also permit comparison between the condition status of veteran oak (*Quercus robur*) populations at the sites and to potentially identify wider demographic trends (see fig 15).

7.6.4 Dunnett's comparisons[1] were made on the data using Hördalen as a reference population. This test confirms the visual picture in that the veteran oaks in the survey population score significantly lower in terms of viability when compared with all the UK sites surveyed using this method except Lords Bushes. It is notable that there is no significant difference in scores when compared with the population at Särö Västerskog.

7.6.5 Hördalen and Särö Västerskog have *Quercus petraea* making up a significant portion of the oak population. Whilst this could potentially make a difference when drawing conclusions, it is thought that the similarity between the two species and the fact that many of the trees from both sites were clearly hybrids makes the comparison worth doing.

Figure 15: A comparison of viability scores for veteran oak populations highlights the lower average viability scores of the oaks at the Swedish sites visited when compared to populations in the UK except for Lords Bushes. Only live trees were included in these analyses. Error bars show 95% confidence limits for the mean.

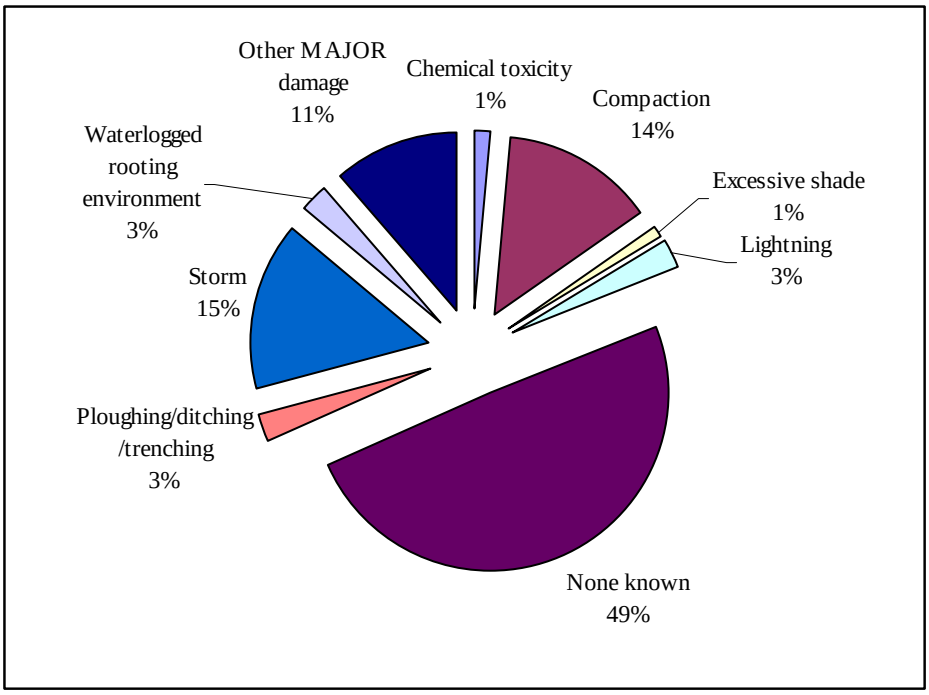


7.6.6 It is worth noting the conditions under which the oaks grow in the UK populations which have been surveyed. Lords Bushes has in common with Hördalen and Särö Västerskog a lack of grazing, with the majority of the trees being in an overgrown situation. At the other sites, grazing does occur and the overgrown aspects of the sites are less significant when the population is taken as a whole. The soils conditions are different with the majority of the UK sites having more fertile soils including heavy clays.

7.6.7 Part of the SSM requires an assessment of major damage or debilitation which has occurred to the tree or its associated flora and fauna. The main causes of damage where it could be clearly identified were storm and compaction (mainly from footpaths within the crown drip line). Compaction of the soil reduces the amount of air spaces in the soil and in turn therefore reduces the amount of water and nutrients available to the tree roots. Competition features less significantly than might be expected, however it is likely that this is due to sensitive clearance work which has taken place within the last ten years (see figure 16)

[1] Dunnett's comparisons check a two-sided confidence interval for the difference between each population mean and a control mean. A family error rate of 0.05 was used.

Figure 16: The types of damage affecting the veteran trees.



7.6.8 Dead veteran oaks were included in this survey. It is possible that some were missed due to the terrain. However, 5 standing dead oaks were recorded and a further 6 were found fallen. Due to the condition of the standing dead and fallen trees, it is likely that these have died within the last 25 years or so. This has been further confirmed by those who have known the area well over the last 30 years (Appleqvist, pers comm.). On this assumption a minimum of 15% of the veteran oak population has been lost during the past 25 years. This would represent a mortality rate of 0.6% per year (c.f. Särö Västerskog 0.5%, Lords Bushes 1.0%, Hatfield Forest 0.9%), which would be expected to increase if no management takes place. The viability scores support this by the fact that 9 trees would likely be lost if no management takes place within the next five to ten years (scoring under 15). That represents a mortality rate of 1.4% (c.f. Särö Västerskog 1.7%) if the loss is spread over ten years rather than five.

CHAPTER 7 – ARBORICULTURAL APPRAISAL - SUMMARY

- 6.3% of live trees scored less than 10 and a further 7.9% scored between 11 and 15: a total of 9 trees (maximum possible score = 30)
- Over 50% of the live population scored over 20 (c.f. Särö Västerskog 34%)
- The mean viability score is 19.4 which is significantly lower than all other sites previously studied other than Särö Västerskog and Lords Bushes (all to a greater or lesser extent suffering from competition)
- Competition features less significantly than might be expected as a result of the sensitive clearance work that has been carried out over the last 10 years
- 14% of the population is showing signs of suffering from soil compaction mainly due to the presence of footpaths within the crown drip line
- The estimated mortality rate per annum for the last 25 years is 0.6%, however if no management takes place, the viability scores suggest a mortality rate of 1.4% per annum over the next ten years – one tree per annum, resulting in a complete loss of the population within 75 years.

8.0 THE FEATURES OF NATURE CONSERVATION INTEREST AT HÖRDALEN

8.0.1 Appropriate management of a tree's environment is an important factor for tree health and longevity. In addition appropriate veteran tree management is crucial to the conservation of the organisms that depend on the associated habitat for some part of their lifecycle.

8.1 The Quantity & Quality of Decaying Wood Habitats

8.1.1 Of the recorded sites in the UK and Ireland, 10 are known to have more than 1000 ancient trees, some 35 sites have between 100 and 1000 ancient trees and a further 250-300 between 20 and 100 trees (Alexander unpublished). Hördalen, with 63 live ancient trees, is a relatively small site, but would be accounted within the third tier of known sites in the UK. It is worthy of conservation in its own right, but especially due to its relatively close proximity to other sites with old oaks. The high number of Red Data Book species associated with the old trees recorded from the site makes Hördalen a nationally important site (Jansson, 2004).

8.1.2 With a total area of 31 hectares, but with the ancient trees clustered within a maximum area of 15 hectares, the site has a mean density of 5 veteran trees per hectare. An investigation into the age of the old oaks in Hördalen by ring counts from bore samples, indicate that these may date from between the beginning of the 1600's, but it is very possible that they are older than that due to the fact that the trees tested were hollow (Niklasson, 2003).

8.1.3 Hördalen has the highest score for dead wood attached to the trees than from any sites previously studied. This could be as a result of previous shading, which caused significant dieback or the fact that dead wood has never been removed from the crown, which is known to have occurred on some of the sites in the UK. Living trees with decaying wood are known to be of the greatest value for saproxylic communities (Alexander, 1999). Previous studies have shown that the site supports a high level of saproxylic communities and it is important that this be sustained (Jansson, 2004). The decaying wood habitats present on the live veteran trees are significant and exceptionally high.

8.1.4 There is a high level of all three types of rot in the old trees and this is a factor of significance in terms of the nature conservation value of the site. In particular, the rarest habitat is mulm (black soil type rot) and this was identified in more than 20 trees.

8.1.5 Brown rot was the most common type and this supports a number of the red data book species which have been recorded from the site *Ampedus hjorti*, *Dorcatoma flavicornis* and *Anitys rubens*. This is most likely to have been created by the presence of *Laetiporous sulphurous* and *Fistulina hepatica*. Brown rot is the first stage of decay before black rot or mulm formation, so this suggests a good future for this habitat at Hördalen, assuming future management is successful.

8.1.6 A factor of interest from Hördalen is the effect of the wind and salt due to the close proximity to the sea. It is possible that the salty winds have had an impact on the general condition of the oaks as they are relatively intolerant of salt. The soils are also relatively thin, which also does not favour *Quercus robur*. Wind sculptured oaks are a feature of the site.

8.2 Remnant Wooded Pasture and Meadow Structure

8.2.1 Wooded pasture and meadow structure commonly supports a diverse array of organisms owing to the presence of the large number of niche habitats. This form of habitat structure is highly valued and rare in Sweden and in Europe. Fennoscandian wooded meadows are a priority habitat for conservation within the Natura 2000 system. Many of the organisms associated with wooded pastures and meadows that are now rare depend on old trees for at least part of their life cycle.

8.2.2 Hördalen is a relatively small area of overgrown wooded pasture. However if it were to be extended by linking directly with other areas with old trees and areas where wood pasture could develop then it could act as a dispersal source and a refuge. It has great value in the conservation of organisms associated with wood-pasture in the region.

CHAPTER 8 – THE FEATURES OF NATURE CONSERVATION INTEREST AT HÖRDALEN – SUMMARY

- ❄ Hördalen has the highest score for quantity of attached dead wood when compared with all other sites previously studied which supports a specific saproxylic community
- ❄ Brown rot was the most commonly recorded type of rot, which is the pre-cursor to black rot; the rarest type of all and suggests a sustainable future for this habitat type assuming management takes place to stabilise the trees
- ❄ The effect of the wind and salt is a factor of interest and may have influenced the general condition of the oaks.

9.0 AN ASSESSMENT OF THE CONDITION OF THE FEATURES OF INTEREST

9.1 The Quantity & Quality of Decaying Wood Habitats

9.1.1 Based on the assumption that 15% of the veteran oak population has been lost during the past 25 to 30 years, that the competitive pressure from the surrounding trees is increasing, that 9 trees have been identified as having a high probability of failure within the next ten years, that many of these trees may be in progressive decline with a relatively low average viability score, it is expected that without management a further reduction of a similar order may occur during the next 10 years.

9.1.2 The continuation of the decaying wood habitats is not only dependent on the preservation of the existing veteran population but also in recruiting and securing successive generations. Currently the veteran tree habitat is under threat at Hördalen and there exists a generation gap between the oldest trees and the next oldest. There is a risk that without management the resource of ancient trees will die before the next generation are in a suitable condition with appropriate levels of habitat.

9.1.3 The current high, levels of dead wood are not believed to reflect dead wood volume trends associated with the recent past or near future at the site. In the past it is known that fallen wood was gathered and used as fuel or as a generally useful material. It is likely that the volume of dead wood now present has accumulated through both the rates of tree loss combined with the cessation of wood collection. As volumes of dead wood may be at a peak due to the relatively high, recent mortality rates at the site, it is unlikely that there are sufficient large trees to sustain current levels of dead wood in future decades. Therefore a decrease in dead wood volume is expected to coincide with improved measures to reduce rates of veteran tree decline in condition that have in the past led to mortality.

9.2 The Remnant Wooded Pasture and Meadow Structure

9.2.1 Competitive growth of trees surrounding the veteran trees is particularly harmful as, not only do the surrounding trees directly compete for light with the trees and the epiphytes on the trees, but indirectly this causes tree decline. This has not been identified as a major threat to the population of ancient trees in the current survey due to the fact that there has been intermittent clearing over the past 60 years, which has stopped shading from being as serious as it otherwise would have been. However shading even at lower levels has likely encouraged the process of stem attenuation, creating an over-extended lever arm, making them more susceptible to structural failure. In addition below-ground competition for nutrients and water is taking place. The overall effect of this competition is to compromise the viability of the populations, potentially leading to a significant reduction

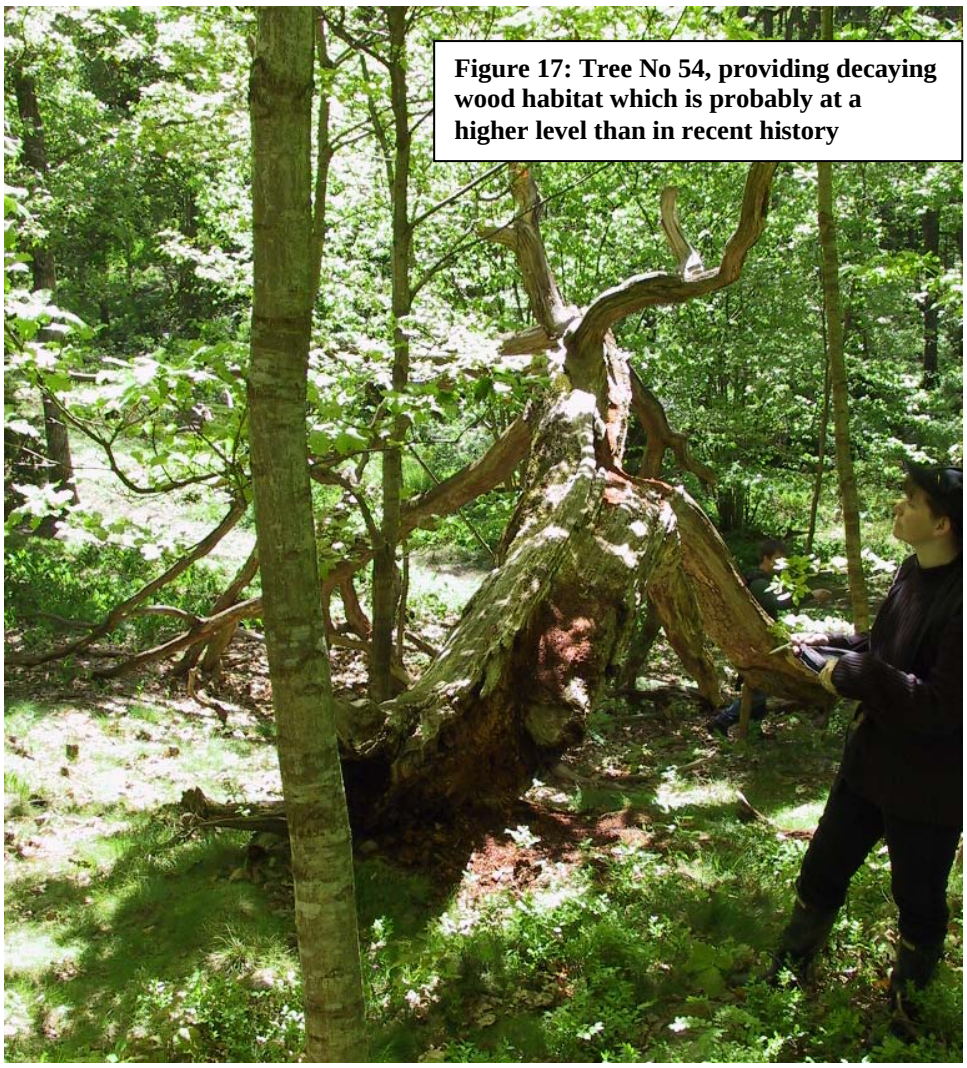


Figure 17: Tree No 54, providing decaying wood habitat which is probably at a higher level than in recent history

in habitat diversity and potentially, progressively leading to the local extinction of species that require specialised niche habitats.

9.2.2 Scrub habitats appear to be relatively scarce in the close canopy areas. The presence of juniper is consistent with the view that the site was grazed. Oak populations in wooded, grazed landscapes seem to develop through the species association with thorny bushes (as 'fringe and mantle') - a process similar to the cyclical turnover of vegetation described by Vera (2000). This however is reliant upon open spaces, where thorny bushes can develop followed by regeneration of oak. When the canopy becomes too dense, then the understorey shrub layer disappears along with the opportunity for natural regeneration of oak. Flowering bushes provide a valuable source of pollen and nectar for many saproxylic invertebrates.

9.2.3 The wide crowned open grown trees are a characteristic feature of wooded pastures and meadows. Experience shows that oaks in this situation tend to live longer and therefore have a greater likelihood of supporting the rare and specialised species that we find associated with old oaks. This is an important element to ensure continues to develop in Hördalen by the selection of suitable young oaks which can be released from the surrounding competition and therefore allowed to develop this structure.

Figure 18: An open grown oak which has lost its apical dominance possibly as a result of storm damage or snow

9.2.4 It is clear that the general viability of the population at Hördalen is significantly lower than most of the sites in the UK except one; Lords Bushes. The viability score is equally low from Särö Västerskog. It is thought however that the number of very low vitality or dying trees is not significantly greater than other recorded UK sites. The differences may be due to a number of different factors, relating to the position of the sites; being affected by salty winds. The sites have a poorer soil environment than those sites in the UK which may also result in a general lower vitality. There may also be issues relating to the genetic variation both between Sweden and the UK as well as between the two oak species along with their hybrids. It is also likely however that competition of both the crown and rooting environment have had a significant impact on the trees at Hördalen in the relatively recent past.

9.2.5 There appeared to be a significant number of trees which have some kind of storm damage, which was different to that seen from the populations of oaks in the UK. This may be a consequence of the higher levels of snow fall and a phenomenon known as 'wet snow', which due to its weight can cause limb failure in a similar way to storm damage.

9.3 The Overall Condition of the Site

9.3.1 The remaining features of the wooded pasture habitat are fading as oak (mainly *Quercus petraea* and not *Q. robur*) regenerates but without any of the open grown characteristics found in the older trees. With this change there has been and will continue to be a reduction in habitat complexity. The oaks will grow up in a woodland environment, which does not generally contain trees of an age much greater than 250 years of age. This

is because the trees need to grow tall to compete and the more shaded environment does not allow for the growing downwards process associated with old age and thus they are more susceptible to failure at an younger age. This will also progressively reduce space available for organisms with specialised niches. The condition of the population also means that without intervention the population of ancient oaks is likely to decline and may even be completely lost within 50 – 75 years.

9.3.2 The conclusion, in the light of the above factors is that the current condition of this site, particularly in those areas where the soils are richer along the valley floor is unfavourable and declining.

CHAPTER 9 – AN ASSESSMENT OF THE CONDITION OF THE FEATURES OF INTEREST – SUMMARY

- ❄ The veteran tree habitat is currently under threat and there is a risk that without management the resource of ancient trees will die before the next generation is in a suitable condition with appropriate levels of habitat
- ❄ Current volumes of dead wood are unlikely to be sustained in future decades assuming management takes place
- ❄ Competition has been identified at low levels due to recent management activities, however this has had an impact in the recent past and will increase again without management
- ❄ Without management there are unlikely to be wide crowned open grown oaks in the future which are generally longer lived than woodland grown oaks
- ❄ The generally lower viability scores of the trees in Hördalen when compared with the UK populations may be due to a number of different factors including genetics, soil and salty winds
- ❄ Without intervention it is possible that the population of ancient oaks may be completely lost within 75 years
- ❄ The site is assessed to be unfavourable condition and declining.

10.0 SITE MANAGEMENT RECOMMENDATIONS

10.0.1 As a result of this study it is recommended that the aim of management should be to restore the structure of a wooded pasture or meadow that has been degraded. It is understood that recreation and amenity is also an aim for the site and options for restoration will need to take these requirements into account.

10.0.2 Certain veteran trees are under current threat of failure. Many of these show potential to be viable, if subject to remedial measures. These trees need immediate attention and detailed prioritised management. Examples of the recommendations for some of these trees can be seen in Appendices III and IV. General recommendations with regard to the veteran trees are summarised in Chapter 11.

10.0.3 It is recommended that young trees be identified and managed for their potential as future open grown candidate veterans. Such management would seek to replicate historic wooded pasture features by ensuring that these trees have enough light to develop wide crowns and branches lower down on the trunk.

10.0.4 The principal features of habitat interest are threatened largely by the successional transition towards high forest. These features and their biodiversity value will progressively deteriorate if current conditions prevail. Additionally, the efforts required to reverse this change will increase as time passes. At this stage, the extent of management required to protect the veteran trees alone is relatively considerable, with over two thirds of the population requiring some form of management within the next 10 years. The focus both on the creation of a future generation of ancient trees and stabilising the existing ancient trees must be incorporated into the management plan.

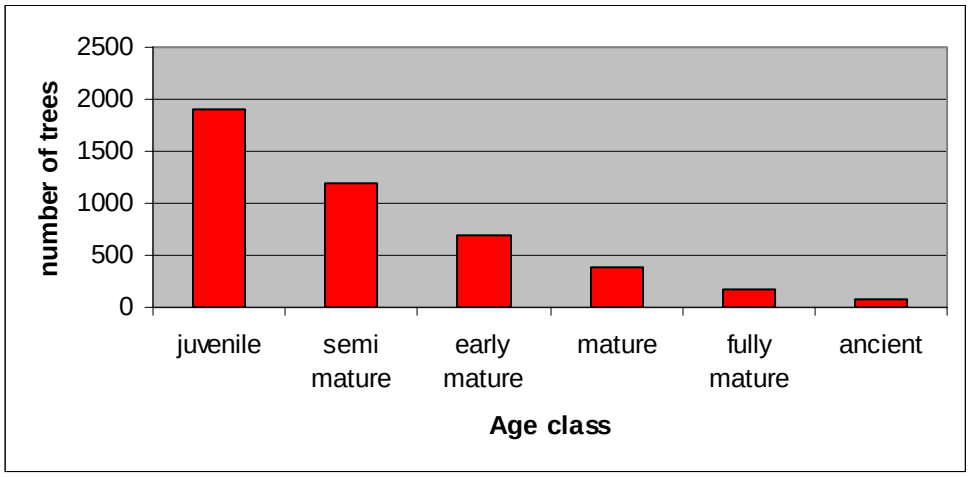
10.0.5 Where intervention is proposed, this is typically because indications have prompted the surveyor to raise the level of vitality of a vulnerable specimen. Where this is the case (and if successful) the average vitality of the population overall will be raised. Due to the lack of historical tree management (unlike the majority of sites surveyed in the UK, where many of the oaks have been pollarded), the level of intervention has generally been recommended at a low impact level and over long periods of time. These recommendations are intended to reduce the *risk* of future decline or collapse and thereby extend the life expectancy of the existing ancient tree population.

10.1 Management of the Vegetation Structure

10.1.1 If the site is allowed to continue to develop into high forest, further decline in the condition of the site will ensue. Therefore a sensitive transition to open growth conditions is required to protect the veteran trees and the suite of conditions and species of value on the site.

10.1.2 Management should be directed towards creating more open conditions and will necessarily involve the clearance of trees. However, it is essential that mature trees and fully mature trees are retained wherever possible. This is because in terms of population dynamics, it is precisely these age classes that are needed to provide the succession generation of decaying wood habitats. The age class distribution highlights that there are fewer mature trees than ideal to ensure a sustainable population of ancients. Regeneration is also happening mainly on the slopes and is *Quercus petraea*.

Figure 19: Age class distribution of oak at Hördalen – based on visual assessment and recording over the whole site. Dead or declining trees were not counted.



10.1.3 The stabilisation and consolidation of the veteran tree population and the recruitment of sufficient and selected candidates from the mature generation could be enhanced in the longer term, with a targeted 'veteranisation' of younger age classes to develop bridge saproxylic habitats. This should, however be a lower priority and considered within the latter half of the next management plan cycle, given the tree resources available at Hördalen and the level of investment required to secure the ancient tree generation currently surviving. A higher priority should b to clear around individual trees to allow them to develop the wide crowned structures seen in the existing population.

10.1.4 The clearance of competitive vegetation around the veteran trees should be carefully carried out under supervision. This should be phased to ensure that environmental conditions around the veteran trees are not rapidly changed, since if insensitively implemented this could undermine the viability of the veterans and their dependent associates.

10.1.5 Planting in general terms has not been recommended due to the existence of natural generation within a wide range of age classes, at least for the time being. Planting of flowering bushes has been recommended in some areas where there appeared to be a lack. It is important that planting be considered in the future if the current population appears to be lacking in recruits, particularly of *Quercus robur*.

10.1.6 Two principal proposals that could potentially cater for the nature conservation interests and the long term sustainability of ancient tree habitat at the site are outlined below.

OPTION A – IDEAL MANAGMENT
Restore the Wooded Pasture Structure by Re-introducing Grazing

a) The proposed ideal management for the site would involve the introduction of grazing animals. If this were combined with manual clearance of areas of young regenerating trees, a wooded pasture structure could be re-established. This would require the site to be secured for grazing animals.

b) Due to the geology and topography of the site it is unlikely that even if the site were perimeter fenced and the animals allowed to roam freely, that they would venture up onto the steep slopes. This would effectively mean that these areas would be left to minimum intervention and the values associated with that habitat retained. It is also likely that due to the poor growing conditions for oak, that ancient trees or at least ancient tree characteristics will develop in the trees which grow in these areas. It is therefore recommended that perimeter fencing be considered, which also makes access for the public easier.

c) Flowering and thorny bushes are a part of the historical ecosystem, providing a range of habitat for invertebrates and birds. These important nectar and pollen sources should be encouraged as part of a dynamic grazed system, so in places planting of groups of thorny bushes has been recommended. Therefore the proposed grazing levels should be governed and monitored to permit the development and growth of an appropriate proportion of suitable scrub habitat about the site.

d) The site is relatively small and compact, requiring few grazing animals to create the desired effect on the vegetation structure. Ideally the site should be grazed with cattle. This should then be monitored carefully to inform appropriate grazing levels. A suggested level to begin with would be 0.3 livestock units per hectare or 10 – 12 cattle. It will perhaps be necessary to carry out additional manual clearance until the ideal number of animals is identified to maintain the desired structure.

e) The species ratios of tree regeneration should be assessed and monitored. Guide-line regeneration targets should be set within certain time-scales. If insufficient oak regenerates naturally in the open conditions, supplementary planting may be required to meet optimum levels. The aim should be to create at least double the number of mature open grown oaks before the current generation of ancient trees die out. It is worth considering the ratio of *Quercus robur* to *Quercus petraea* as it would seem important to at least maintain some of each species within the ancient tree population.

OPTION B
Artificial Creation of Open Woodland Conditions
(this is less ideal due to the less dynamic nature of management by hand)

a) The manual clearance of young trees is a method of creating open conditions. However trees will re-colonize or re-grow from the cut stumps so efforts must be regular and sustained to ensure the structure remains in the desired state. Achieving open grown conditions may require cutting operations that will produce considerable volumes of live and decaying wood.

b) Open spaces around the veteran trees should be sensitively increased to reduce competition and allow healthy growth, moderated as appropriate by regard for the potential ill-effects of exposure and compaction. It is important that material cut is dealt with without burning in the vicinity of the old trees due to the risk of damage to the sensitive root systems.

c) The provision of nectar and pollen sources (e.g. hawthorn and other thorny bushes) close to the veteran trees should be ensured. This could be done by the planting and protection of individual trees and the promotion of thorny growth.

d) The species ratios of tree regeneration should be assessed and monitored. Guide-line regeneration targets should be set within certain time-scales. If insufficient oak regenerates naturally in the open conditions, supplementary planting may be required to meet optimum levels. The aim should be to create at least double the number of mature open grown oaks before the current generation of ancient trees die out.

e) It is important that the mechanisms for manual clearance are considered carefully to minimise the impact on the root systems of the trees.

Dead Wood Management

10.1.7 Dead wood should be left *in situ* where fallen. If clearance for access is required, the minimum amount of cutting is recommended. The arboricultural reduction of trees will require dismantling operations that will produce smaller lengths of timber. In this situation either the use of habitat piles or the scattering of arisings on the woodland floor is advocated. The method of creating dead wood piles that give maximum benefit to invertebrates is recommended as an appropriate use of arisings produced by the clearance of excessive regeneration. This approach must be balanced with the security of the site from fire during drought times.

10.1.8 It is recommended that mortality rates of the veteran population be monitored and recorded in order that the current estimate can be improved. This will also help to inform the speed of response that is required for the recruitment of 'new' veteran trees.

CHAPTER 10 – SITE MANAGEMENT RECOMMENDATIONS – SUMMARY

- The ideal management would be to restore the site to a wooded pasture with grazing animals by a programme of sensitive clearance followed by perimeter fencing
- Two thirds of the population requires some form of management within the next ten years
- The tree management recommendations are intended to reduce the risk of failure
- The age class distribution highlights that there are currently fewer mature trees than ideal to sustain the ancient tree population
- A high priority should be to clear around individual trees to allow the development of wide crowns
- Dead wood should be left in situ wherever possible and burning in the vicinity of the ancient trees should be avoided
- The mortality rates of the population should be recorded to improve current estimates
- The aim should be to create at least double the number of mature oaks before the current generation dies out

11.0 ARBORICULTURAL MANAGEMENT RECOMMENDATIONS

11.0.1 A comprehensive arboricultural management programme has been formulated for each veteran oak in relation to its individual condition and requirements. Examples of the reports produced are contained in Appendix III and IV and identifies treatment priorities, sometimes spanning quarter of a century. The highest priority treatments are scheduled for trees in danger of structural disintegration or accelerated physiological decline but which are considered possible to save with intervention.

11.0.2 The management schedule has been arranged by priority. However, each tree may have a range of phased treatments ordered in stages over a number of years. Monitoring and regular re-inspection of trees is essential for the full benefit of the management regime to be realised. Data should be systematically recorded and retained. Subsequent stages of management programmes should take account of the response of veteran trees to previous phases of treatment programmes and should be sensitive to adjustment. Adjustment to the programme of work should also be given following extreme weather conditions e.g. severe drought or extreme water logging.

11.0.3 A recording system is essential to ensure that the best value is obtained from the system of assessment, management and monitoring. Therefore it will be necessary to record and archive changes in tree condition and detail the works carried out. The recording system should record both biotic (e.g. incidence of fungi) and abiotic factors (e.g. drought, compaction, severe water logging) that may affect tree growth.

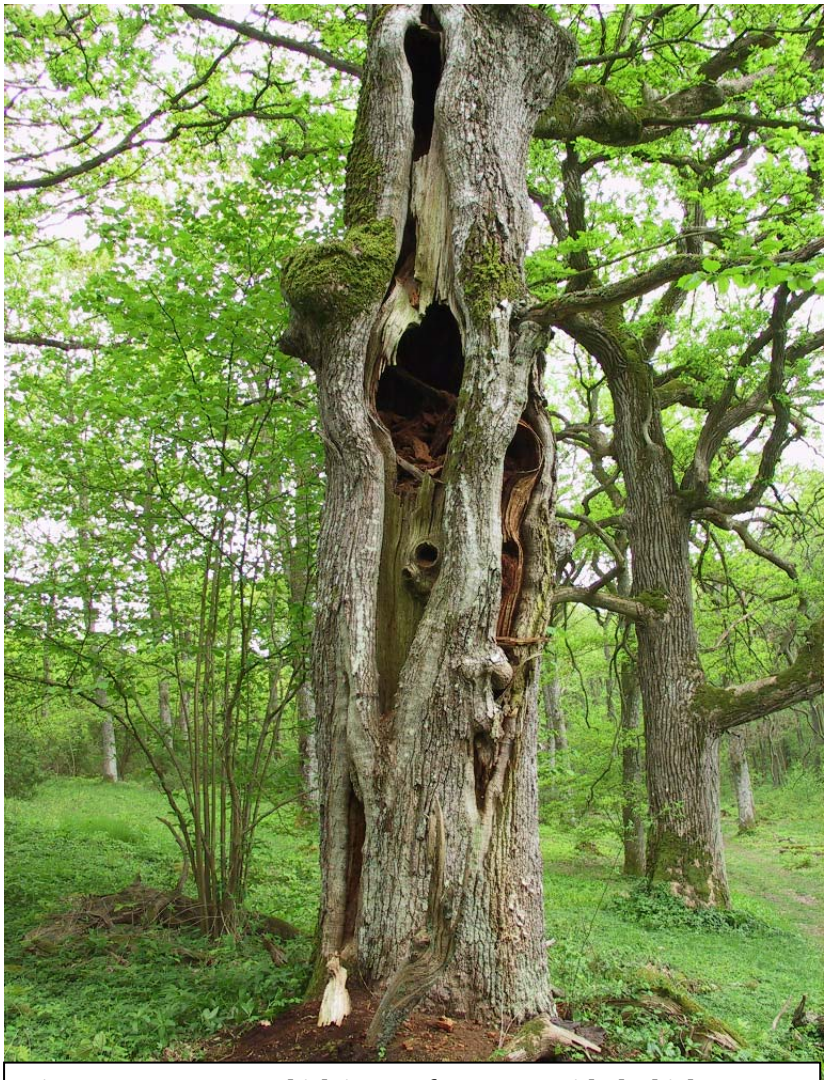


Figure 20: Tree No 1 which is one of two trees with the highest habitat value in Hördalen, but is at great risk of mechanical failure.

11.1 Measures Proposed for Tree Stabilisation and Rejuvenation

11.1.1 When considering the means to stabilise weight imbalances and mechanical weaknesses the recommendations address the need to integrate the threat of structural failure with the risk of traumatic physiological response to restorative treatment

11.1.2 Where it is considered favourable to retain high canopy form recommendations may specify no action being taken at present. However in order to preserve the canopy at optimum scale minor targeted crown modification may be proposed, where localised weight imbalance or decline is noted.

11.2 Special Techniques

11.2.1 Promotion of internal shoot growth focuses on strategies to invigorate the mid and lower crown through preparatory techniques that redirect growth and energy about the stem, canopy and branch tracery.

11.2.2 Treatments specifically recommended above involve the pruning out of apical buds (in a similar manner to fruit tree pruning), re-allocating the distribution of suppressant hormones so that dormant and adventitious buds are stimulated to develop.

11.2.3 Tip pruning will generally involve work with secateurs or small turbo-saws systematically progressing throughout the canopy, selecting between 5 and 10 buds for retention to provide the source for future redirected growth. As intervention in the dynamics of epicormic growth may have variable result if undertaken without sensitivity, this procedure requires a selective approach taking care to avoid indiscriminate removal of apical growth.

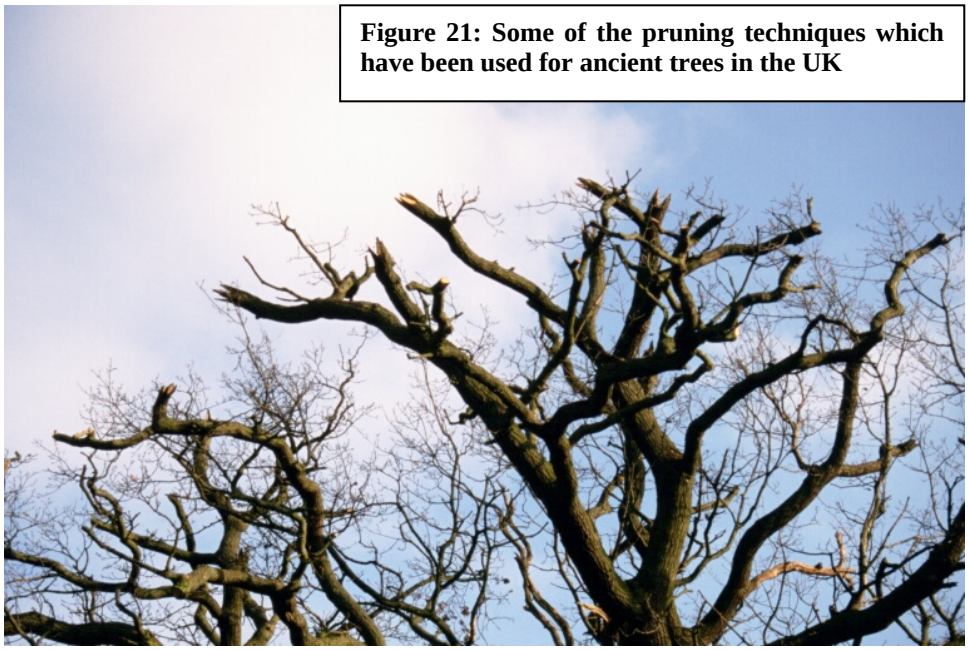
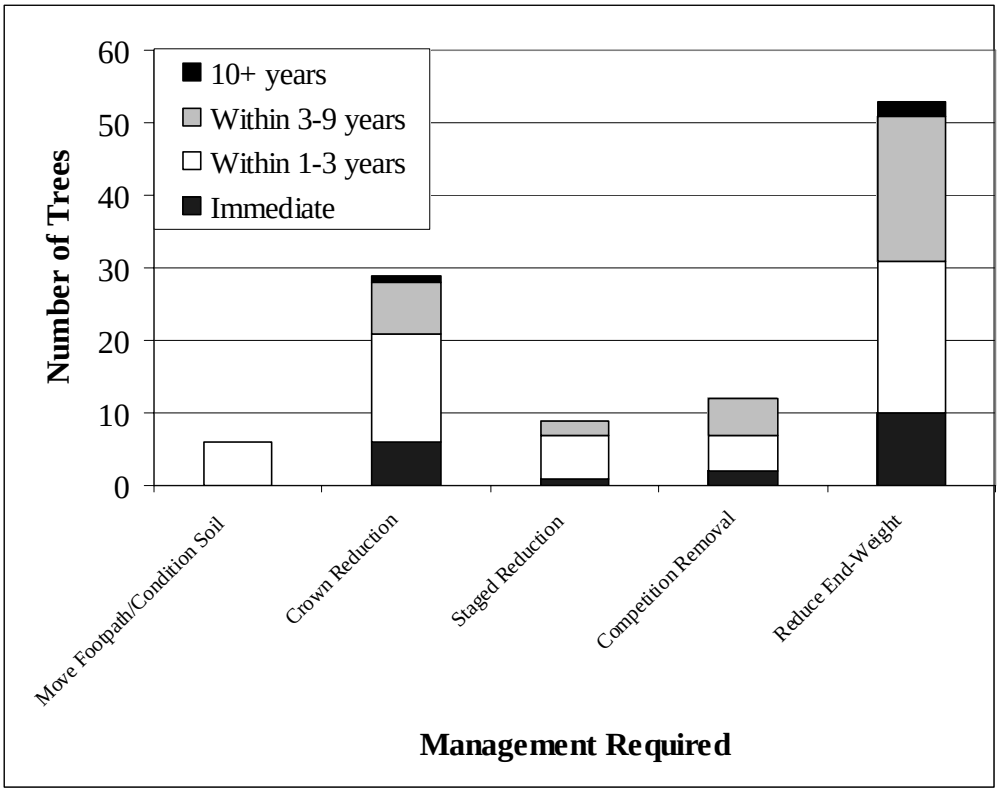


Figure 21: Some of the pruning techniques which have been used for ancient trees in the UK

11.2.4 Particular trees affected by compaction should be assisted by the application of composted wood chip mulch and leaf mould. Over a few years this will normally restore structural and biological soil conditions suited to healthy development of tree roots. Compaction decreases diversity and ecological functioning of soil organisms around the tree. Without the relationship with beneficial soil organisms the tree's ability to obtain water and essential elements from the soil is reduced and the weakened tree becomes vulnerable to pathogen attack. The mulch should be applied to a depth of 5-10cm around the tree, extending to at least the drip line. Deeper layers should be avoided because excessive use of mulch can induce fermentation, immobilize nutrients, cut off the oxygen supply, and lead to tree death. The mulch layer should not be laid in direct contact with the base of the stem as the above harmful effects may cause bark death and leave the tree

susceptible to pathogenic colonisation. The rooting zones of compacted trees may be further protected with thorny dead-hedge halos.

Figure 22: A summary of all of the works that have been recommended at Hördalen. These operations relate to both the veteran trees and adjacent trees with the aim of increasing tree longevity.



11.2.5 Veteran trees may be intolerant of drastic change to their environment. Thinning operations intended to restore open conditions, characteristic of ancient wood-pasture, should be gradual. The degree, orientation and scale of thinning coups should be carefully considered. Trees in a forest situation grow as a community, protecting each other from the elements typically growing tall, with elongated crown stems and high canopies. Ill-advised, heavy thinning may have a range of harmful effects upon individually retained veteran trees and upon their associated habitat.

11.2.6 Too much thinning too quickly is liable to expose the remaining trees to sunlight and wind. The higher levels of exposure may cause sun scorch to the trunks and branches and result in higher rates of transpiration from canopy foliage. In certain instances desiccation of the previously shaded woodland floor may occur. Retained trees may experience damage from wind, snow or ice loading. Changes about the tree may affect habitat circumstances that may have previously favoured certain species and repressed the development of others. Too severe clearing may also cause an alteration in the water table, which may be unfavourable. Strategy governing thinning and the control of stump re-growth should attempt to balance the long term objectives with the initial and intermediate responses of the woodland community.

CHAPTER 11 – ARBORICULTURAL MANAGEMENT RECOMMENDATIONS – SUMMARY

- The highest priority treatments are scheduled for trees in danger of structural disintegration or accelerated physiological decline but are considered possible to save with intervention
- Monitoring, re-inspection recording of all work undertaken is essential for the full benefit of the management regime to be realised
- Special treatments are recommended specifically for ancient trees and should be carried out by a suitably experienced arborist
- All work should be undertaken taking into consideration the likely intolerance of ancient trees to drastic changes to their environment

12.0 FURTHER SURVEY REQUIREMENTS

12.01 To deepen understanding of the veteran trees and understand more about particular aspects of site management the following surveys are proposed (assuming that these have not already been carried out):

i. The data collected with respect to the saproxylic invertebrates and epiphytes at the site is tied together to the tree data in order to confirm the locations and allow future monitoring.
ii. Investigation into the general vitality of the younger oaks in order to set in context the condition of the older oaks as well as an assessment of the mortality rates across the whole population.
iii. The relative importance of both Quercus species and the hybrids in terms of their habitat value for associated species.
iv. Consultation with a grazing animal specialist is advised in order to assess the feasibility of introducing grazing animals to the site.
v. An assessment into the requirement for oak planting so that future generations of oak and in particular *Quercus robur* can be secured.

13.0 REFERENCES

Alexander, K.N.A. (unpublished). Significant sites for old growth communities in lowland Britain and Ireland – a working document.

Alexander, K.N.A. (1999). The Invertebrates of Britain's Wood Pastures. *British Wildlife,* Vol 11, No 2. 108-117.

Fay, N. (2002). Environmental Arboriculture, Tree Ecology and Veteran Tree Management. *The Arboricultural Journal*, Vol 26, No 3. 213-238.

Fay, N. & de Berker, N. (1997). *Veteran Trees Initiative Specialist Survey Method.* English Nature, Peterborough.

Fritz, Ö. (1996). *Inventering av skogliga nyckelbiotoper inom naturskyddade områden I Hallands län 1995. Del 2. Norra länsdelen.* Länsstyrelsen Halland,meddelande 1996:10

Fritz, Ö. (2001). *Indikatorartövervakning i biologiskt väredfulla ädellövskogar i Hallands län.* Halmstads Tryckeri AB, Halmstad.

Jansson, N (2004). *Vedskalbaggar i 20 lövskogs områden i Hallands Län*: Länsstyrelsen i Halland:2004

Lonsdale, D. (1999) *Tree Hazard Assessment and Management.* HMSO, London.

Niklasson, M. (2003). *En undersökning av trädåldrar I halländska skogsreservat.* Halmstads Tryckeri AB, Halmstad.

Read, H. (2000). *Veteran trees: A guide to good management.* English Nature, Peterborough.

Vera, F.W.M. (2000). *Grazing Ecology and Forest History.* Oxford: CABI.

Åhren, P.M. (1983). *Skötselplan för naturreservatet Vallda dalar Kungsbacka Kommun, Hallands län.* Fastställd av Länsstyrelsen, 1984.

Appendix I - Glossary of terms

Arboriculture	The cultivation of trees in order to produce individual specimens of the greatest ornament, for shelter, or any other primary purposes other than the production of timber.
Assessment	In relation to tree hazards this is the process of estimating the risk which a tree or group of trees poses to persons or property (This involves a visual inspection for defects and contributory site factors. This may require a detailed investigation of suspected defects).
Bark	A term usually applied to all the tissues of a woody plant lying outside the vascular cambium.
Body language	In trees, the outward display of growth responses and/or deformation in response to mechanical stresses.
Canopy	The uppermost layer of twigs or foliage in a woodland, tree or group of trees.
Crown	The spreading branches and the foliage of the tree supported by trunk(s).
Crown reduction	Overall reduction of both the height and spread of the crown. This involves only the outer part of the crown, and therefore provides only a modest reduction in overall height (i.e. the lever arm of the tree). This, combined with the accompanying decrease in sail area, is often sufficient to mitigate all but the most severe of hazard. The resulting wounds are usually quite near the tips of the branches and are therefore comparatively small.
Dead wood	In some situations dead wood can pose a hazard as it can fall from the tree. However it also provides a range of habitats both when aerial and when on the ground. The habitat offered changes as the wood decays. Past woodland management has retained little dead wood and so dependent organisms are now uncommon.
Dieback	The death of a part of a tree, usually starting from the branch tips and progressing in stages.
Forest	A large area chiefly covered by trees and undergrowth.
Grazing	The taking of grass close to the ground by sheep, horses, cattle and deer. It is essential or highly desirable for the conservation of the vast majority of grassland and heathland habitats in the UK.
Field layer	The part of the woodland structure containing herbaceous plants and undershrubs. Usually about 10cm to 2m above ground level.
Ground layer	The part of the woodland structure, up to about 10cm above ground level, containing mosses, herbs and the seedlings of plants of the higher layers.
Habitat	The natural or semi-natural home of a plant or animal or groups of animals; it is the place where a plant or animal occur. Thus for example, trees may be part of a woodland, hedgerow, or wood-pasture habitat and a reed bed may be classed as suitable habitat for Reed Buntings or Marsh Harriers.

Layering When aerial parts of a tree (or the whole tree) touch the ground and roots form new, but initially connected, plants. This can be natural or as the result of human influence. This is often the process by which phoenix trees are produced.

Maiden A tree that has not been cut back.

Microclimate The climate of a confined space or minute geographical area. Microclimates are particularly important in terms of shelter (as opposed to local climates).

Monitoring To maintain regular visual assessments of a tree in order to identify potential hazards. Unless otherwise stated monitoring should occur annually.

Monolith A large hulk of standing dead wood. Usually the trunk of the tree or the trunk with the base of the branch framework. These should be retained for habitat where possible.

Moribund A tree which is almost dead. It may still have some live growth but this is considered unlikely to sustain the tree.

Native Originating in a particular place.

Natural regeneration Regeneration of woodland through naturally occurring seedlings.

Phoenix A tree which has fallen or split apart and that has successfully continued growing.

Saproxylic species Species that depend on dead wood habitats for a part of their life-cycle.

Scar This is an aged tear with exposed tissue surrounded with a roll of callous tissue.

Scrub Small trees and bushes, forming the seral stage of succession between open habitat and woodland. Highly valuable for invertebrates and birds, but often invasive and can threaten the survival of other rarer habitats if left unmanaged.

Shrub layer The part of the woodland structure, from about 2-4.5m above ground, containing shrubs and young growth of canopy trees.

Soil compaction Soil compaction restricts the growth of trees, damages roots and reduces infiltration of water into the soil. As the air getting into the soil is also restricted, the biological activity and root growth is affected. This reduces the fertility of the soil and, more specifically, the availability of plant nutrients. So it is important to minimise all forms of soil compaction. If soil structure is damaged, take positive steps to correct the problem.

Split limb A longitudinal split or crack in a branch, usually occurring when end weight is sufficient to start the process of limb loss and transmits stress along the limb.

Standards Widely spaced trees left to grow on to maturity, often with coppice or a successor generation growing under or between them. These form the dominant layer of the canopy.

Stool The stump or cut base of a shrub or tree from which new shoots grow.

Stress	In plant physiology, a condition under which one or more physiological functions are not operating within their optimum range, for example due to lack of water, inadequate nutrition or extremes of temperature.
Structure	The pattern of woodland and habitat elements such as the height and density of crowns, position and size of glades and the shape and orientation of margins.
Tear	Exposed woody tissue wounds usually elongated in shape, principally torn along the grain. These are associated with the recent shedding of live limb parts.
Understorey	The layer of trees below the dominant tree species in the canopy.
Veteran trees	Veteran trees are trees that are old for their species and valued for their historical, biological, aesthetic or cultural significance. They are significant for the habitat that is offered in their complex woody structure that providing continuity for species that depend on this substrate at some stage of their life cycle.
Vigour	In tree assessment, an overall measure of the rate of shoot production, shoot extension or diameter growth.
Visual tree assessment	In addition to the literal meaning, a system expounded by Mattheck & Breloer (1995) to aid the diagnosis of potential defects through visual signs and the application of mechanical criteria.
Vitality	In tree assessment, an overall appraisal of physiological and biochemical processes, in which high vitality equates with healthy function.
Windthrow	When trees are blown over by wind.
White-rot	Various kinds of wood decay in which lignin, usually together with cellulose and other wood constituents, is degraded.
Wood-pasture	Woodland in which grazing or browsing has been the dominant influence.

Appendix II – Additional Results from Surveys of Tree Details & Habitat

Figure 23: The assessment of live growth does not account of the shape of the tree or past crown collapse. This assesses the current proportion of live growth about the tree.

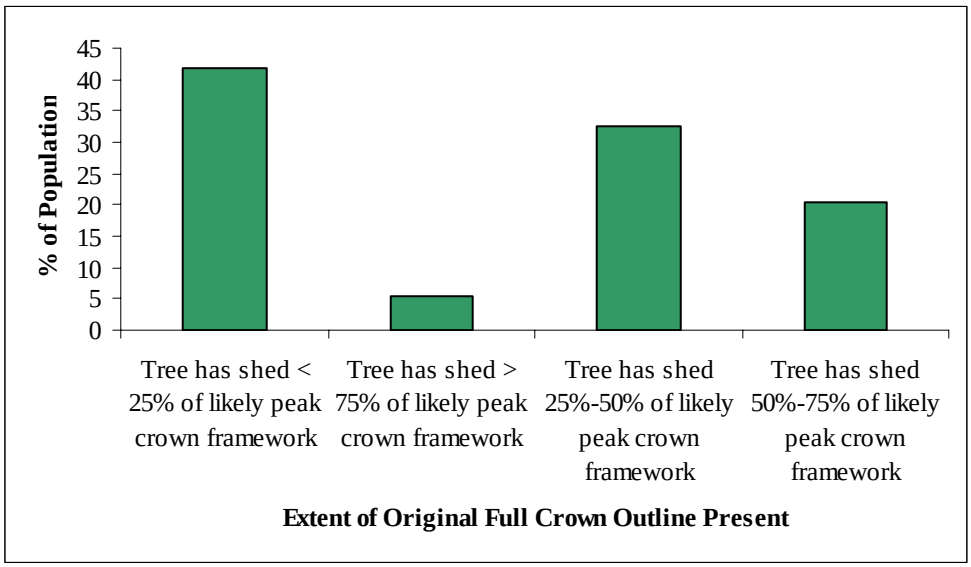


Figure 24: Most of the trees were found to have a full crown outline.

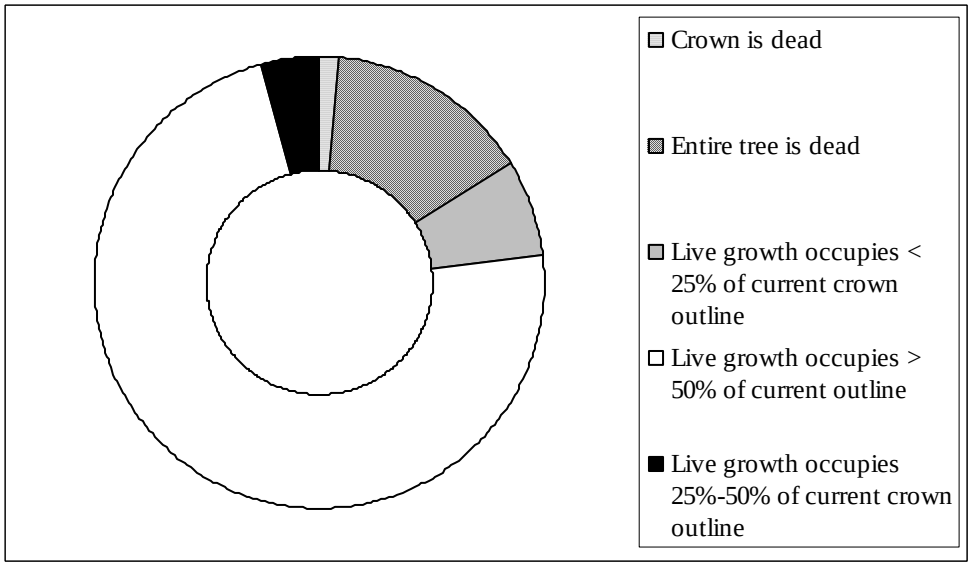


Figure 25: Location of loose bark and other bark habitats

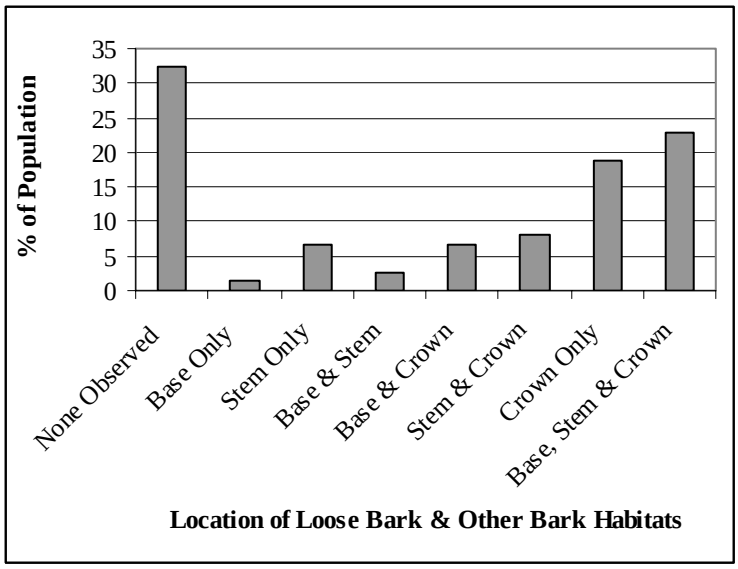


Figure 26: Most of the trees were not seen to have sap runs or other exudates leaking from the trunk. This suggests that the invertebrates that depend on this resource may not be present in high numbers.

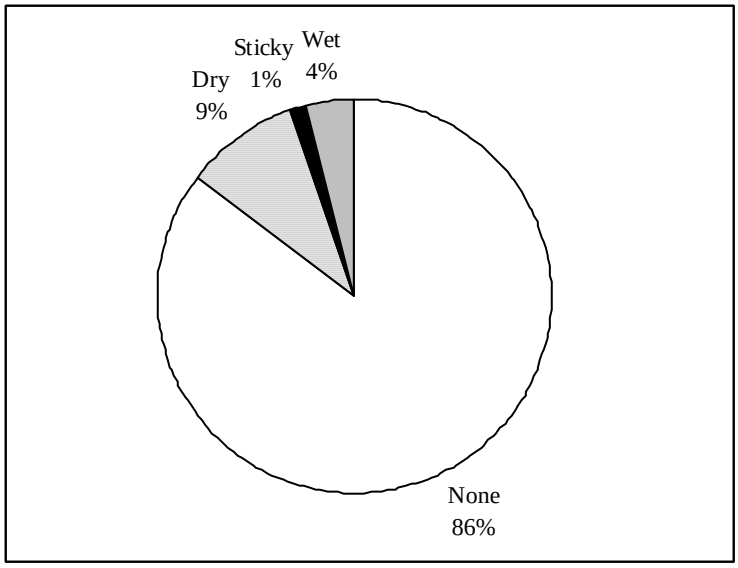


Figure 27: The frequency of crown hollows and holes observed on trees in the survey population. Error bars show 95% confidence intervals for the mean.

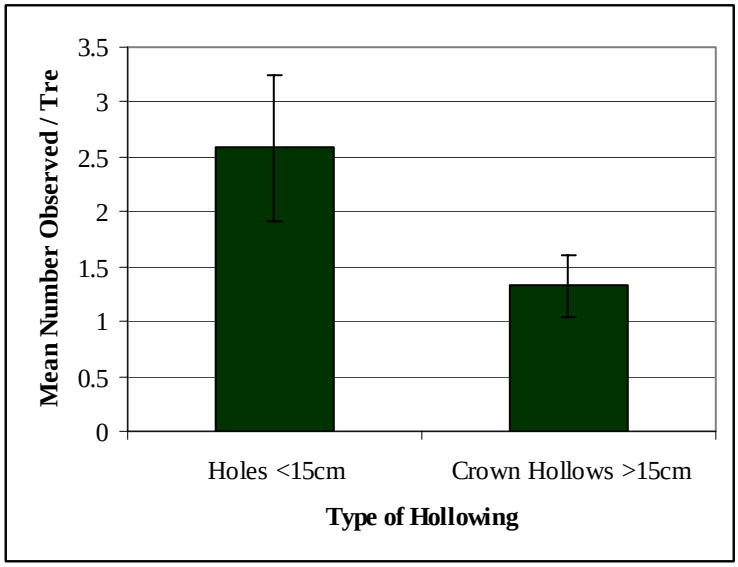
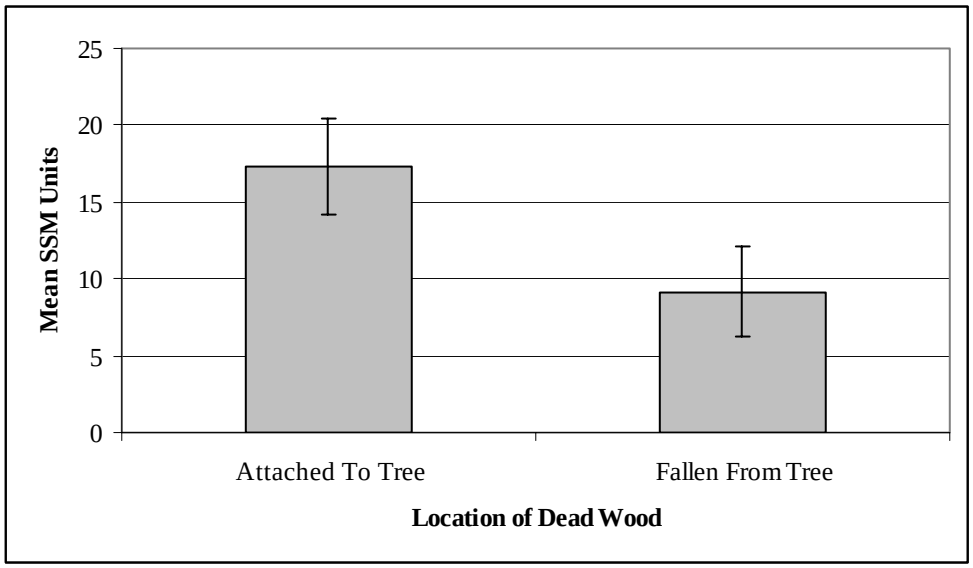


Figure 28: The mean quantity of dead wood associated with each veteran oak. Error bars show 95% confidence intervals for the mean.



Appendix III – Extraction from the Tree Details & Tree Habitat Report

Veteran Tree Habitat

Hördalen

Tree No	Species	Girth	S/F	Tree Form	Bark	Limbs	Exposed Sapwood	Hollowing	Rot	Deadwood	Habitat Value	Arb. Value
1	Quercus petraea	4.35	1	Maiden Tree	Con: 7 Flux: 0	Split: 2 Stubs:	Tears: Scars: 4 Lightning:	Base: 5 Mid: 4 Top: 4 Crown: 3 Holes: 5 W.Poc: 0	Brown * Black *	Att'd: 10m Fallen: 21m	17	12
2	Quercus robur	4.09	1	Maiden Tree	Con: 2 Flux: 0	Split: 0 Stubs: 0	Tears: 1 Scars: 0 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 0 Holes: 0 W.Poc: 0	White	Att'd: 34m Fallen: 5m	7	21
3	Quercus robur	3.25	1	Maiden Tree	Con: 5 Flux:	Split: 0 Stubs: 0	Tears: 0 Scars: 2 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 0 Holes: 0 W.Poc: 0	White	Att'd: 57m Fallen: 3m	7	10
4	Quercus sp. (Deciduo	3.38	1	Maiden Tree	Con: 7 Flux:	Split: Stubs:	Tears: Scars: Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 0 Holes: 1 W.Poc:	White *	Att'd: 43m Fallen: 6m	10	1
5	Quercus petraea	3.40	1	Maiden Tree	Con: 3 Flux:	Split: 1 Stubs:	Tears: Scars: 1 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 1 Holes: 1 W.Poc:	White	Att'd: 23m Fallen: 7m	10	22
6	Quercus petraea	2.72	1	Maiden Tree	Con: 3 Flux:	Split: Stubs:	Tears: Scars: 1 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: Holes: W.Poc:	White	Att'd: 13m Fallen: m	5	23
7	Quercus sp. (Deciduo	2.70	1	Maiden Tree	Con: 7 Flux:	Split: Stubs:	Tears: Scars: 1 Lightning:	Base: 1 Mid: 1 Top: 3 Crown: 1 Holes: 2 W.Poc:	Black White *	Att'd: 28m Fallen: 2m	12	1
8	Quercus robur	4.67	1	Maiden Tree	Con: 0 Flux:	Split: Stubs: 1	Tears: 1 Scars: 2 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 3 Holes: 1 W.Poc:	White Brown	Att'd: 22m Fallen: 36m	13	21
9	Quercus robur	2.74	1	Maiden Tree	Con: 0 Flux: A	Split: Stubs:	Tears: Scars: 1 Lightning:	Base: 1 Mid: 1 Top: 1 Crown: 0 Holes: 2 W.Poc: 0	White	Att'd: 26m Fallen: 2m	8	24

Veteran Tree Habitat

Hördalen

Tree No	Species	Girth	S/F	Tree Form	Bark	Limbs	Exposed Sapwood	Hollowing	Rot	Deadwood	Habitat Value	Arb. Value
10	Quercus robur	2.88	1	Maiden Tree	Con: 4 Flux:	Split: Stubs: 1 Lightning:	Tears: 1 Scars: 1	Base: 1 Mid: 2 Top: 1 Crown: 0 Holes: 0 W.Poc: 0	White *	Att'd: 15m Fallen: 3m	7	21
11	Quercus robur	3.60	1	Maiden Tree	Con: 1 Flux:	Split: Stubs: Lightning:	Tears: Scars: 1	Base: 1 Mid: 2 Top: 1 Crown: 0 Holes: 3 W.Poc:	White	Att'd: 9m Fallen: 0m	5	22
12	Quercus robur	2.12	1	Maiden Tree	Con: 7 Flux:	Split: Stubs: Lightning:	Tears: Scars: 2	Base: 3 Mid: 1 Top: 1 Crown: 0 Holes: 1 W.Poc: 0	White Black	Att'd: 23m Fallen: 2m	10	1
13	Quercus robur	2.70	1	Maiden Tree	Con: 3 Flux:	Split: Stubs: Lightning:	Tears: Scars: 2	Base: 1 Mid: 1 Top: 4 Crown: 3 Holes: W.Poc:	White Brown * Black	Att'd: m Fallen: 7m	9	23
14	Quercus petraea	2.79	1	Maiden Tree	Con: 0 Flux:	Split: 1 Stubs: Lightning:	Tears: Scars: 2	Base: 1 Mid: 1 Top: 1 Crown: Holes: 2 W.Poc:	None	Att'd: 19m Fallen: 2m	7	9
15	Quercus petraea	2.01	1	Maiden Tree	Con: 0 Flux:	Split: Stubs: Lightning:	Tears: Scars:	Base: 1 Mid: 1 Top: 3 Crown: 1 Holes: W.Poc:	White	Att'd: m Fallen: 3m	5	23
16	Quercus sp. (Deciduo	2.50	9	Maiden Tree	Con: 6 Flux:	Split: Stubs: Lightning:	Tears: Scars: 1	Base: 3 Mid: 3 Top: 3 Crown: Holes: W.Poc:	Brown * Black *	Att'd: m Fallen: 23m	11	1
17	Quercus petraea	2.50	1	Maiden Tree	Con: 4 Flux:	Split: Stubs: Lightning:	Tears: Scars: 2	Base: 2 Mid: 3 Top: 4 Crown: 1 Holes: 5 W.Poc:	Brown * White Black *	Att'd: 24m Fallen: 15m	18	21
18	Quercus petraea	2.66	1	Maiden Tree	Con: 0 Flux:	Split: Stubs: Lightning:	Tears: Scars: 4	Base: 4 Mid: 4 Top: 1 Crown: 0 Holes: 1 W.Poc:	Brown *	Att'd: 10m Fallen: 0m	8	18

Appendix IV - Extraction from the Individual Tree Management Reports

Hördalen

Tree No. 1 — Quercus petraea

Dimensions

Girth: 4.35
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 6
Collapse: 1
Vigour: 5

Hab. Score **17**

Arb. Score **12**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Initiate crown Restoration tree(s) to 12m height.	Urgent, treat immediately
Reduce 5 high canopy competion at 20m to South by 4m.	Treat within 6 years

Aspect: N

Tree No. 2 — Quercus robur

Dimensions

Girth: 4.09
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 7
Collapse: 8
Vigour: 6

Hab. Score **7**

Arb. Score **21**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Reduce end weight about crown by 10%.	Treat within 36 months.
Reduce end weight about crown by 10%.	Treat within 10 years.
Reduce 2 high canopy competion to South by 4m.	Treat within 6 years

Aspect: W

Hördalen

Tree No. 33 Quercus robur

Dimensions

Girth: 3.25
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 6
Collapse: 5
Vigour: 5

Hab. Score **10**

Arb. Score **16**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Reduce end weight about crown to North, East and West by 20%.	Urgent, treat immediately
Reduce end weight 1 limb(s) at base of crown to West to 8m from union.	Treat within 36 months.
Thin crown(s) 9 candidate veteran(s) to South, East and West by 20%.	Treat within 48 months.
Select 9 candidate veteran(s) to South, East and West	Treat within 48 months.

Aspect: S

Tree No. 34 Quercus robur

Dimensions

Girth: 2.92
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 7
Collapse: 7
Vigour: 6

Hab. Score **7**

Arb. Score **20**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Select 5 candidate veteran(s) to South, East and West	Treat within 6 years
Thin competition within crown drip line to all aspects by 20%.	Treat within 36 months.

Aspect: S

Hördalen

Tree No. 45 Quercus sp. (Deciduous)

Dimensions

Girth: 2.80
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 8
Collapse: 1
Vigour: 8

Hab. Score **9**

Arb. Score **17**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Reduce end weight about crown to South, East and West by 40%.	Urgent, treat immediately
Conduct staged reduction to tree(s)	Treat within 48 months.
Reduce end weight 3 candidate veteran(s) to East and West by 30%.	Treat within 48 months.
Thin high canopy competion to South, East and West by 30%.	Treat within 60 months.

Aspect: SW

Tree No. 46 Quercus robur

Dimensions

Girth: 3.51
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

Decline: 8
Collapse: 6
Vigour: 7

Hab. Score **8**

Arb. Score **21**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Conduct staged reduction to crown to 17m height.	Treat within 48 months.
Conduct staged reduction to 7 candidate veteran(s) about tree to 19m height.	Treat within 48 months.
Plant 12 nectar source at 10m beyond crown drip line	Treat within 6 years

Aspect: SE

Hördalen

Tree No. 63 Quercus robur

Dimensions

Girth: 3.74
Meas't Ht:

Tree Form

Current: Maiden Tree

Arboricultural Assessment

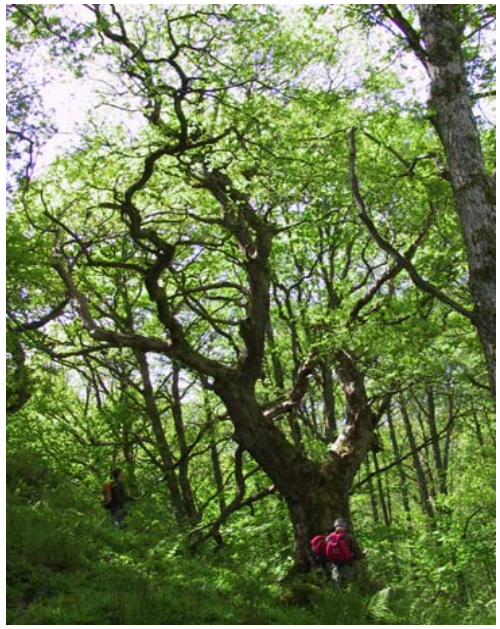
Decline: 7
Collapse: 3
Vigour: 8

Hab. Score **14**

Arb. Score **18**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Conduct staged reduction to crown to 11m height.	Urgent, treat immediately
Thin crown(s) 7 candidate veteran(s) adjacent to tree to South and West by 25%.	Treat within 36 months.
Select 12 candidate veteran(s) to all aspects	Treat within 6 years

Aspect: E



Tree No. 64 Quercus robur

Dimensions

Girth: 4.87
Meas't Ht:

Tree Form

Current: Multi-stemmed

Arboricultural Assessment

Decline: 10
Collapse: 4
Vigour: 9

Hab. Score **19**

Arb. Score **23**

Tree Management Objectives (Phasing of operations is specified in "Tree Management Schedule")	Priority
Reduce end weight about crown by 15%.	Urgent, treat immediately
Reduce crown by 15%.	Treat within 36 months.
Select 9 candidate veteran(s) to South, East and West	Treat within 6 years
Thin crown(s) high canopy competion about tree by 15%.	Treat within 6 years

Aspect: W

Appendix V – Extraction from the Prioritised Tree Management Schedule

Tree Management Schedule: Urgent, Treat Immediately

No.	Species	Management Objective	Return Period	Duration	First Operation
1	Quercus petraea	Initiate crown Restoration tree(s) to 12m height.	Repeat every 4 years	20 years.	Reduce end weight by 15%.
8	Quercus robur	Reduce end weight about crown at 25m	Repeat every 4 years	4 years.	Reduce end weight by 15%.
10	Quercus robur	Reduce end weight about crown to East by 20%.			
26	Quercus robur	Reduce end weight about crown to South and East by 25%.			
27	Quercus robur	Reduce end weight about crown to all aspects by 25%.	Repeat every 3 years	3 years.	Reduce end weight by 15%.
28	Quercus robur	Reduce 1 candidate veteran(s) to 8m height.			
32	Quercus robur	Reduce end weight about crown to South and East by 20%.			
33	Quercus robur	Reduce end weight about crown to North, East and West by 20%.			
36	Quercus petraea	Reduce crown by 10%.			
45	Quercus sp. (Deciduous)	Reduce end weight about crown to South, East and West by 40%.	Repeat every 4 years	4 years.	Reduce end weight by 25%.
55	Quercus robur	Reduce end weight about crown to South and East to 5m from union.	Repeat every 3 years	12 years.	Reduce end weight by 20%.
58	Quercus robur	Conduct staged reduction to tree(s) to 10m height.	Repeat every 4 years		Reduce end weight by 15%.
59	Quercus robur	Reduce 1 limb(s) at base and mid of crown to Southwest by 40%.			
63	Quercus robur	Conduct staged reduction to crown to 11m height.	Repeat every 3 years	15 years.	Reduce by 10%.
64	Quercus robur	Reduce end weight about crown by 15%.			
65	Quercus robur	Reduce crown by 15%.			
67	Quercus robur	Reduce end weight 2 limb(s) at base of crown to East by 25%.			
72	Quercus robur	Reduce crown by 30%.	Repeat every 4 years	8 years.	Reduce by 15%.
74	Quercus robur	Reduce crown by 20%.			

Tree Management Schedule: Treat Within 12 Months.

No.	Species	Management Objective	Return Period	Duration	First Operation
3	Quercus robur	Promote internal shoot growth by pruning epicormic growth at mid crown	Repeat every year.	6 years.	
8	Quercus robur	Move footpath(s) to beyond crown drip line.			
9	Quercus robur	Reduce end weight about crown to South and West by 20%.			
13	Quercus robur	Thin competition to all aspects within crown drip line by 20%.	Repeat every 3 years		Thin by 20%.
13	Quercus robur	Reduce end weight 2 limb(s) at base of crown to South and East by 20%.			
17	Quercus petraea	Thin competition to all aspects by 20%.	Repeat every 3 years		Thin by 30%.
18	Quercus petraea	Reduce end weight 6 candidate veteran(s) adjacent to tree to all aspects by 20%.	Repeat every 3 years	3 years.	Reduce end weight by 10%.
18	Quercus petraea	Reduce end weight about crown by 15%.			
19	Quercus petraea	Thin crown(s) 9 candidate veteran(s) to all aspects			
20	Quercus petraea	Reduce end weight about crown by 25%.	Repeat every 4 years	4 years.	Reduce end weight by 10%.
21	Quercus robur	Move footpath(s) to beyond crown drip line.			
21	Quercus robur	Condition soil within crown drip line to South, East and West	Repeat every year.	5 years.	
24	Quercus robur	Thin crown(s) 4 high canopy competion to South and West by 30%.	Repeat every 4 years	4 years.	Thin crown(s) by 15%.
28	Quercus robur	Reduce end weight about crown to South by 20%.	Repeat every 5 years	5 years.	
32	Quercus robur	Thin crown(s) 1 candidate veteran(s) adjacent to tree to Northwest by 15%.	Repeat every 3 years	6 years.	Reduce end weight by 10%.
35	Quercus robur	Reduce crown by 10%.			
41	Quercus robur	Reduce end weight about crown to South and East by 25%.	Repeat every 4 years	4 years.	Reduce end weight by 10%.
42	Quercus petraea	Thin crown(s) 2 candidate veteran(s) by 30%.	Repeat every 5 years	10 years.	Reduce end weight by 10%.
42	Quercus petraea	Conduct staged reduction to crown to 8m height.	Repeat every 4 years	16 years.	Reduce by 10%.
43	Quercus petraea	Reduce end weight about crown to all aspects by 25%.	Repeat every 5 years	5 years.	Reduce end weight by 15%.
48	Quercus robur	Reduce crown by 10%.			
49	Quercus petraea	Move footpath(s) beyond crown drip line			
49	Quercus petraea	Condition soil over foot path	Repeat every year.	4 years.	

Tree Management Schedule: Treat Within 6 Years

No.	Species	Management Objective	Return Period	Duration	First Operation
62	Quercus robur	Thin crown(s) 5 candidate veteran(s) to all aspects by 20%.	Repeat every 4 years	4 years.	Thin by 10%.
62	Quercus robur	Select 5 candidate veteran(s) to all aspects			
63	Quercus robur	Select 12 candidate veteran(s) to all aspects			
64	Quercus robur	Select 9 candidate veteran(s) to South, East and West			
64	Quercus robur	Thin crown(s) high canopy competion about tree by 15%.			
65	Quercus robur	Select 5 candidate veteran(s) to South and East			
66	Quercus robur	Reduce end weight about crown by 15%.			
66	Quercus robur	Select 11 candidate veteran(s) to all aspects			
66	Quercus robur	Thin crown(s) 6 high canopy competion to South, East and West by 20%.	Repeat every 3 years	3 years.	Reduce end weight by 15%.
67	Quercus robur	Reduce end weight about crown to South and East by 15%.			
67	Quercus robur	Select 5 candidate veteran(s) to South, East and West			
68	Quercus robur	Select 11 candidate veteran(s) to all aspects			
69	Quercus robur	Select 12 candidate veteran(s) to all aspects			
71	Quercus robur	Select 7 candidate veteran(s) to all aspects			
72	Quercus robur	Select 10 candidate veteran(s) to all aspects			
73	Quercus robur	Select 12 candidate veteran(s) to all aspects			

Appendix VI – Map Showing Location of Ancient Oaks at Hördalen

N

0 200 400 Meters

Ancient Oaks
Nature reserve boundary