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# Ancient tree survey of Staverton Park and The Thicks SSSI, Suffolk

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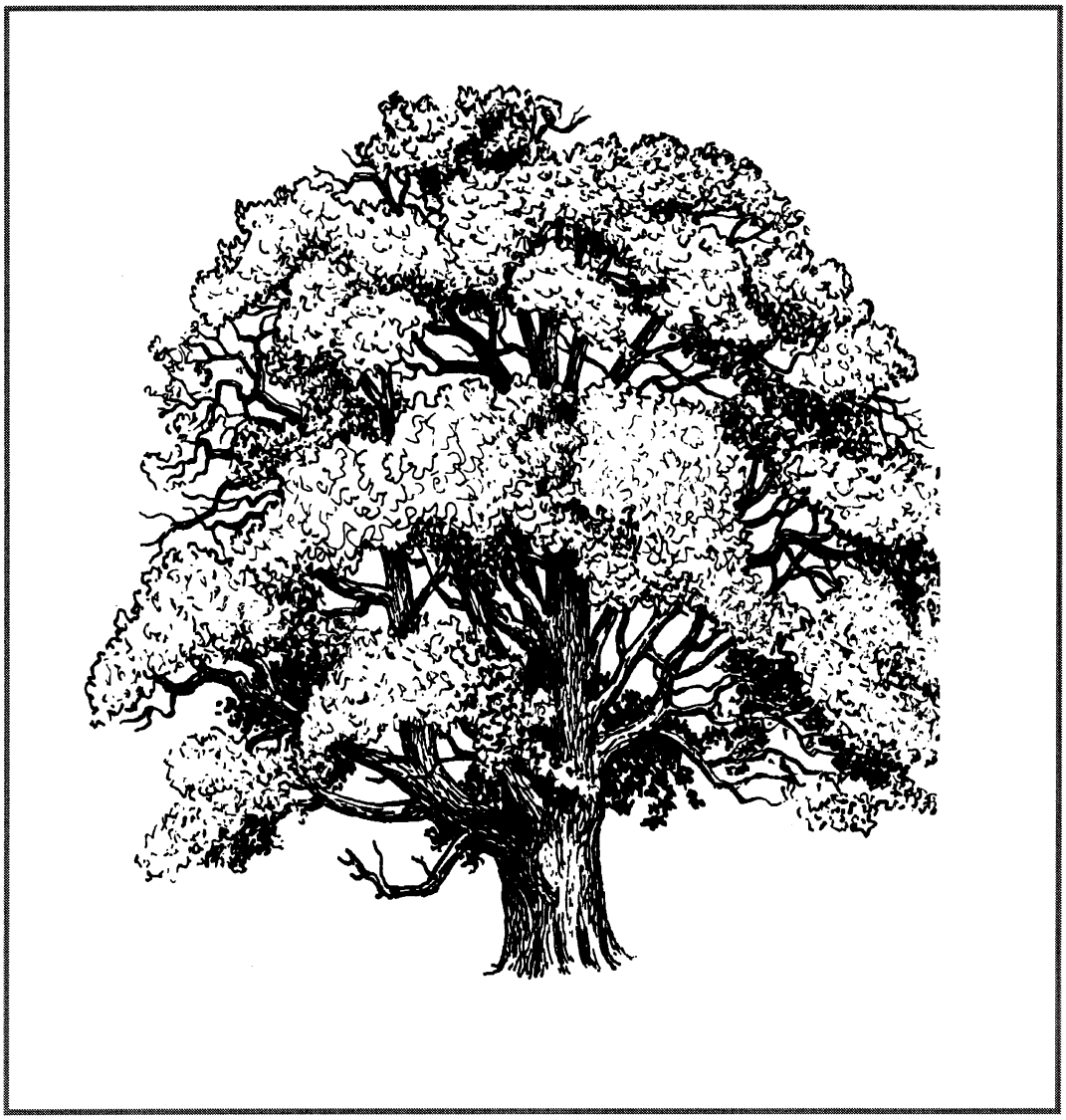

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No

# Ancient Tree Survey of Staverton Park and The Thicks SSSI, Suffolk

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# Summary

## Method

Each tree in Staverton Park and Little Staverton was surveyed for the a number of attributes, and galvanised steel labels (43mm x 25mm) with consecutive numbering were nailed to each tree with an aluminium nail. The trees in Staverton Park only were mapped with great accuracy at a scale of 1:2500.

## The number of all trees

The total number of trees were counted for each species. Previous estimates have been similar ('about 4000 oaks', '1200-4680 oaks'). The ancient trees of Staverton Park and the Thicks are one of the largest concentrations in the country.

| species | all trees | living trees |
|---|---|---|
| *Quercus robur* - oak | 3020 | 2899 |
| *Betula pendula* - silver birch | 1990 | 1919 |
| *Ilex aquifolium* - holly | 375 | 347 |
| other species | 122 | 120 |

## Sizes of trees

The oak trees ranged from under 20cm diameter to above 740cm diameter, with most between 60-160cm. The mean diameter, calculated by adding up the diameters and dividing by the number of trees, is 101cm for Staverton Park oaks and 99cm for Little Staverton oaks. The birch trees were up to 139cm diameter, with most under 40cm diameter. The holly trees were up to 139cm, with most between 20-60cm. Rowan trees reached up to 79cm, with most under 20cm. No similar data has been collected from the site before.

## Features used by invertebrates - sap runs, rot holes, branch stumps and heart rot

730 trees had rot holes and 115 trees had sap runs. 33 of these trees had both rot holes and sap runs. A total of 9337 broken or cut branch stumps were recorded from 2720 trees, with a mean of 3.43 branch stumps per tree that had branch stumps. Of the 2510 trees surveyed for heart rot, 1869 trees had heart rot fungus. The high number of such features recorded in Staverton Park and Little Staverton provide a massive resource for the wide range of common and rare invertebrates.

## The amount of dead and/or fallen wood

A total of 4198 dead branches were recorded on 1549 trees, which is a mean of 2.71 dead branches per tree with dead branches, giving a total volume of dead branch wood of 263.20m$^3$. There were 23 living tree stumps and 68 dead tree stumps. There were 174 standing dead trees, 166 of which were in Staverton Park and the remaining 8 in Little

Staverton. There were 113 fallen dead trees, 95 of which were in Staverton Park and the remaining 18 in Little Staverton. They are shown in table 12. For the dead oaks, the volume of dead oak wood is 262.07$m^3$, of which 246.02$m^3$ is in Staverton Park and 16.05$m^3$ is in Little Staverton.

The volume of dead wood within living oak trees is 3321.65$m^3$. This comprises 240.7$m^3$ dead oakwood for Little Staverton and 3080.94$m^3$ for Staverton Park. The volume of dead wood in living trunks is six times greater than the combined dead wood in dead branches (on living trees) and in standing/fallen dead trees.

The total amount of dead wood on the site is 3846.9$m^3$.

# Introduction

Staverton Park and the Thicks lies about ten kilometres east of Woodbridge, in Suffolk. It is a Site of Special Scientific Interest and has been proposed by Government as a Special Area of Conservation. It has three distinct parts, named Staverton Park, Little Staverton and The Thicks respectively. It is an ancient deer park, with a well documented history (e.g. Rackham 1980, Peterken 1969, Peterken 1993). There are thousands of ancient pollarded oaks which support wildlife not found on younger trees. It is one of the biggest groups of ancient trees in Europe.

Rotting heartwood in the middle of trees, and other dead wood, is abundant and supports many rare invertebrates. A rich lichen flora is found on the old trees, even though the remainder of East Anglia is generally poor in lichens compared to other parts of the United Kingdom. Fungi are abundant, including one species found in just three other places in the United Kingdom. The ancient trees are ideal for hole-nesting birds.

Between the ancient oaks are occasional younger trees of birch, holly and rowan. A few hawthorn and elder bushes make up the shrub layer. The ground vegetation is dominated by bracken, with some bluebells, bramble and honeysuckle. Acid grassland is found alongside the rides, where mowing or vehicular action keeps bracken from thriving, and grassland of a more nutrient-rich nature is found in a fenced deer enclosure in the north of Staverton Park.

Staverton Park covers by far the largest area of the site than the other two parts. The Thicks has a dense canopy of the tallest hollies in Britain which compete with the oaks. The more sheltered microclimate, however, means that the Thicks has an even higher number and abundance of lichens than in Staverton Park. The dense vegetation at ground level makes surveying difficult and so it has been omitted from this survey. Little Staverton is an outlying wood within the original mediaeval park boundary, with similar trees to Staverton Park although with rather more bramble in the ground vegetation. A map of the site is included.

Although there is much published work on Staverton Park and the Thicks, no-one had before tried to measure the resource of trees and dead wood. This made management decisions difficult. For example, the number of new trees required per year to achieve a stable population depends on the rate of death and the existing number, neither of which are available. By identifying and mapping each tree, it is possible to follow changes in individual trees as well as the resource as a whole. As the trees age, grow or reduce canopy size, thrive or die, we need to be continually watching to ensure management decisions are taken to maximise the wildlife benefit and the character of the site.

This report describes the mapping, numbering and survey of every tree in Staverton Park and Little Staverton, so that we can be confident that the scale of the resource is known and can be monitored through time.

Staverton Park and the Thicks is private. Permission is required for access off the public footpath which runs through the Thicks and alongside the Park.

**Map: Staverton Park and the Thicks SSSI.**

# Method

Each tree in Staverton Park and Little Staverton was surveyed for the following attributes, as developed by Ted Green, then of English Nature.

- species
- trunk diameter, 1.2m above ground level
- alive or dead
- fallen or standing
- if it was a stump under/over 4m high
- the number of dead limbs over 15cm diameter for over 2m of length
- the number of broken or cut branch stumps
- presence of red or white heart rot
- the number of living limbs over 15cm diameter for over 2m of length
- location of hollowing in the trunk (bottom/middle/top/none)
- presence of rot holes or sap runs
- any other species on the tree e.g. fungi, invertebrates

A galvanised steel label (43mm x 25mm) with consecutive numbering was nailed to each tree with a 75mm aluminium nail. Each nail was placed 2.5m above ground to keep them out of easy reach of people. The nail was hammered 10mm into the tree, so the metal label hung loose to allow an estimated two to three decades of tree growth before the nail and label become engulfed by wood.

The position of each numbered tree was marked approximately on a 1:5000 map by the surveyors. Approximately 2500 trees were surveyed in October 1994 by Ted Green and John Smith, and a similar number were surveyed in February 1996 by Petty and Sons.

In January and February 1998, the trees in Staverton Park only were mapped to much greater accuracy and greater scale by Kathy Harmer, using aerial photography and ground survey. Colour vertical aerial photographs of Staverton Park and the Thicks SSSI were taken in May 1997, at a scale of 1:2500. Tracing paper of A4 size was laid over each aerial photograph, and the centre of each tree canopy was marked with a dot. Commonly, it was not possible to distinguish individual trees, and two or more tree canopies were merged and were plotted as a single point. Following this, the dot maps were taken to the site with the aerial photographs to check them on the ground. The numbered tags on the trees were vital in establishing base points each day identifiable on the ground and on the aerial photograph. Considerable time was spent measuring the distances between trees to accurately position them, particularly where a group of trees could not accurately be individually distinguished from the aerial photos. It was also necessary to allow for the distortion of the 'vertical' aerial photographs, as the trees at equal spacing would appear closer together at the edges of the photographs than at the centre.

The map has subsequently been digitised by Suffolk County Council, to allow further analysis.

# Results

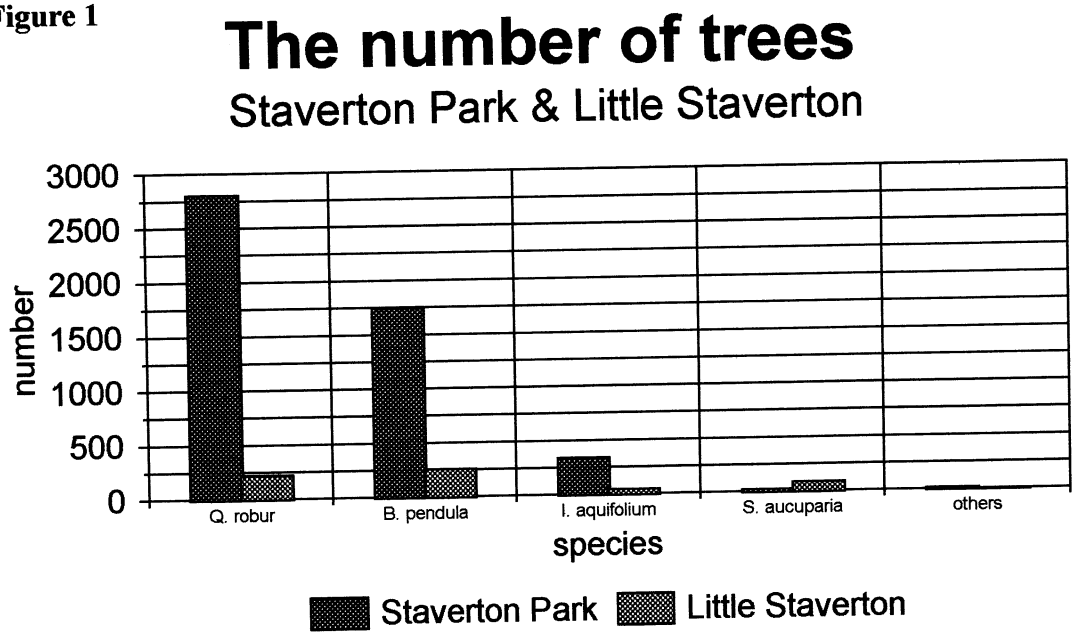
## The number of all trees

The total number of trees in Staverton Park and Little Staverton were counted for each species and are tabulated in table 1 and illustrated in figure 1.

**Table 1** The number of all trees by species at Staverton Park and Little Staverton, alive or dead, from surveys in 1994 and 1996.

| Species | Staverton Park | Little Staverton | Total |
|---|---|---|---|
| *Quercus robur* | 2800 | 220 | 3020 |
| *Betula pendula* | 1735 | 255 | 1990 |
| *Ilex aquifolium* | 334 | 41 | 375 |
| *Sorbus aucuparia* | 20 | 85 | 105 |
| *Crataegus monogyna* | 11 | 0 | 11 |
| *Prunus spinosa* | 2 | 0 | 2 |
| *Corylus avellana* | 1 | 0 | 1 |
| *Aesculus hippocastanum* | 1 | 0 | 1 |
| *Prunus avium* | 1 | 0 | 1 |
| *Salix caprea* | 0 | 1 | 1 |
| **Total** | 4905 | 602 | 5507 |

**Figure 1**



## The number of living trees

Table 1 and figure 1 include all trees, alive and dead. Three hundred and two trees, recorded as remnant trunks fallen and dead, standing dead trees, or standing dead trunks, were present, forming 5.48% of all trees surveyed. Table 2 and figure 2 show the total number of living trees in Staverton Park and Little Staverton.

**Table 2** The number of all living trees by species at Staverton Park and Little Staverton, from surveys in 1994 and 1996.

| Species | Staverton Park | Little Staverton | Total |
|---|---|---|---|
| *Quercus robur* | 2694 | 205 | 2899 |
| *Betula pendula* | 1673 | 246 | 1919 |
| *Ilex aquifolium* | 308 | 39 | 347 |
| *Sorbus aucuparia* | 20 | 85 | 105 |
| *Crataegus monogyna* | 9 | 0 | 9 |
| *Prunus spinosa* | 2 | 0 | 2 |
| *Corylus avellana* | 1 | 0 | 1 |
| *Aesculus hippocastanum* | 1 | 0 | 1 |
| *Prunus avium* | 1 | 0 | 1 |
| *Salix caprea* | 0 | 1 | 1 |
| **Total** | 4709 | 576 | 5285 |

## Sizes of trees

The trees were grouped into 20cm size classes to show the range of trees present and to identify gaps in the size distribution. This was done for *Quercus robur*, *Betula pendula*, *Ilex aquifolium* and *Sorbus aucuparia* only, as there was not sufficient numbers of other species to form a meaningful analysis. The results are shown in table 3 and figure 3. The mean diameter, calculated by adding up the diameters and dividing by the number of trees, is 101cm for Staverton Park oaks and 99cm for Little Staverton oaks.

**Table 3a** - The size of *Quercus robur* and *Betula pendula* in Staverton Park and Little Staverton

| Diameter of tree in cm, at 1.2 metres above ground | *Quercus robur* | | | *Betula pendula* | | |
|---|---|---|---|---|---|---|
| | Staverton Park | Little Staverton | Total | Staverton Park | Little Staverton. | Total |
| <20 | 3 | 1 | 4 | 615 | 138 | 753 |
| 20-39 | 54 | 4 | 58 | 867 | 98 | 965 |
| 40-59 | 141 | 14 | 155 | 159 | 16 | 175 |
| 60-79 | 406 | 50 | 456 | 72 | 2 | 74 |
| 80-99 | 739 | 49 | 788 | 14 | 0 | 14 |
| 100-119 | 749 | 42 | 791 | 5 | 1 | 6 |
| 120-139 | 448 | 31 | 479 | 3 | 0 | 3 |
| 140-159 | 160 | 15 | 175 | 0 | 0 | 0 |
| 160-179 | 61 | 8 | 69 | 0 | 0 | 0 |
| 180-199 | 21 | 4 | 25 | 0 | 0 | 0 |
| 200-219 | 11 | 1 | 12 | 0 | 0 | 0 |
| 220-239 | 3 | 1 | 4 | 0 | 0 | 0 |
| 240-259 | 1 | 0 | 1 | 0 | 0 | 0 |
| 260-279 | 1 | 0 | 1 | 0 | 0 | 0 |

**Table 3b** - The size of *Ilex aquifolium* and *S. aucuparia* in Staverton Park and Little Staverton

| Diameter of tree in cm, at 1.2 metres above ground | Ilex aquilinum | | | Sorbus aucuparia | | |
|---|---|---|---|---|---|---|
| | Staverton Park | Little Staverton | Total | Staverton Park | Little Staverton | Total |
| <20 | 17 | 19 | 36 | 4 | 76 | 80 |
| 20-39 | 167 | 16 | 183 | 7 | 4 | 11 |
| 40-59 | 119 | 5 | 124 | 4 | 5 | 9 |
| 60-79 | 22 | 1 | 23 | 1 | 0 | 1 |
| 80-99 | 7 | 0 | 7 | 0 | 0 | 0 |
| 100-119 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120-139 | 2 | 0 | 2 | 0 | 0 | 0 |
| 140-159 | 0 | 0 | 0 | 0 | 0 | 0 |

**Figure 2**

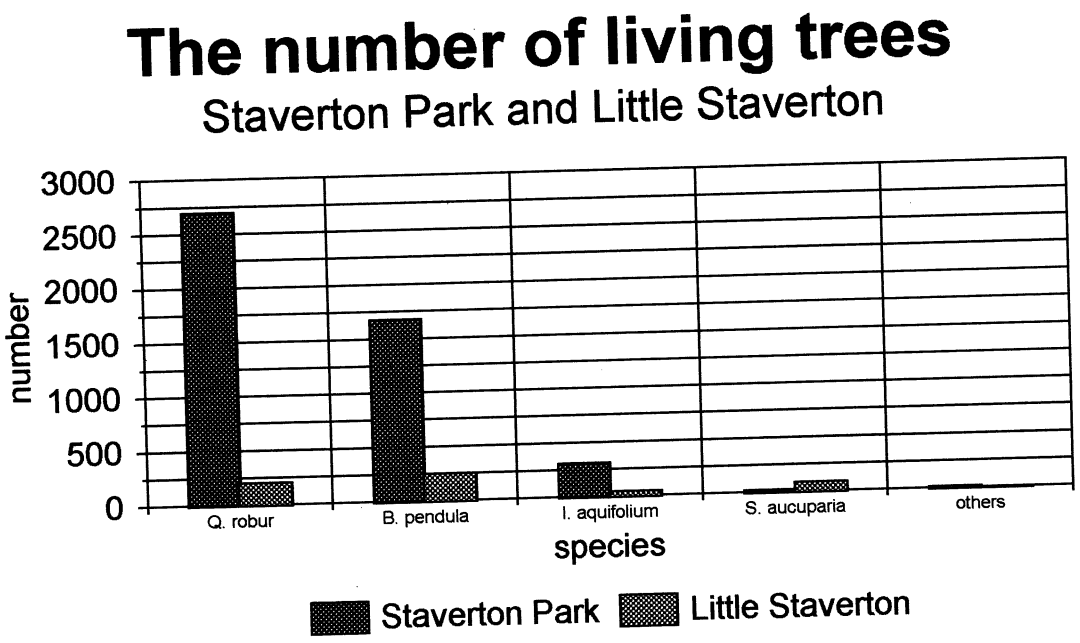

The number of living trees
Staverton Park and Little Staverton
3000
2500
2000
1500
1000
500
0
number
Q. robur
B. pendula
I. aquifolium
S. aucuparia
others
species
Staverton Park
Little Staverton

**Figure 3a**

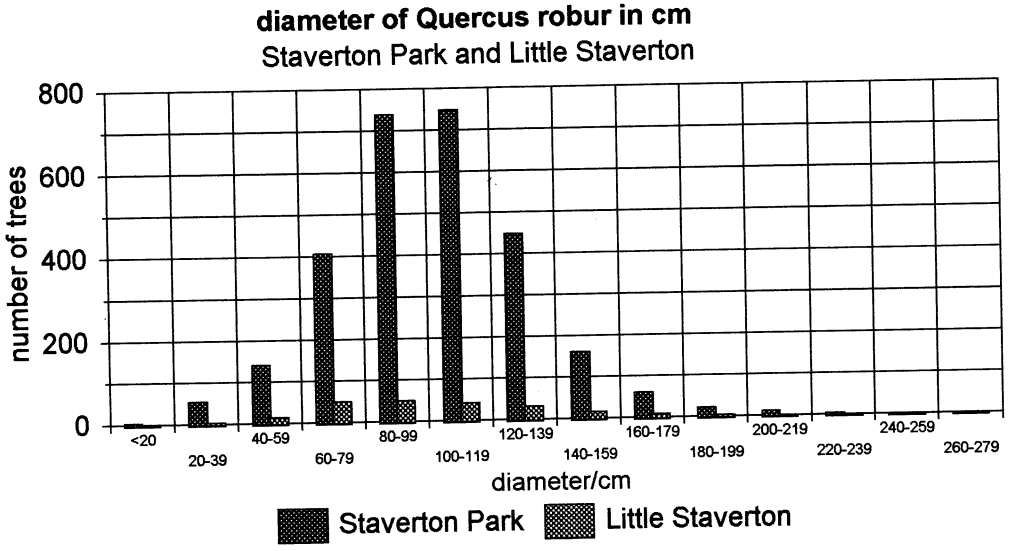



**Figure 3b**

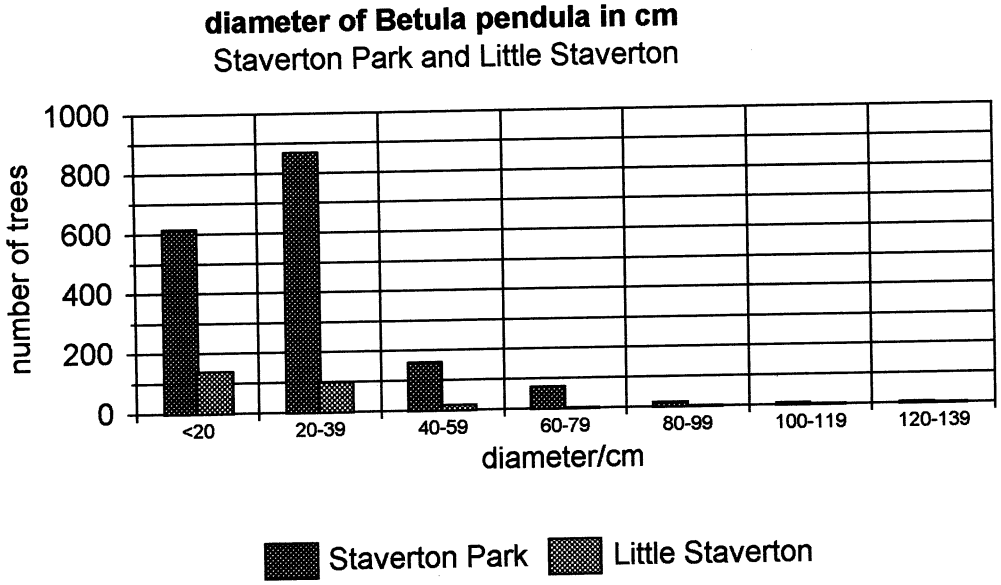


Figure 3c

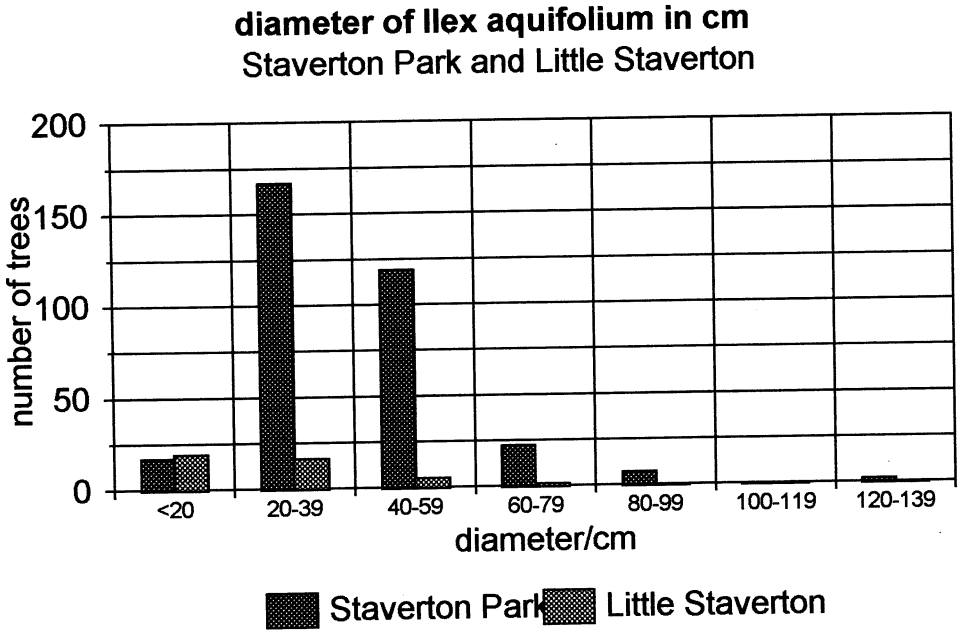
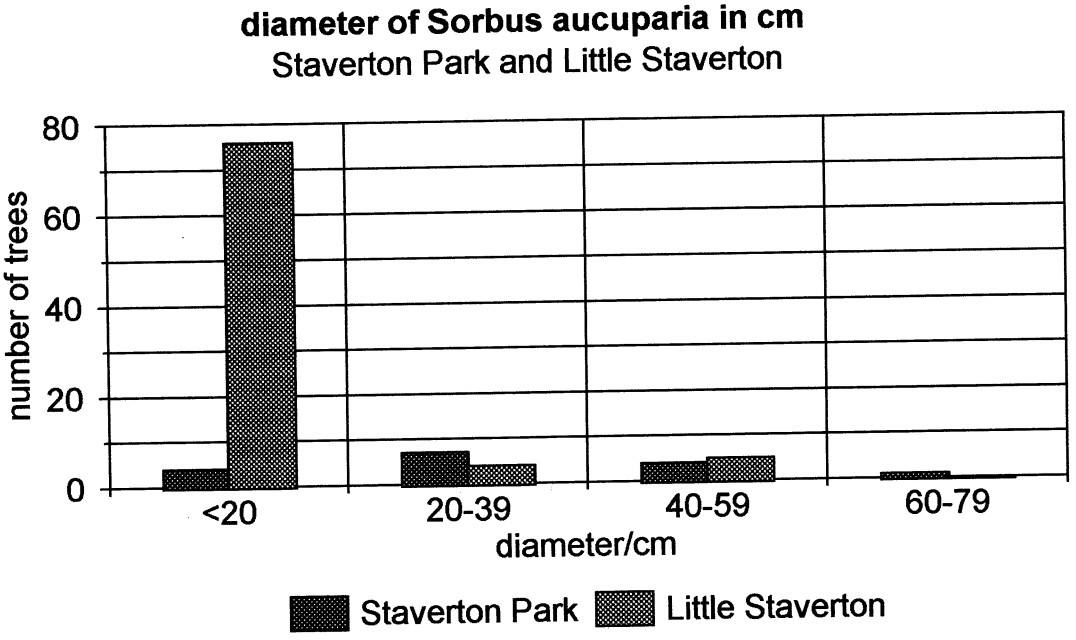



Figure 3d



## Features used by invertebrates - sap runs, rot holes, branch stumps and heart rot

730 trees had rot holes, 33 of which also had sap runs. A breakdown by species and site is given as table 5.

115 trees had sap runs, 33 of which also had rot holes. A breakdown by species is given as table 6.

A total of 9337 broken or cut branch stumps were recorded from 2720 trees, with a mean of 3.43 branch stumps per tree that had branch stumps. Table 7 shows the number of trees with different numbers of broken or cut branch stumps.

Of the 2510 trees surveyed by Ted Green, 1869 trees had heart rot fungus. Within these trees there were significant associations of heart rot fungus with large DBH and older trees (Mann-Whitney U-test, $U=206312.00$, $P<0.0001$). No heart rot fungus was recorded by Malcolm Petty but this is not thought to reflect an absence of this group of species.

**Table 5** The number of trees with rot holes.

| Species | Little Staverton | Staverton Park | Total |
|---|---|---|---|
| *Quercus robur* | 139 | 360 | 499 |
| *Betula pendula* | 14 | 146 | 160 |
| *Ilex aquifolium* | 10 | 55 | 65 |
| *Sorbus aucuparia* | 4 | 1 | 5 |
| *Prunus avium* | 0 | 1 | 0 |
| Total | 167 | 563 | 730 |

**Table 6** The number of trees with sap runs.

| Species | Little Staverton | Staverton Park | Total |
|---|---|---|---|
| *Quercus robur* | 4 | 32 | 76 |
| *Betula pendula* | 1 | 75 | 76 |
| *Ilex aquifolium* | 0 | 2 | 2 |
| *Prunus avium* | 0 | 1 | 1 |
| Total | 5 | 110 | 115 |

| **Table** 7 The number of trees with numbers of cut and broken limbs | |
|---|---|
| Number of broken or cut branch stumps | Number of trees |
| 0 | 2787 |
| 1 | 598 |
| 2 | 450 |
| 3 | 285 |
| 4 | 832 |
| 5 | 160 |
| 6 | 188 |
| 7 | 91 |
| 8 | 50 |
| 9 | 24 |
| 10 | 26 |
| 11 | 7 |
| 12 | 2 |
| 13 | 0 |
| 14 | 4 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 2 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 1 |

## The amount of dead and/or fallen wood

A total of 4198 dead branches were recorded on 1549 trees, which is a mean of 2.71 dead branches per tree with dead branches. Table 9 shows the number of trees with numbers of dead branches. The survey recorded dead branches only if they were a minimum of 15cm diameter and 2m long. To allow for the unknown but possibly great variation in branch size, the volume of dead wood in dead branches can be calculated assuming a cylinder of 20cm diameter and 2m length. This gives a total volume of dead branch wood of 263.20$m^3$.

There were 23 living tree stumps, and they are shown by species and site in table 8.

There were 68 dead tree stumps, and they are shown by species and site in table 10.

There were 174 standing dead trees, 166 of which were in Staverton Park and the remaining 8 in Little Staverton. They are shown in table 11. There were 113 fallen dead trees, 95 of which were in Staverton Park and the remaining 18 in Little Staverton. They are shown in table 12. For the oaks, assuming that their trunks were cylindrical, of the mean diameter presented above, four metres long, and half of the volume is empty space rather than dead wood, the volume of dead oak wood can be calculated. This gives a volume of 262.07$m^3$, of which 246.02$m^3$ is in Staverton Park and 16.05$m^3$ is in Little Staverton. It is interesting that the volume of dead wood in dead trunks is very similar to the volume of dead wood comprising dead branches on living trees.

There were 96 trees which had fallen over and alive, which are shown by species in table 13.

A similar calculation can be made for the dead wood in living tree trunks. Assuming a nominal length of 4m, and a cylinder with one-third occupied by dead wood, the volume of dead oak wood is 3321.65$m^3$. This comprises 240.7$m^3$ dead oakwood for Little Staverton and 3080.94$m^3$ for Staverton Park. It is interesting that the volume of dead wood in living trunks is six times greater than the combined dead wood in dead branches (on living trees) and in standing/fallen dead trees.

The total amount of dead wood on the site, allowing for the above assumptions, is 3846.9$m^3$ and is summarised in table 14.

**Table 8** The number of living stumps by species

| Species | Little Staverton | Staverton Park |
|---|---|---|
| *Quercus robur* | 4 | 7 |
| *Betula pendula* | 3 | 4 |
| *Ilex aquifolium* | 0 | 5 |
| Total | 7 | 16 |

**Table 9** The trees with their number of dead branches

| Number of dead branches | number of trees | Number of dead branches | number of trees |
|---|---|---|---|
| 0 | 3958 | 18 | 0 |
| 1 | 658 | 19 | 0 |
| 2 | 407 | 20 | 3 |
| 3 | 151 | 21 | 2 |
| 4 | 139 | 22 | 0 |
| 5 | 46 | 23 | 0 |
| 6 | 48 | 24 | 0 |
| 7 | 18 | 25 | 1 |
| 8 | 18 | 26 | 1 |
| 9 | 7 | 27 | 2 |
| 10 | 14 | 28 | 0 |
| 11 | 5 | 29 | 0 |
| 12 | 8 | 30 | 0 |
| 13 | 1 | 31 | 0 |
| 14 | 4 | 32 | 2 |
| 15 | 10 | 33 | 0 |
| 16 | 0 | 34 | 1 |
| 17 | 3 | | |

**Table 10** The number of dead stumps by species and site

| Species | Little Staverton | Staverton Park |
|---|---|---|
| *Quercus robur* | 7 | 17 |
| *Betula pendula* | 4 | 33 |
| *Ilex aquifolium* | 1 | 6 |
| Total | 12 | 56 |

| **Table 11** The number of standing dead trees by species | | |
|---|---|---|
| Species | Little Staverton | Staverton Park |
| *Quercus robur* | 6 | 128 |
| *Betula pendula* | 0 | 20 |
| *Ilex aquifolium* | 2 | 16 |
| *Crataegus monogyna* | 0 | 2 |
| Total | 8 | 166 |

| **Table 12** The number of fallen dead trees by species and site | | |
|---|---|---|
| Species | Little Staverton | Staverton Park |
| *Quercus robur* | 9 | 42 |
| *Betula pendula* | 9 | 43 |
| *Ilex aquifolium* | 0 | 10 |
| Total | 18 | 95 |

| **Table 13** The number of standing dead trees by species and site | | |
|---|---|---|
| Species | Little Staverton | Staverton Park |
| *Quercus robur* | 12 | 12 |
| *Betula pendula* | 12 | 39 |
| *Ilex aquifolium* | 3 | 13 |
| *Sorbus aucuparia* | 2 | 0 |
| *Salix caprea* | 1 | 0 |
| Total | 30 | 66 |

| **Table 14** The volume of dead wood in cubic metres, for oak trees (see text above for calculation methods and assumptions) | | | |
|---|---|---|---|
| location of dead oak wood | Staverton Park | Little Staverton | total |
| dead branches on living trees | n/a (approx 250) | n/a (approx 13.2) | 263.2 |
| Trunks of dead oaks (standing or fallen) | 246.02 | 16.05 | 262.07 |
| within trunks of living trees | 3080.94 | 240.7 | 3321.65 |
| Total | 3576.96 | 269.94 | 3846.9 |

## The tree map

The tree map is included separately with this report. It clearly shows the difference in tree density, with the trees much closer together in the southern part of Staverton Park than in the north, possibly indicating past management or natural differences in tree regeneration. Areas with a low frequency of trees are easy to see, indicating possible areas for encouraging natural regeneration or planting trees grown on from Staverton seeds. Indeed, the map shows the beginning of positive action to encourage new trees, with fifty trees mapped which were planted in winter 1997/98, after the tree surveys were carried out. The map allows individual trees to be found again, and any management work can clearly be mapped in relation to the trees. Any future work to existing trees, such as restoration pollarding, can also be mapped accurately so that the trees can easily be found again for monitoring purposes.

# Discussion

## Method

The method of tagging trees, as developed by Ted Green, has been used at a number of ancient tree sites in Britain such as Burnham Beeches, Windsor Great Park, Dunham Massey, and Duncombe Park. However, data has only been published for only one of these sites, Duncombe Park in North Yorkshire (Clayden 1996). Comparisons can be made with Duncombe Park, but it becomes hard to assess Staverton Park against other sites. The number of ancient trees has been counted or estimated for some other sites, however, and these are discussed below.

## The number of trees

Previous estimates of the number of trees are surprisingly accurate. Horrill and Kerr, as reported in Peterken (1969), estimated that the oaks were at a density of 49±29 trees per hectare in Staverton Park only. This is equivalent to a total in sixty hectares of 1200-4680 oaks, mid range of 3480 oaks, which is not too different from the results of this survey of 2800 living or dead oaks. However, the wide range of the estimate makes it hard to decide whether trees have been lost or gained since. Rackham (1980), without explaining his methods, estimates 'about 4000'
oaks on the whole site. With 3020 oaks reported in this survey, and including perhaps several hundred unsurveyed in the Thicks, Rackham's estimate is reasonable although again it is hard to decide whether trees have been lost or gained.

Visitors to the park, and often scientific studies, tend to be selective about the tree species they see. The oak trees are widely reported, as are the hollies in The Thicks (not part of this study), but rarely are the birch trees given emphasis. As over one-third (1990 out of 5507) of the number of trees counted, the birches have been under-reported. Dense clumps of birch are found in the Park alongside or close to the main track along the south edge of the deer enclosure. These are thought to have sprung up in the period from 1900 - 1945 (Peterken 1945) and may have arisen as a result of wartime military activity disturbing the soil and so encouraging birch seed germination. The classical model of plant succession predicts that oak may colonise and eventually out compete the oak, but deep bracken litter and deer browsing is preventing any natural regeneration of trees in Staverton Park. Some of these birch areas may be suitable for continuing the new tradition of planting oaks grown from Staverton acorns back into the site, if there are no other suitable areas.

The numbers of ancient trees has been reported for several sites, which are shown in table 15. This shows that the ancient trees of Staverton Park and the Thicks are one of the largest concentrations in the country.

A single turkey oak *Quercus cerris* that was three metres high in 1946 and growing vigorously in 1969 (Peterken 1969) has gone. It was felled in 1994 (personal observation) because of concerns that it was an alternate host for the Knopper wasp *Andricus quercuscalicis* which produces galls on *Quercus robur* acorns and may reduce their likelihood of survival.

| **Table 15** The number of ancient trees at various sites in Britain. | | | |
|---|---|---|---|
| Site name | area/hectares | number of ancient trees | reference |
| Staverton Park and the Thicks SSSI | 80.8 | 3020 oaks counted + 1000 estimate for the Thicks | this report |
| ancient pasture woodlands, New Forest | 3800 | not given | Hayward (1996) |
| Epping Forest | 2429 | 'tens of thousands' | Dailey & Burman 1996 |
| Hainault Forest | 36.4 | 15,000 estimate* | Sidwell (1996) |
| Windsor Forest & Great Park | 3000 | 6000 | Searle (1996) |
| Savernake Forest | not given | 2500 | Budden & Buchanan (1991) |
| Ashstead Common NNR | 130 | <2000 | Forbes and Warnock (1996) |
| Moccas Park NNR | 139 | 1765 | Wall (1996) |
| Birklands, Sherwood Forest | 150 | 1600 | Barwick (1996) |
| Duncombe Park NNR | 103 | 1200 | Clayden (1996) |
| Hatfield Forest NNR | 420 | 600 | Reid (1996) Atkinson (1996) |
| Burnham Beeches NNR | 80 | 547 | Read et al (1996) |
| Ashton Court | not given | 220 | Fay (1996) |
| Bredon Hill NNR | 50 | 70-100 | Reid (1996) |
| Kingley Vale NNR | 150 | 30 | Reid (1996) |
| Avon Gorge NNR | 20 | not given | Reid (1996) |

*possibly an overestimate; this would mean a density of over 400 trees per hectare, or trunks only 5m apart, eight times as dense as Staverton Park oaks.

## The sizes of trees

Few attempts have been made at measuring the diameter of the trees at Staverton Park. In 1960, Dr Jermy of the Natural History Museum asserted that oaks in The Thicks were 'often 2-3m in girth' (Jermy 1960). Peterken (1969) gives the mean girth of the oaks as 317cm in the Thicks and 324cm in the Park, but there is no supporting data. The mean girth, as measured here (see section 4.3 above) is 317cm (101cm diameter) for Staverton Park and 311cm (99cm diameter) for Little Staverton. Peterken's figures are presumably based on a sample and are slightly higher than the current measurement. Perhaps the size of his sample

lead to the discrepancy, because over the last thirty years growth would have occurred and girths would expect to be bigger now rather than smaller. There is the possibility that some of the larger trees have died and been removed in the last three decades, but the records have not been kept to confirm this. Now each tree is tagged, it will be much easier to track changes in the tree population.

Peterken also measured the girth of thirty hollies in one small part of the Park, and found that there were none with a girth under 50cm (i.e. diameter 16cm), most having a girth between 100-150cm (i.e. diameter 31cm - 47cm) and only one above a girth of 200cm (diameter 62cm). Figure 3c above shows that with the full data the range of holly sizes is greater but still with the majority of diameters being between 20 and 59cm.

## The age of trees

Ever since Farmar (1949) started a myth that the trees were planted in 1529-1538 by the monks of nearby Butley Abbey, there has been speculation about their age and origin (e.g. Rackham 1980, Salisbury 1945, Simpson 1955, Jermy 1960). The comments typically concentrate on reporting 'many' or 'the' ancient oaks, lack of young oaks, decay, decline, and gloomy predictions of future survival. Peterken (1969) counted the rings on one oak in the Park, one in the Thicks, and two in Little Staverton. He added an estimate for the missing decayed heartwood, assuming constant rates of growth although recognising the possibility of faster early growth, and added an estimate for the length of time the tree had been dead before he counted the rings. He estimated the age of those trees as 191, 420, 330 and 150 years respectively, meaning they started growing in 1778, 1549, 1639, and 1819. It is hard from the published data to correlate the age with diameter. Peterken states that the tree that started growing in 1549 was 'rather below average girth of mature pollards' and that the 1778 tree was 'one of the smallest'. There are no measurements to support these statements, except for the 1639 tree where he measured 11 annual increments per centimetre radius.

White (1994), whose method was used to calculate the age of the trees in section 4.4 above, states that for its first century of life an oak tree in open woodland managed as a boundary pollard will achieve a diameter of 70cm with ring width of 3.5mm each. The ring width will then gradually reduce, laying down a constant cross-sectional area of wood around an ever-increasing trunk, until the crown disintegrates and ring width becomes to the minimum sustainable of 15 rings per cm. Peterken's 11 rings per cm on his 1639 tree indicates that it had many decades of growth left before it senesced. He realised that the estimates were rough but suggested that there was a wide range in the ages of the oaks and that some were over 400 years old.

If White's formula is applicable to Staverton Park and Little Staverton, it can be calculated that one-quarter of the trees are under 120 years old, half are under 160 years old and three-quarters are under 200 years old. At 200 years old, there is a survival rate of on average about 70% every twenty years, until a few survivors reach 400 years old. Survival is then apparently higher, so if they survive past 400 years they might live for another century or more, with the oldest apparently being around 750 years old, originating in 1246. The formula assumes all trees grow at equal rates with no allowances for variation in soil type or drainage across the site, varying shading effects from place to place, or variability in the number of times each tree was pollarded and thus temporarily slowing growth. These assertions about survival rates also assume constant regeneration of young oaks in the past, which might be an inaccurate assumption. Less trees may have originated four hundred years ago than two hundred years ago, which is why fewer four hundred year old trees are present now.

Furthermore, the White's formula is based on an average growth rate of oaks at many sites. The dry sandy soils retain water poorly, and pollarding slows growth, so growth rates are likely to be much slower than average. Consequently, the trees are probably much older than the estimates presented here.

One way of resolving the question would be to track the age of the belt of oaks planted in 1949 along the eastern edge of the Park. According to White (1994), they will achieve 70cm radius in 2049 and then grow according to his formula. I challenge an ecologist reading this in the middle years of the next century to test this hypothesis!

Tank training in the Park, crashed aircraft and clearance of a flare path to guide aircraft in the Thicks during the Second World War (Kemball, 1982) created bare ground which has subsequently regenerated with birch or holly. The regeneration in the Thicks only has been reported by Peterken (1969) but never before has regeneration in the Park after tank training been reported. This helps provide an age for many of the birch and holly, for which no standard formula for age estimation has been published.

A quicker way to determine the age of the trees would be to repeat the ring analysis, by counting rings on a number of trees of known diameter. We will need to be vigilant for opportunities as trees fall, for it will not be acceptable to fell trees for this purpose. It might be possible to bore into the trunks to take cores of wood to count the ages, and this would be particularly useful for the smaller (supposedly younger) oaks.

## Features used by invertebrates - sap runs, rot holes, branch stumps, heart rot and dead wood

The beetle fauna of Staverton Park and the Thicks has been studied in detail, and is the best site for invertebrates associated with ancient trees and dead wood in Eastern England (JNCC/ English Nature 1993). The site is of national importance for its invertebrate fauna, according to Harding and Alexander (1993).

Sap running out of splits or holes in tree trunks supports a very interesting and varied assemblage of invertebrates, mainly beetles and flies. Rot holes and heart rot support many rare species of invertebrate. Branch stumps (and other splits and holes) provide ideal sites for invertebrates to colonise, reaching the inside of trees where dead wood may be available. The invertebrates associated with the decay of timber, on living trees, dead trees or fallen on the ground, are of exceptional value for nature conservation. Heart rot is not believed to be a factor in the death of the trees, as dead heartwood is rotted rather than living tissue. Hollow or substantially decayed trees retain much of their strength, and abnormal stresses are compensated for by growth of new wood in localised swellings (Mattheck & Breloer 1994). The many forms of dead wood each have a separate distinctive fauna (Kirby 1992). The high number of such features recorded in Staverton Park and Little Staverton provide a massive resource for the wide range of common and rare invertebrates. The trees are currently not managed to increase or reduce the amount of these features, although fallen dead wood on or close to the rides may be moved further into the wooded areas. The burry nature of the oaks mean that self-pollarding is highly likely; new branches grew well following the removal of older branches during the high winds of October 1987 (personal observation, and Mitchell 1988). Ride edges are mown to reduce the bracken growth, and any dead wood there will obstruct the machinery.

There is no other published data to compare the volume of dead wood and the number of

invertebrate features in Staverton Park/ Little Staverton with other sites in the country. Hopefully this report will stimulate the publication of similar data. It might also be possible, using the raw data from this study, to look for correlations between the size of the trees and the number of features available to invertebrates.

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