

Oak tells a story

Gabriel Hemery FICFor and **James Morison** summarise what was discovered about a single oak, thanks to a project that aimed to promote forestry in a positive way to the public

Modern society is increasingly removed from the natural world and, although we still use many wood products, people often react negatively to tree felling and to woodland management.

The Sylva Foundation's OneOak project is following the full life story of one oak tree, aiming to reconnect people with growing trees for wood. Sylva decided that telling the stories behind the life of a single oak tree would be a powerful way of communicating the often complex nature of sustainable forestry.

A mature oak tree on the Blenheim Estate in Oxfordshire was selected for the project and by working with local schools, artists, wood users and scientists, activities were initiated to promote forestry in a positive way through science, art, crafts and active education.

The OneOak tree was felled on a freezing day in January 2010, witnessed by 250 children and 150 guests. It has now become one of the most studied trees in Britain thanks to work by a dozen scientists, exploring its size, volume, weight, carbon and age. This is its scientific story:

TREE MEASURING

Forest Research (FR) scientists visited the tree before it was felled to undertake traditional mensuration assessments; including tree height, stem diameter, crown diameter and timber height (Table 1).

A camera with a hemispherical lens was used to capture the tree's canopy. This was analysed to estimate the size of crown area and the leaf area per area of ground (leaf area index equals 1.7), which is a key determinant of light interception and growth.

LASER SCANNING

The laser scanning research was carried out by Leica Geosystems and scanning specialists SCCS Survey prior to felling, when the tree was leafless. A Leica C10 Laser Scanner was placed at five sites around the tree and by measuring the laser reflections from 54 million 'hits' produced five 'point clouds'.

The data collected was merged to produce a detailed digital 3D 'virtual' model of the tree, with the exact position of six million points on the tree accurate to within 2-3mm. From these, the volume of the stem and potentially all the branches can be assessed. For example, the crown diameter and timber height are 17.3m and 12.5m, agreeing well with the traditional mensuration (Table 1).

TABLE 1: TREE MENSURATION

Tree height: 23.9 metres
Stem diameter: 89.9 centimetres
Crown diameter: 17.8 metres
Timber height: 12.9 metres

Right: Forest Research scientists measuring the OneOak tree. Below: the OneOak's canopy captured by hemispherical camera lens and the software used by Forest Research to calculate leaf area (below right)





TABLE 2: VOLUME AND BIOMASS

	Volume m ³	Fresh weight kg	Moisture content %	Dry weight kg OD
Stem	5.13	6,036.1	43.2	3,428.5
Branch > 7cm	6.45	6,273.0	45.9	3,393.7
Branch 4-7cm	na	863.7	49.8	433.6
Lop & Top <4cm	na	1,212.2	50.0	606.1
Total above ground	11.58	14,385.0		7,861.9

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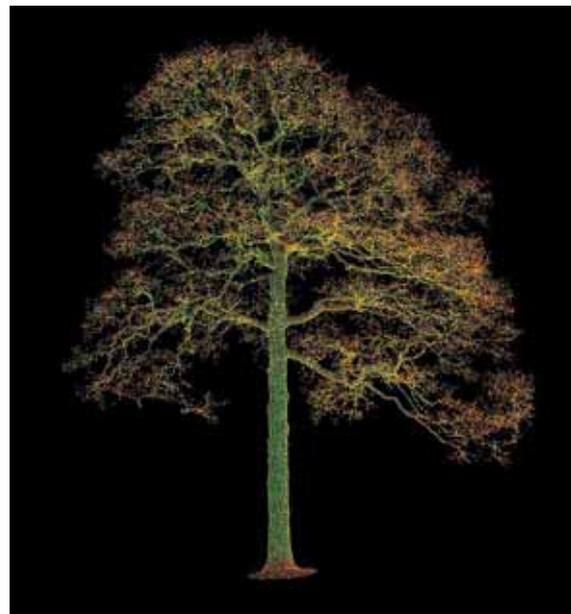
A film showing the scan in 3D is available for download from the OneOak website.

VOLUME AND WEIGHT

Immediately after felling, the tree was prepared for the massive effort of weighing and measuring all its above ground components.

The main stem, which was cut into three sections, was taken to a weighbridge during its extraction and transportation to a local sawmill.

Meanwhile, the tree crown was divided into three branchwood diameter categories: over 7cm, between 4-7cm, and lop and top less than 4cm. Fresh (or green) weight was measured by weighing



Above: The 3D shape of the tree from the laser scanner 'point cloud'. Scan data processed by Forest Research

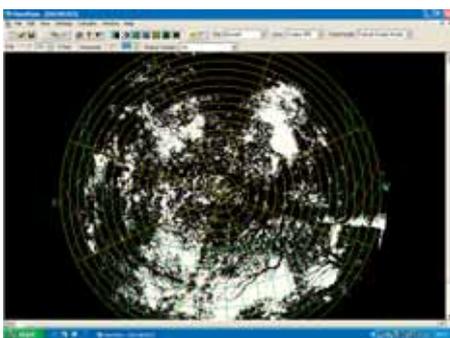
every branch, limb and twig using a spring balance (Table 2; Figure 4), and samples of the different components later oven-dried by FR to give a total dry weight of 7.86 tonnes.

CARBON ESTIMATES

Previous measurements of oak trees by Forest Research and others have quantified the relationship between the tree diameter and root weight: $0.000149 \times \text{DBH}^2.12$ (McKay et al. 2003, see also the FC Carbon Assessment Protocol, Jenkins et al. 2010).



Left and above: Forest Research scientists and Blenheim Estate foresters weighing the OneOak crownwood. Pictures: Ian Craig



FIND OUT MORE

The OneOak project has an active website (www.OneOak.info) and several exhibitions are planned for 2011 and 2012. You can hear more about the project at a Forest Research seminar on 14 January (www.forestry.gov.uk/fr/INFD-89LFL8). Also, the OneOak exhibition will be held at the Royal Botanic Gardens Edinburgh on 15-16 January. A book about the project is also planned.

This suggests that root weight was 2.06 tonnes dry weight (about 21 per cent of total tree weight). Added to the above ground figure of 7.86 tonnes, the total tree weight estimate is 9.92 tonnes dry weight.

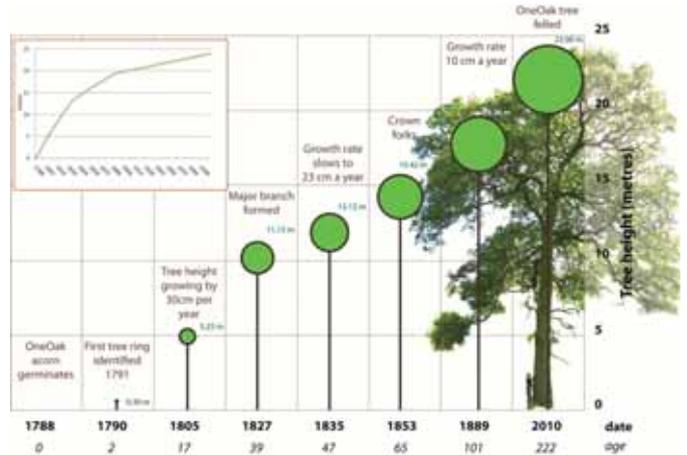
The total carbon content was estimated from this dry weight making the usual assumption that 50 per cent of dry weight (or biomass) is carbon (Matthews 1993) thus: 4.96 tonnes of carbon.

DENDROCHRONOLOGY

Leading dendrochronologist Daniel Miles, Oxford Dendrochronology Laboratory, collected seven discs from the main tree stem and from one branch immediately after felling.

Our original estimate that the tree was about 160 years old, based on estate records, proved to be a considerable underestimate. The lowest disc, taken about 30cm above ground level, proved that the tree was 30cm tall in 1790. The tree probably generated naturally in 1788: making it 222 years old when felled in 2010 (Figure 5).

A major branch formed in 1827, at 11m above ground level, which grew normally for about 20 years until suffering a major trauma causing it to cease growing for the next 30 years. This damage was probably caused by another tree or branch falling against it and injuring the branch. It is possible that another tree was felled in about 1847 which hit



Above: The dendrochronological records of the OneOak tree (inset growth graph)

our tree, causing the damage.

The tree grew about 30cm per year in height for the first 39 years of its life, slowing to 26cm between 39 and 47 years, 23cm between 47 and 65 years, and finally 10cm between 101 and 222 years.

Investigations are currently under way to link the dendrochronological record with the history of Blenheim Palace and woodland management on the estate.

WOOD AND CARBON FOOTPRINTS

Thirty five oak boards were cut from the three main sections of the OneOak tree by the local sawmill, Deep in Wood. These are currently air-drying prior to use by dozens of wood users who will make items during

2011 and 2012: ranging from fine furniture, a door, a boat, and a beam in an oak-framed building, to green working and crafts, as well as firewood logs and chips for heat. Some of these will be followed to calculate their carbon footprints by specialists Best Foot Forward.

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