Classification Protocols Part II

# Ancient, Veteran and Notable: The Specifics of Protocols Application

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DRAFT 3.2

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# AYG Classification Protocols Part II

## Ancient, Veteran and Notable: The Specifics of Protocol Application.

A new classification of our yew population



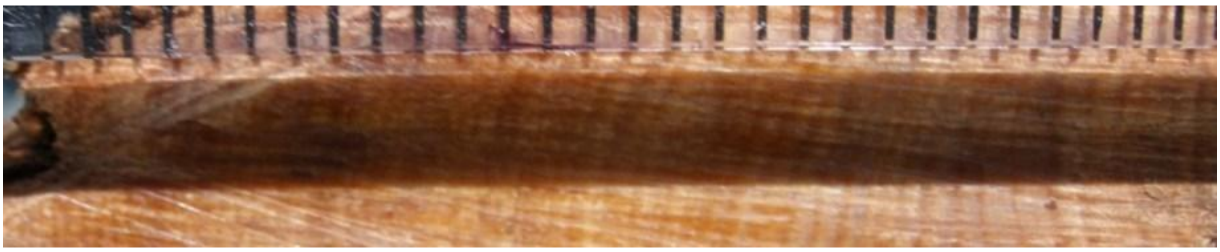
The function of this document is to underpin the protocols briefly described in Part I that the AYG uses to recognise Ancient, Veteran and Notable yew trees, Taxus *baccata*. Explained, illustrated and quantified with worked examples of methodology, here the reader can find the specifics of how the protocols have been applied, and our reasons for thinking that the application is correct. We hope that we have achieved clarity and transparency, and that those people with a need to understand the fundamentals of what we have done can find precise answers in the following material.

It is important to note that yews are only put into the categories when it is clear that they belong there for a particular well argued reason. Many Ancient, Veteran and Notable yews, especially those of low girth that belong in each category will go unregistered unless researched and submitted; the classification system was deliberately designed to be flexible and expandable in order to accommodate methodologies which reveal the age of the smaller yews; we welcome additions to the protocol system which will be periodically updated.

It is hoped that the knowledge there are yews out there waiting for recognition will spur researchers to invent and develop means of proof which have not yet occurred to us, or were beyond our technical ability. These people are part of the reason that this document exists, we want you all to destruct test it, challenge it, use it, add to it, and build on it. Principles to bear in mind are that the burden of proof is with the researcher, it is up to them to convince others that their findings are correct through presentation of evidence, and secondly that the AYG Veteran and Ancient categories particularly are a gold standard; they can be relied on because they are applied conservatively and transparently.

Please be aware that the protocol system is not intended as a mechanism for finding specific ages for particular yews. Some interesting and suggestive results may well be produced as a by product of the investigation process, but further development of these ideas is outside the scope of this particular document. The sole purpose and legitimate range of convenience of the protocol application methodology presented here is categorisation of yews into Ancient, Veteran and Notable age brackets.

The Ancient age bracket is 800 years old and over. Veteran yews are over 500 years old, and may be up to 1,200. Notable yews will usually be over 300 years old.



# Chapter Index

# 1 Geographical application.

For use in England, Wales, Scotland, Northern Ireland and The Republic of Ireland.

The data that are used here for dating evidence and analysis were mainly gathered in the southern half of England, so there is no problem with applying the protocols in that region. Yews in Wales are represented by a Brecon Beacons sample, and those yews dated and used as data from Bridge Sollars and Monnington Walk. Both of the latter are in Herefordshire and quite near the Welsh border. We are able to apply the protocols in Wales, with the caveat that more evidence is needed to see whether we need to refine the categorisation of the yews there in the future.

All yews in mountainous regions and at high altitude are treated differently in any event, and may be classed Veteran or Ancient (V-alt or A-alt) at lower girth than lowland yews. See below. There are no data from yews in Scotland in the sample which we use to project mean ages by girth. Yews in Scotland are to be treated on a case-by-case basis using the protocols as a foundation upon which to proceed. Further work is essential to discover whether Scottish yews, being at different latitude may have a different mean rate of girth increase from southern yews. All parts of northern England are classified with the south, but with caution, as any Scottish rules which may emerge could also apply in parts of England, particularly in the Border counties.

A somewhat similar situation applies in Ireland. Although there is no known obvious scientific reason why T. *baccata* should grow significantly differently in Ireland, it is most important to obtain evidence from the girths found in dated avenues and/or from ring counted and girthed yew stumps to compare with the data gathered in England.

Wherever the yew is found, the critical girth modifiers and other allowances for variables detailed below always apply, and will go a long way towards correcting any geographical bias.

# Further explanation of the various analyses.

## 2 Girth

A-g Girth above 7m V-g Girth above 4.9m

In order to fully understand the basis on which yews are recognised as Ancient or Veteran it is essential to be aware that there is huge variation in girth for different yews of the same age, and to be sure of placing each yew in the right category we have to follow a rigorous selection procedure, the fundamentals of which are illustrated below.

How the range of girths for a given age is decided

We first apply girth and age to an empirically generated non-Gaussian curve. Empirical studies of populations of open-grown same-age yews such as the classic avenue at Monnington Walk in Herefordshire show that a Gaussian bell curve does not satisfactorily reflect the observed variation in girth. Work done about ten years ago by a number of scientists (1) investigating geophysical processes produced a new and exciting model the newspapers of the time (2) popularly called the "Universal Curve". This curve fits the case exactly.

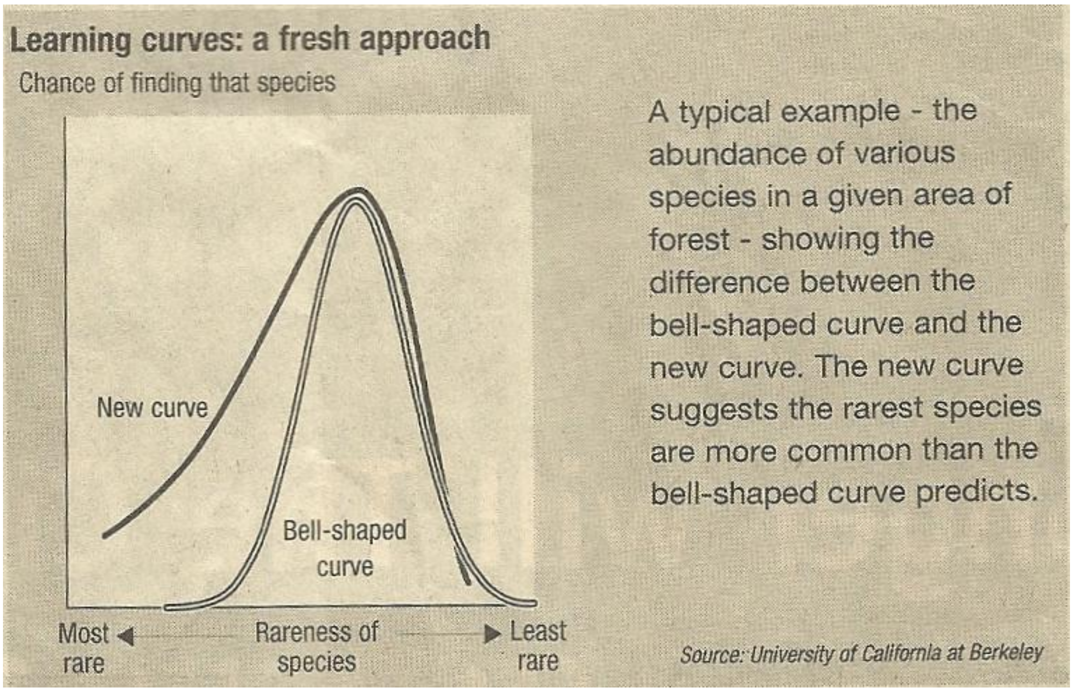
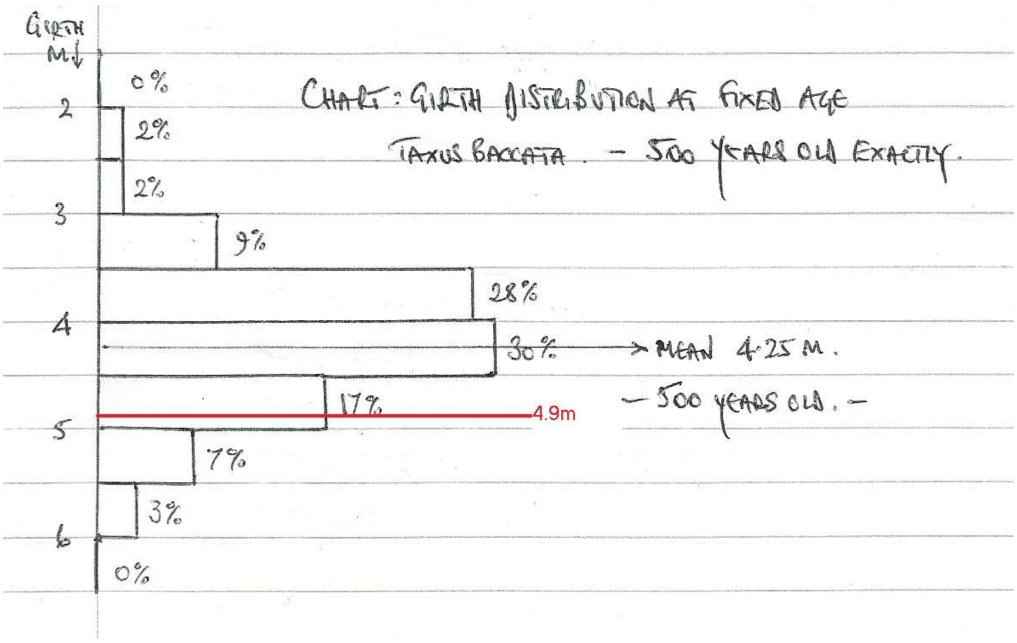



***Figure 1*** *Newspaper cutting (2): A comparison of the Universal and Gaussian curves. For our purposes the axes would be labelled "girths of a yew sample for a given age" on x, and on y "frequency".*

A chief characteristic of the Gaussian curve is symmetry about the mean midline, as per the bell-shaped curve illustrated above. Open-grown yew populations do not present in this way, like the Universal Curve they are weighted towards the norm at the upper end of the scale, and tail off more slowly in the lower values of girth. The consequence is that using this new curve we can be fairly accurate about the maximum girth a typical yew can achieve in a certain time, but the minimum girth is more uncertain.

***Chart 1***: *Extrapolated data set from Monnington Walk (3). All boles are intact. Data: 2% lost in rounding percentages. N=42. 5-6 metre data represents 9.5% of the sample. Selection procedure: census. Normalized for 500 year old yews from a sample planted about 1630 CE. The scaling is not suitable for illustrating the characteristics of the Universal curve clearly.*

*Monnington Walk is chosen because it contains a statistically useful number of yews, and it is known that the yews were shaded by an interplanted avenue of Scots pines until the natural decline of those pines. Early shading and competition followed by open growth is considered to be a very good compromise growth history for a yew population that is used as a basis for statistical work with a broad application.*




<u>Using the range to find a category threshold</u>

When deciding on the cut-off point for categorising a yew as (say) Veteran, it is necessary to first to arrive at mean girth value for a set of all British yews which are 500 years old using age against girth data sets from information collected nationwide (4, 10).

We then generate a Universal Curve using empirical data, in this case a census of girth measurements from the 42 yews at Monnington Walk. The mean girth of the Monnington yews is then compared with the mean girth for yews of 500 years old. The Monnington values are multiplied up so that their mean is the same as the 500 year old mean.

What we have produced is a chart showing the proportion of yews which will be found in each girth category for a sample which are all exactly 500 years old (see Chart 1, above). The possibility of calculating a further deviation from the mean due to increased age at

differing individual growth rates was considered, but rejected as it is not clear what proportion (if any) of the variation is genetic or otherwise stable.
Now the assumption that the mean girth value is an appropriate watershed has to be considered in the light of the fact that if the same mean girth value (which is 4.25 metres) were taken as the cut-off for Veteran, then almost half of a varied girth population of yews all aged 499 years old would also be (wrongly) classed as Veteran.

To get a watershed figure for girth which ensures that any yew categorised as Veteran by virtue of *girth alone* is almost certainly over 500 years old, we plot a Universal Curve for an imaginary population of 499 year-old yews based on the Monnington Walk figures. That means that the population chosen is technically underage for the category "Veteran". Unsurprisingly the chart for 499 year old yews looks identical to the one for 500 year old yews, and we can continue to use Chart 1 for practical purposes.

We then find the girth value on the chart where only a very few yews aged 499 years would be called Veteran. The best point is 4.9 metres, 90% of 499 year old yews will not be rated Veteran if 4.9 metres is chosen as the cut off point. At this stage in the calculation we realize that if most 499 year old yews do not achieve a girth of 4.9 metres, then logically most yews of 4.9 metres are over 500 years old. Both situations are represented by the 4.9 metre point on Chart 1 above.

Looking at Chart 1, at 4.9 metres girth a typical sample of yews with varied ages will consist of 90% over 500 years old. These yews, which would have had to grow for over 500 years to reach 4.9 metres, are represented by the smaller girthed sample in the chart, the majority of the trees in question. The 10% which would be under 500 years when girthing 4.9 metres are the faster growing large girth yews in this same-age sample. Only 2-3% make up the largest girthed and so very fastest growing trees which are 5.5 metres girth or over. These trees will be substantially under the target age at 4.9 metres, being exceptionally large for their age. 4.9 m girth can be used as the watershed on this basis.

<u>Outcome, and Pros and Cons of the method</u>

What we have achieved by this method could be a mixed blessing if we are not careful. On the positive side we do have a criterion which we can use to say that a yew is almost certainly 500 years old or more, and if it isn't then it is very close. The Universal Curve is fortunately more forgiving than the Gaussian curve in this respect, the upper value end of the curve tails off sharply meaning that very large but unusually young yews are extremely rare. On the down side there will be a great many yews of 500 years old which are not classified as Veteran because their girth is under our cut-off point of 4.9 metres girth. Fortunately the criterion "girth" is not the only one by which we measure the age of the yew, and although girth can be seen as a very robust initial test for inclusion of yew specimens in the Veteran and Ancient categories, it is *no basis for exclusion*. Other proofs and their applications are detailed below, and they carry equal weight in the age finding process.

One aspect of the low girth problem is hopeful however, although the low girth Ancient and Veteran yews are hard to identify using this process, all yews currently considered to be of significant interest are already covered by the protocol system in some way. It is fervently to be hoped that many small and unregarded Ancient and Veteran yews now come to light and have their status recognised; where yews of this sort previously occupied an unknown territory there now exists a formal framework for recognising them.

## Exceptions and variations

### Avenues

Groups of yews which have been planted together such as avenues and wind breaks can now be aged quite accurately and will become Veteran or Ancient when all of the yews achieve the correct mean girth, 4.25 metres in the case of Veteran, and 6.5 metres in the case of Ancient. It is assumed that the group of yews being aged mirrors the behaviour of the yews at Monnington Walk, and will produce similar mean girth values at the same ages.

### Woodland Yews

Same age yew populations grown in mixed woodland have greater variability in girth than open grown yews, and do not conform to any simple distribution pattern whether Gaussian or Universal. The increased variability is thought to be caused by individual unique differences in access to sunlight and opportunities for canopy development under deciduous cover. An informal re-analysis of the distribution of yew age data by girth at Alice Holt (4) shows two peaks, a reversed Universal type curve which tails towards high girth, and then another peak at even higher girth. It is thought that this higher peak is representative of the individuals that were fortunate enough to lack much competition with deciduous species *and* were genetically fast growing. They represent 20% of the sample. There is still a huge amount of work to do on woodland yew, although some suggestive stump analysis work has been done at Alice Holt which can be viewed on the AYG website.

### Yew Groves

Work has been done, again at Alice Holt, which shows a relationship between growth rate and proximity to other yews. A recent pilot study shows that in stands of yew the trees do affect each other's girth in direct (linear) proportion to proximity. The relevant work will be published in due course in thesis or article form. The upshot of the preliminary data is that grove yews appear to grow in subordinate/superior relationships when their canopies are locked together, as well as being affected by other forms of competition with one another. We expect that contemporaneous grove yews do not conform to the Universal curve, but are likely to show a double peak on any frequency/girth chart. Two factors will be responsible for the expected double peak, firstly superior/subordinate relationships between yews and secondly the varied shading effect of any surrounding deciduous woodland.

### Woodland and Grove yews: outcomes

Woodland and Grove yews are categorized Ancient or Veteran using the standard girth watershed at present. There may be a case for reducing the watershed for woodland and grove specimens when the variables can be properly quantified. Some preliminary work on the variables is described below under <u>11 Current Growth Rates</u>.

We hope to finish developing a methodology to calculate whether yews are contemporaneous stands soon, so that they can then be accurately aged as a group in the way that avenues are, but accounting for the predicted double peak. A trial methodology which may be suitable is presented in <u>10 Ring Counts</u> below.

Yews that grow on unconsecrated ground
V-wild: Yew that is growing outside a currently consecrated churchyard

Large yews found outside churchyards are considered extremely rare. The area of all the churchyards in the UK compared with the whole landmass in question is very small; there are about 10,000 UK churchyards in almost 100,000 square miles. The ratio of consecrated to secular land is therefore of the order of 1:50,000. Despite the superlative efforts of our researchers and contributors the AYG has so far recorded more Ancient and Veteran yews in churchyards than elsewhere. It is to be hoped that with the new classification of cliff and upland yews the situation will soon be reversed, but to us that statistic is the symptom and eloquent evidence of a silent crisis.

We feel that all old yews outside churchyards must be considered to be under great threat, and in need of substantial protection. To this end we have lowered the watershed girth to the mean value for 500 years old of 4.25 metres (14 feet) for yews which stand on unconsecrated ground. The likelihood that these specimens are 500 years old or more is 50% - 90%, (rising with increasing girth, and statistically speaking 70% for the whole category) rather than the 90% minimum required in a churchyard.

Wild yews are, in general, harder to discover and record in the landscape. Those which have nearly reached Veteran status are, by this practice, given "advance recognition" and consequent suitable protection which is essential if they are in inaccessible or out-of-the-way locations; perhaps unlikely to be found very easily again. In churchyards that is less of a problem.

As soon as the yew categorised Veteran by this method reaches the 90% certainty watershed of 4.9 metres (and most will within a few decades) the index –wild can be removed. Particularly slow-growing individuals will be identified if they fail to reach the watershed quickly. They may then be classed using the V-pg protocol described in chapter 4. As mentioned above, the yews classed V-wild will typically be 70% likely to be 500 years old.

There is a case for grading the Veteran category from 50% to 100% certainty by girth, but the complexity of such a system would most probably make it unworkable.

In upland areas with extreme conditions the critical girth of 4.25 metres for V-wild is further reduced by 10% to 3.8 metres (12 feet 6 inches) when a yew is given the classification V-wild,alt, see 9 Altitude and Latitude. With more research the upland figure may be adjusted in future.

***Table 1**: Summary girth watersheds*

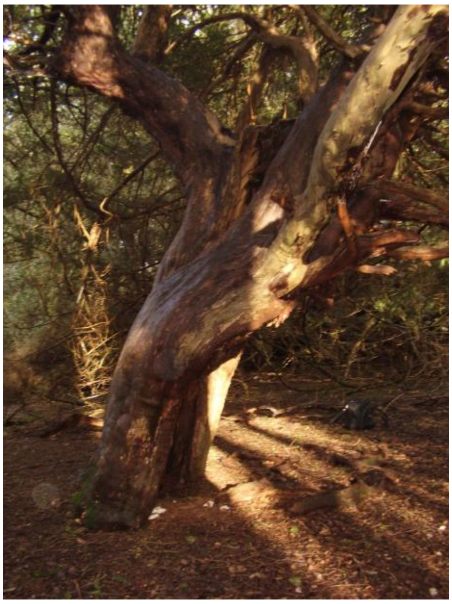
| Churchyard | Wild | Ancient | Veteran | Notable |
|---|---|---|---|---|
| Girth -g | | 7.00 | 4.90 | 3.70 |
| Altitude -alt | | 6.30 | 4.40 | 3.33 |
| Urn shape -urn | | 5.45 | 4.05 | - |
| | | | | |
| | Girth -g | 7.00 | 4.25 | 3.70 |
| | Altitude -alt | 6.30 | 3.80 | 3.33 |
| | Urn shape -urn | 5.45 | 3.40 | - |

Descriptions of the variables that modify the girth based ageing of a yew now follow.

## 3 Fragments and bole damage

Similar lines of reasoning and methodology apply to A-bm/V-bm: Large section of bole missing and A-hsh/V-hsh: Horse shoe hollow. The description of them in Protocols Part 1 is sufficient; no separate explanation needs to be made at present.

A-fr V-fr Single fragment of original tree

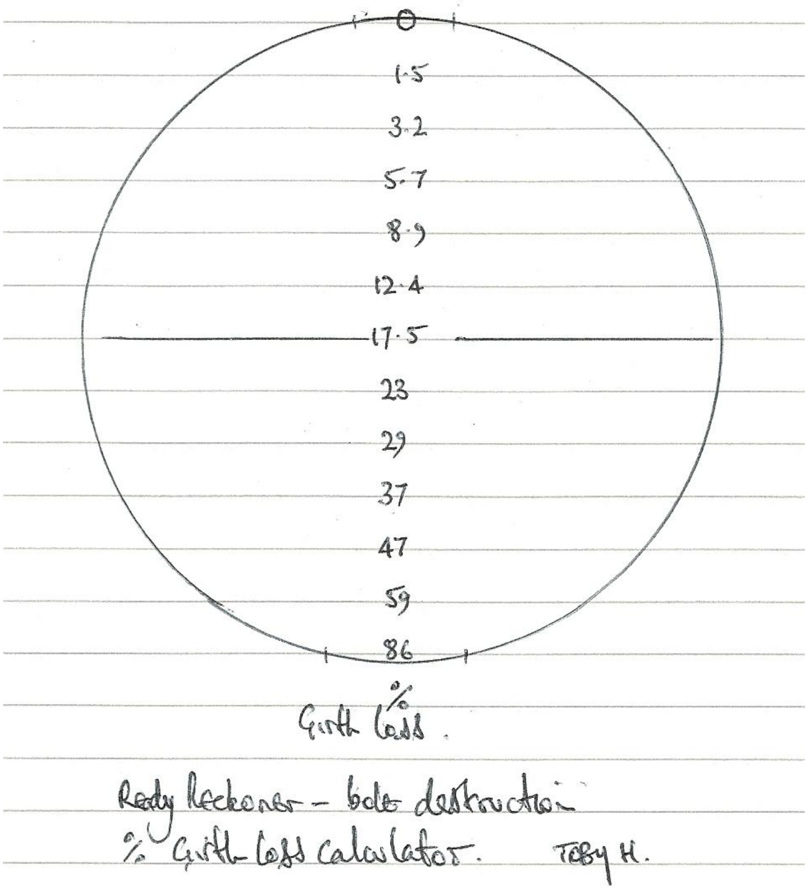

*Merrow Down 2009 – single fragment.*

A-frs V-frs Two or more fragments of original tree


*Woodcott 1997- two fragments.*

Some fragmented yews show quite clear marks of their original girth; where two or more fragments exist which were clearly part of the same individual a large proportion of the original girth is often intact, and the girth loss estimator below can be used to estimate original maximum girth. Other fragments, especially irregularly shaped single fragments are more problematic.

***Figure 2: Girth loss reckoner**. The circumference pictured below represents the girth of a bole. The horizontal lines show the notional tape run across any lost bole circumference. Applying this method is to a certain extent an art rather than a science, but is still a great deal more accurate than guesswork when estimating original bole girth, and has the advantage of being scientifically repeatable and methodical.*




The ready reckoner shown was produced (and the percentages calculated) geometrically. The percentages are not represented with absolute mathematical precision. The accuracy is good, however, and suitable for the task required.

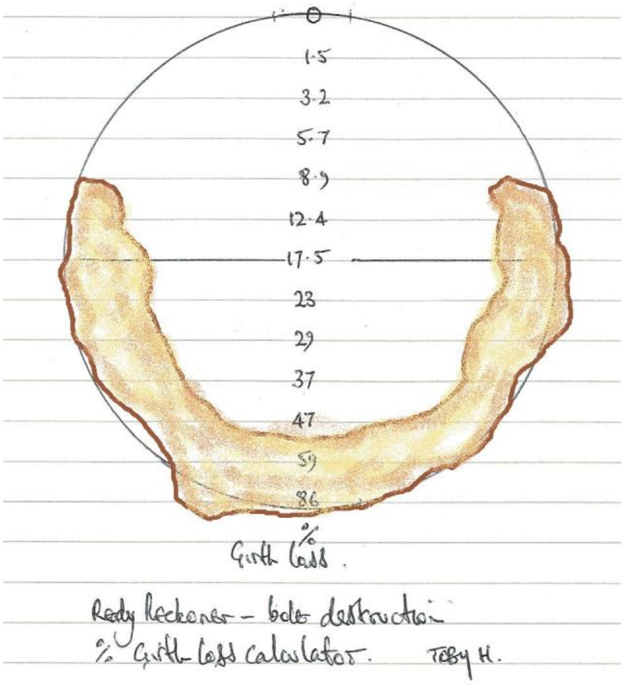
## Using the girth loss reckoner

In the example below, the reckoner circumference is overlaid on a diagram of the horizontal cross-section of the damaged yew taken at the girth measure height above ground.   Yews are usually uneven in circumference, so one has to make a “best fit” as shown in the diagram.

We can see that the yew has lost 8.9% of its girth.   The difference when the tape measure follows the curved complete circumference makes the total girth 8.9% more than if the tape follows the straight line across the gap.   If the yew pictured below was 10 metres in girth in its broken state, then its notional girth (i.e. the “completed circumference” girth), would be 8.9% more, that is to say 10 metres and 89 cm.

The reckoner can be used to estimate more than one loss on the same yew by repetition of the process for each lost shell section, and calculation of the sum of all the resulting bole loss percentages.   This method may underestimate the total bole loss, but by an insignificant amount.   A more complicated and accurate method involves finding a set of notional girths for the yew, one showing the loss for each missing section, but we consider the considerable effort involved unnecessary in most cases because the difference that using this method makes is usually trivial.

***Figure 3:*** *Girth loss reckoner use*




## Multiple fragments

Sometimes it can be hard to decide whether a pair or cluster of fragments are all parts of the same yew.  Signs to take into account include:  Do the foliage characteristics of all the fragments match?   Are all the fragments male or all female?   Is there bare wood on one side of each of the fragments that face a common centre?   Or was there at one time, but cambium re-growth has covered the evidence?

If there is no conflict with these criteria, then the fragments are very likely to be part of a single original yew, although if the projected girth is unacceptably or unbelievably huge, then the "fragments" may be layers forming a grove around a lost yew. In that case, see 13: Layers, and discussion of the possibility of the DNA matching of fragments or potential layers that may be a part of a single original bole.

Single fragments

What was the original girth?

Usually bole remainders include or consist of a piece of buttress, which does not give a useful idea of the curve of the circumference. If the only evidence is the curvature of the outside of the fragment, aging may be impossible by curve extrapolation, which is the intended method for use with the girth loss ready- reckoner. In this case a complete girth measure can be taken, and a conservative assumption made about the proportion of the yew lost. The girth loss ready – reckoner can be used as a guide to estimate the original girth on this slightly different basis.

In the field, one can sometimes see where the old base of the yew was. Look for dips where roots have rotted out, and signs of buttress fragments in the ground. Use a stick placed vertically in the ground to represent each bole position you can find, and measure around these, bearing in mind that the buttress curves inwards and upwards (except on an urn shaped yew). One is trying to represent the girth at which the measure would usually be taken given the individual shape of the yew in question. This method has the potential to produce a very accurate result if carried out carefully using clear evidence on the ground, and also avoiding "contaminating" the results with any expectation of what that result should be.

Is the yew fragment offset on a mound? Ancient and Veteran yews often produce a mound by accretion of wind-blown dust, dry matter from fallen wood and foliage and the dumping of waste. A noticeable mound is suggestive of substantial age, and may show where the rest of the yew stood.

Having found the notional girth of the yew, the next step is to reckon when the girth loss occurred, the time lapse since loss needs to be added to the age calculated by notional girth. If the researcher is fortunate, the date of the collapse of the yew will be recorded. Failing that, an estimate based on the amount of cambium regeneration and re-growth may be possible. Low branches may be coeval with catastrophic bole loss; boles shoot and regenerate soon after breakage. The size and age of such regeneration material is a very good indicator of the date of the event.

# 4 Using previous girth measurements and historical references

A-pg V-pg Previous girth measurements available
A-hist V-hist Historical references

There is a clear difference between a previous girth measure and an historical reference. The former contains specific girth information, the latter, while still valuable, does not. Both may be part of the same "stream of references" however. An old girth measure provides an opportunity to re-measure, and thus secure an opportunistically captured growth rate. A historical reference may provide a planting date possibility to be investigated, or perhaps continuity in a stream of references where otherwise significant gaps would exist that cast doubt on the likelihood that the existing references apply to the same yew, or there may be botanical information which proves to be of value in aging the yew. An example of the latter relevant to the Brockenhurst yew is found with a girth reference in Brayley and Britton (5), and is discussed at the end of this section.

Table 2 below shows an example of a good and informative stream of references, in this case relating to the yew in Brockenhurst churchyard, which covers the growth of the yew during the last two centuries.

***Table 2**: An individual yew reference stream*

*The use of Imperial measures is here (as elsewhere) used to preserve the coherence of the data, and the historic integrity of the original references.*

| **Year** | Girth | at | Reference Brockenhurst churchyard yew 1999 |
|---|---|---|---|
| **1793** | 15 feet | unknown | J.Loudon (in J.Lowe) (6) |
| **1805** | 15 feet | unknown | E.Brayley and J.Britton *The Beauties of England and Wales, Hants Vol. VI* |
| **1895** | 18 feet | 3 feet | J.Lowe (1896) *The yew-trees of Great Britain and Ireland* (7) |
| **1963** | 19'2" | 1 metre | A.F.Mitchell (1972) *Conifers of the British Isles* (8) |
| **1999** | 20'9" | 3 feet | T.Hindson *field notes, The Yews of Hampshire, unpublished* |

Evidence like this reference stream gives us two kinds of information.

Firstly it shows the sort of growth that the yew achieves over the given time span. Good examples of this kind of evidence were gathered and used by Allen Meredith in *The Sacred Yew* (9) to illustrate (though not to analyse) the slow growth rate of the yew. Many such streams have now been gathered and analysed to give a broad picture of the bole growth rates of large yews, both slow and faster growing (10).

Secondly, using the data, we can begin to individually age the Brockenhurst yew, with a starting point in 1793 rather than in the present. The yew is growing quite fast for such an old tree; it has put on over 25% of its girth in the last 200 years. Immediately an approximate figure for its age is around 800 years.

To be rather more accurate, we consider the stage of growth and physical form of the yew. It is very hollow and very tall, statistical work done in 1999 (11) has shown that yews of this type have temporarily high rates of bole girth increase. At 15 feet in girth, the yew was most probably growing slower, as per John White's rule of "Constant Annual Increment" (CAI)(12). On the other hand it was almost certainly growing fast in its earlier years*. We therefore apply the age/girth curve for yew which appears in the Protocol document Part 1 for the tree's growth rate up to 15 feet, and then add the 217 years up to 2010. The probability is that the yew will have taken approximately 500 years to reach 15 feet in girth, making it somewhat over 700 years old.

We don't think the Brockenhurst yew has quite reached the 800 year old watershed for Ancient, but it is close, and will celebrate its Ancient status in about 2090. For now it is correctly categorised as Veteran which means that it is between 500 and 1,200 years old.

More evidence may change things however; Tim Hills (pers. com.) has noticed that on the side of the yew facing the church is a structure merged with the outer bole which could be an internal stem remainder. If it could be proved to be so a new analysis would be necessary, and the yew would certainly leap into the Ancient category. See 15 Internal Stems.

*Brayley and Britton describe an enormous oak that was in the Brockenhurst churchyard about 1805 "9 yards in diameter" (5) – I hope they meant girth? If it could be shown that the yew was competing with this and perhaps other oaks for light and moisture, the early curve for the yew would be adjusted using Alice Holt felled woodland yew data. Specifically, the growth rate breakdown of yew AH335a (4) would provide the model allowing us to adjust the yew's early growth rate for shading by oak canopy. The process would almost certainly reveal extra decades of growth that would push it into the Ancient category.

Re-measures

Re-measuring the yew is more complicated than it may appear. For the first two references in 1793 and 1805 we do not know the height above ground at which the measures were taken. Sometimes this factor matters a great deal, sometimes it does not. Broadly, the older the measure the less detail about height above ground matters; that is in tension with the fact that the more uneven the bole is, the more height above ground matters.

Finding the height that the measure was taken at is sometimes possible using comparison with other references where they are available, that has been done with yew data from Crowhurst in Surrey, Farringdon and Boarhunt, among others.

These issues become irrelevant when the bole is even and the measures at various heights above ground are very similar. Happily that is the case with the Brockenhurst yew, and so the measures at unrecorded height above ground are adequate for the purposes of calculating growth rate, especially in view of the fact that the references are over 200 years old.

There is further discussion and illustration relating to re-measures in the sections Current Growth Rates and Hollow Shells.

Tim Hills points out that many references found in 19th century guide books like the reference to the Brockenhurst yew in The Beauties of England and Wales are plundered from earlier works, he has found a number which are lifted unchanged from the works of J. Loudon for example. Very old references need careful handling and analysis, so it is important that we hold a complete database of reference streams that include and identify the inevitable spurious inaccurate and plagiarized measures.

Verbal History with corroborating evidence

A-hive  V-hive  Verbal history, confirmed

History is not always written, in some cases local knowledge can prove very useful in assessing yew ages. Bearing in mind that local knowledge can become confused, and a certain humorous mendacity can creep into local explanations to outsiders, such verbal information is treated with caution. Verbal information followed up by research and examination of the yew can however result in a yew being classified Veteran or Ancient, and an example report is included for illustration.

## **Green Well Farm Yew** (Address supplied)

Elevation: C180 metres   Geo: Dent Fault.   Situation: Garden, a few feet from farmhouse wall.
1 Yew.   Taxus *baccata:*  Female 368 cm girth at 30-60 cm from base.  Exaggerated base plate C4.5 metres in girth.

The yew was being crowned/ dead wooded at the time of the visit. It had previously been partly topped a few years before, and the new growth following the earlier operation is evident in the picture above. The yew is hard to measure because of an extensive base plate perhaps 16 feet in girth; the base plate buttresses up the bole making it impossible for the tape measure to bite. When measured at the lowest point where the tape will tighten without slipping the girth is 368 cm (12 feet 1 inch). Height above ground here is 30-60 cm (12-24 inches) the yew being on an incline.
Note the old bole surface on the left of the image, and the regeneration on the right hand side. The whole bole surface is alive, but it is possible to slide a hand under the bole at ground level in places, including on the regenerated right side, and pull out fragments of rotten wood. The yew is rotting out. The crowning that the yew is currently receiving is therefore entirely appropriate; it will ensure that the crown will not outgrow the ability of the bole to support it while the yew goes through the hollowing process. The rotting out of the centre of the yew is normal for these trees and no cause for concern.

The owner reports that yews were commonly planted to ward off witchcraft in this region. He suggests that the tree was planted when the farmhouse was built, as per local custom. His family has certainly been associated with this site for several centuries (e.g. see 1851, 1901 census returns). He states that the building is C500 years old, and we have found corroborating evidence in that that the first known reference to it is in the will of Thomas Mason of Broadmire, Dent, 1664/5 when it was inhabited by Emma, the wife of Miles Mason.


The yew is pictured in a postcard sent in 1935; the picture was probably taken in the few years previously, 1930-35. The tree is full-canopied about 1935, considerably sheltering the end of the building. A section of branch which started growing at exactly this time was cut from the upper canopy during the dead-wooding and continued crowning carried out today. It is likely part of a second generation of branch stems associated with the regenerated bole section, and as the postcard shows this second flush of branches probably began growing in the early Victorian era after the primary bole and canopy was compromised in some way. The yew on the right hand side of the postcard has now, I think, gone.

*Green Well 2010 branch section*

79 rings are found in a 19/2 = mean 9.5 cm radius (pith off-centre). The cut section of the branch girths 58 cm. The pith of this branch point has a year date of 1931 CE.

The state and configuration of the yew are indicative of its age. The substantial base plate, the regenerated bole material on the house side of the yew, the owner knowledge, the extensive rot in the centre and the girth of the main bole over the base plate all point to the yew having been planted 500 years ago when the farm house was built.

The AYG categorises this yew as V-hive. The yew is Veteran. It is being effectively and competently managed by its owner and his family.
Many thanks to Diane Elphick for supplying much of the historical detail.

# 5 Hollow Shells

A-hol V-hol Hollow shell, lack of roof to hollow interior, thin bole walls.
Implications for categories: These yews are always Ancient.

Hollow shell yews are really collections of fragments which form a complete girth and the impression of a low, fragmented bole. They increase girth at a negligible rate. This is growth stage "Type 6" (11). Two perfect exemplars of hollow shell yews will be examined in order to illustrate the type, and evidence pointing to an almost complete stall in bole increase for several centuries. This category has particularly important implications for yews in the fragment category. If it can be shown that a fragment was part of a hollow shell that fragment is immediately classed as Ancient.

*Farringdon Yew October 2008*
*The inner surfaces are mainly white wood rather than rot, and the remaining bole radii are low.*

Historical reference: Hudson (1902) "The Farringdon yew in its biggest part, about five feet from the ground, measures thirty feet, and to judge by its ruinous condition it must have ceased adding to its bulk more than a century ago." (7)

***Table 3:*** *Reference stream for Farringdon*

| Date | Girth | at | Author | Reference stream: Farringdon | |
|---|---|---|---|---|---|
| 1781 | 30` | X | Gilbert White | *Natural History of Selborne* (14) | |
| 1903 | 30` | 5` | W.H.Hudson | *Hampshire Days* | |
| 1902 | 30` | X | Cox | In Meredith: *The Sacred Yew* | |
| 1958 | 29`6" | 5` | Mitchell | Field Notes | |
| 1984 | 30`6" | 5` | Meredith | *The Sacred Yew* | |
| 1999 | 30`10" | 5` | Hindson | (Fieldwork, more measures below) | Rate 1 = 0.12 mm pa |
| 2008 | 30'10" | 5' | Hindson /Boardman | (Fieldwork verified and assisted by Tom Boardman) | |

According to the data in Table 4 above, there has been an explosion of growth since 1958, after the tree was measured by Mitchell.   This change is very likely an artefact of measuring styles.   It`s fairly probable that Hudson and Mitchell were measuring different 5 foot girths.

While Mitchell can usually be taken as cast iron certain, in this instance I think that he measured the tree lower down than other researchers, probably simply measuring five feet up from the lowest part of the bole available on the uneven ground surface, which is what he appears to have done at elsewhere, for instance at Durley in Hampshire. (8)  This was sensible, as to go above the level at which he probably measured is to get mixed up with young vertical branches, which makes measurement even more uncertain than it usually is on such an uneven bole.   As he also seems to demonstrate a preference for minimum measures, it seems likely that his 5' is at or near my 4' measure (in the table of 1999 measurements below).

***Table 4***: *Bole girth mapping*

| *T. Hindson Bole girth mapping: Farringdon Hants.  The ground level point is taken to be at the left hand side of the entrance to the hollow facing the path. See illustration of yew above.* | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Base min.* | *1'* | *2'* | *Waist* | *3'* | *4'* | *5'* | *Ht from ground* |
| *28'11* | *29'7"* | *30'7"* | *30'2"* | *30'1"* | *29'10"* | *30'10"* | *1999* |
| | *29'8.5"* | | | | | *30'10"* | *2008* |

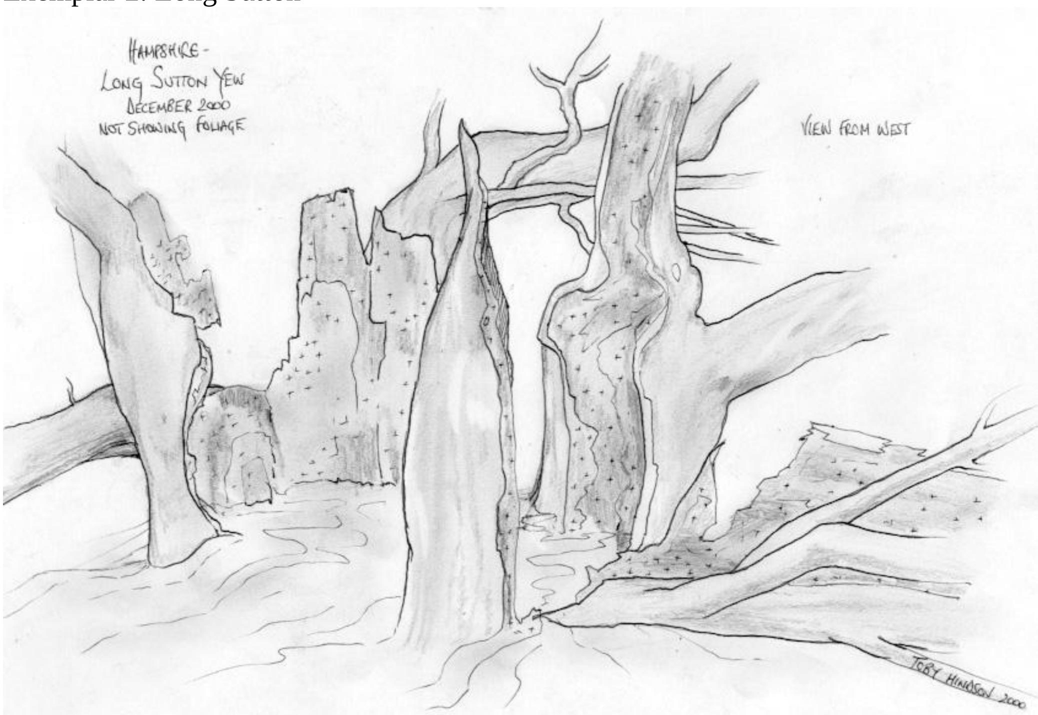
We can deduce one important thing about the growth rate.   The yew's girth has not grown more than 10 inches since Gilbert White measured it in 1781 (14), and it may not have grown at all.   The <u>maximum</u> growth rate is therefore 0.046 inches, or  1.2 mm per annum. Although he was a naturalist, and curate at Farringdon, he wrote about the Selborne yew in detail, rather than this one.   One can infer that he largely ignored it because it already appeared to be in serious decline.

The Farringdon yew is nearing the end of its existence as a shell.   After many centuries in severe canopy decline, and producing a very slight but constant and determined girth increase it has now almost reached the critical girth (usually above 10 metres at any height on the bole) at which the canopy is spread enough for it to begin to throw up major vertical shoots from the lower bole.   I predict that during the next century or two there will be an explosion of growth which will cause this yew to resemble the Breamore yew, which is a huge and vigorous mix of large vertical stems and chunks of ancient living shell.   The yew at Farringdon will show girth increases of up to 1 cm per annum as the ring of outer trunks themselves expand in girth, with some setbacks as shoots with their origins in the upper canopy overgrow and break the lower bole.   This overgrowth and collapse will usually benefit the whole tree at this stage, however, encouraging regeneration from the base, clearing the upper canopy and reducing shade, allowing the base to throw the shoots which will form complete new trees, ultimately forming that most stable, ancient and immortal yew stage of all, the ring.   In light of this information it is clear that on NO account should the lower part of the Farringdon yew have any new growth pruned or removed.   The temptation to speed the stage 7 ring formation by reducing the canopy should also be treated with great suspicion and circumspection.

Long Sutton

Another example of the hollow shell is at Long Sutton, in the churchyard to the north of the church. Again, a number of fragments have remained, and form an almost complete girth, despite the large section that fell under the weight of new growth and snow in 2000. Because of the very full and low canopy an accurate sketch is more informative than a photograph in this case.

Exemplar 2: Long Sutton




The yew was 26’7” at ground level in 1896 (Lowe) and 27’1” in 1999, an increase of 6” (15 cm) in 103 years. Though extremely slow, the rate exceeds that of Farringdon. The girth of Long Sutton yew is only slightly lower than that of Farringdon, but the typical bole radius (mean thickness of the remaining bole wood) is rather greater and the canopy is fuller and healthier looking. Long Sutton yew also has more rotten wood and less whitewood on the inner surface. There appears to be a correlation which happens to be intuitively satisfying that the thinner the bole wall the slower the growth rate. Clearly the effect is produced by the growth of the yew relative to the timescale it takes the yew wood to decay. Long Sutton yew is therefore thought to be younger than the Farringdon yew; it has, to date, spent a shorter time as a slow-growing shell.

# 6 The Urn Shape

A-urn V-urn Urn shape, girth narrowest at ground, bulging upper bole

*"Julian's tree" A classic urn shaped yew at Merrow Down 2009*

The urn shape is a conundrum. This huge yew looks ancient, and the measure in 2009 at 90 cm from ground places the yew well within the Ancient category at 7.21 metres. However, the base measure is only 6.04 metres, almost a metre below the Ancient watershed. Is the yew Ancient or not?

To investigate, we look at the base girth measure. There are two reasons; firstly it is the most stable part of the bole to re-measure. Measures on other bole levels can vary wildly on urn shapes. The most stable measure is the most accurate measure. Secondly, yews of this shape seem to fall apart when they reach a certain size, sometimes they then shoot from the break near ground level, preserving and regenerating the wood on which the old girth measure was taken. The bases of urns are therefore the best place at which to estimate the original girth from remaining fragments.

A fortuitous circumstance is that a yew of this shape, growing on the same North Downs chalk and in similar woodland at Cherkley Court was found felled, and has been ring counted. It yielded the highest count of any yew we have found so far at 467 rings, plus a substantial rotten core 1.2 metres in circumference which was filled with a mass of almost 50 small internal stems. The base minimum girth of CC467r as it is coded (10) was 4.85 metres, and it is thought that a complete ring count reconstructing the lost centre would have yielded 601 rings. The girth of this felled yew at 90 cm is not measurable without digging, but exceeds 6 metres.

A comparison of base girths between the two yews shows a difference of 119 cm. It has been noted that for a given girth, the typical growth rate for solid yews (see the graph in Protocols Part I) matches ring counts on the broken base material on other urn shaped yews at Newlands Corner. The burned "urn" fragment pictured in Robert Bevan Jones' book *The Ancient Yew*(15) yielded a valuable sample for instance, providing evidence that the very low growth rate of 0.3cm girth increase per year is applicable here (Graph A, 11). If this rate seems very low, then bear in mind that large areas of the bark at the base of Julian's Yew are dying off, and being colonised by puffballs and lichens. The cambium at the base level is, in parts, in fatal decline and it is predicted that this beautifully shaped yew will start to break up over the next few centuries.

*CC467r showing the cleared lines for ring counting and the measure site.*

The time taken for CC467r (601 years old when felled) to reach the same girth as Julian's yew would have been 397 years if the correct annual rate of increase is indeed 0.3 cm per year at base. So the total age of Julian's Yew at Merrow Down is estimated at 601 + 397 = 998 years old in 2009.

This Merrow Down specimen is Ancient, classed as A-urn. The lost yew CC467r at Cherkley Court is, having a partial ring count approaching 500 rings, classed V-rc,urn. The fact that it is an urn shape is not directly germane to the primary aging process, but it is a relevant fact that the measure which can be used for comparison purposes is taken at base minimum. The reference –urn is therefore used but placed second.

We find that the critical girth for an urn shaped yew to reach Ancient status is a basal minimum girth of 5.45 metres. The critical girth for urn shaped Veteran yews is calculated at 4.05 metres in churchyards, and is a nominal (uncalculated at present) 3.4 metres at base in the wild, although at this girth very few examples exist and the category may well remain unused.

Hourglass shaped yews

 Alice Holt 1997

It is likely that the yew bole shape, the “hourglass” with an extremely pinched waist, and very large base plate and upper bole will be measured at minimum girth and given Veteran and Ancient status using the same critical girth values as we have calculated for the urn shape.

## 7 Stump Re-growths

A-reg V-reg Regrowth from stump

Difficult to age, the best method seems to be to take the minimum girth near the ground, then allow for the faster girth increase that comes with regeneration. The time period since felling is important, and the age of the new stems will give a clue to this if no records exist. At the moment, until further evidence and analysis are available, the girth at ground level is used for categorisation.

# 8 Lost Girth

A-lgth V-lgth Shape suggests a once larger girthed tree

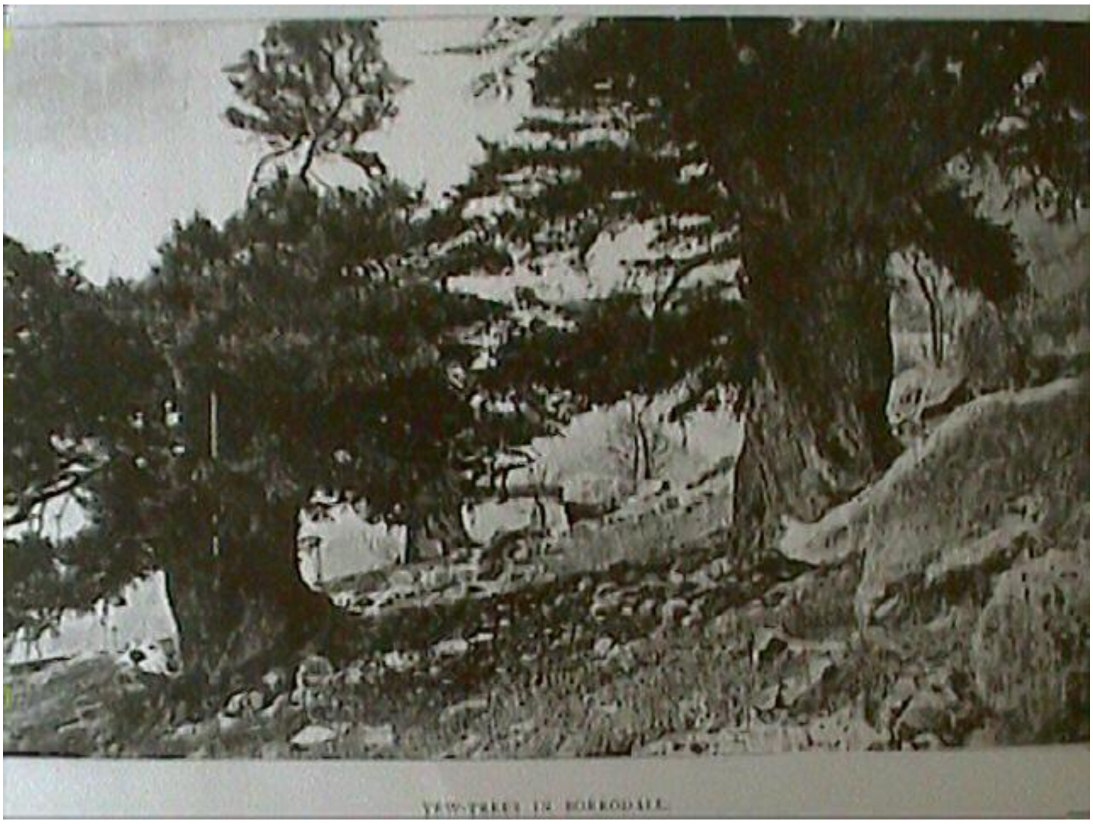
The yew at Ninfield is a good exemplar for “lost girth”, though there could be any number of reasons for applying the category. The -lgth category is to be applied entirely on a case by case basis with credible supporting scientific argument. For example: at Ninfield, the appearance of the yew (the remaining bole of which consists entirely of internal stems) is what the Ankerwyke yew might look like without its “shell”. The remaining stems at Ninfield measure 538 cm at ground level, giving a diameter of 170 cm.

In order for such stems to grow, there needs to be a core of rot inside the bole that could contain the stems, rather in the manner of a flowerpot. The “walls” of the “pot” are estimated at a minimum of 30 cm, adding two 30 cm radii to the existing 170 cm diameter. The total notional diameter is therefore 230 cm, and the total notional girth before bole loss is thus 722 cm. The time elapsed since the loss of the bole walls can be added to the resulting age figure, and as no signs of the bole walls remain, that elapsed time must be very great, measured in centuries. This yew is Ancient and categorised A-lgth.

On reading this Andy McGeeney tells me that at Ninfield he scraped around in the grass and found hard remnants of the bole hidden underground. He also tells me that there is photographic evidence of a much bigger Victorian tree at Ninfield. This is an excellent example of corroboration and further evidence giving definition and solidity to the historic picture of the yew sketched by the application of the protocols.

# 9   Altitude, Exposure and Latitude

A-alt   V-alt         allowance made for altitude, exposure and/or latitude



*Borrowdale yews; Lowe 1896 (7)*

Statistical evidence

Generalized girth modification data analysis

The statistical reason for supposing that upland yews, (i.e. nominally those growing at an altitude above 300 metres and/or unduly exposed to wind or sea-spray) are generally slower growing than their lowland counterparts is found in the data summary table at the end of *Studies of Felled Yews,* reproduced below.   The sample of upland Brecon Beacon yews is, as the chart shows, substantially slower growing than the other samples, including the Alice Holt sample which comes from mixed woodland with a preponderance of deciduous species, and some compartments of dense commercially planted conifers.

From the finding that the Brecon Beacon sample is more slow-growing than the southern lowland samples, and noting that the difference is greater than 10% we believe that there is a case for adjusting the girth requirement for yews growing in extreme upland circumstances by a like factor.

Latitude is not yet fully explored as a variable, but it is possible that a similar factor will apply to yews growing in Northumberland and Scotland.

Consequences for critical girth measures

With a reduction of 10% for the categorisation V-alt the churchyard Veteran watershed girth becomes 4.4 metres, the Ancient watershed girth becomes 6.3 metres. Outside a churchyard the critical girth for lowland yew to be Veteran is 4.25 metres. With the 10% V-alt reduction the critical girth becomes 3.80 metres.

***Table 5**: Mean Graduated Total Girth Increase by Age*
Reproduced from *Studies of Felled Yews (10)*

The data in the chart below is inclusive of all the single stem yew data in this report, and separates Southern and Brecon Beacon sites. Alice Holt is also excluded from the mixed data so that it can be compared.

Sites in the south of England

(All sites except Brecon Beacons and Alice Holt)

| Years | mean age | n=* | rate, cm | **Brecon Beacons** (rate) | Alice Holt |
|---|---|---|---|---|---|
| 0-50 | - | 0 | - | | |
| 0-100 | 79 | 4 | 1.3 | **0.9 n=3** | |
| 101-150 | 111 | 23 | 1.3 | **1.0 n=6** | 1.4 n=16 |
| 151-200 | 178 | 5 | 1.2 | | 1.3 n=3 |
| 201-250 | 210 | 1 | 1.1 | | |
| 251-300 | - | 0 | - | **0.8 n=1** | 1.1 n=3 |
| 301-350 | 310 | 6 | 1.0 | | 1.0 n=1 |
| 351-400 | - | 0 | - | | |
| 401-450 | 450 | 1 | 1.1 | | |
| 450-500 | - | 0 | - | | |
| 501-550 | - | 0 | - | | |
| 550-600 | - | 0 | - | | |
| 601-650 | 601 | 1 | 0.8 | | |

**n= means the number of yews that contribute to the sample.*
*(rate) refers to the raw bole circumference growth rate in cm per year.*

Applying the upland variation using the evidence in Table 3

The difference between the Brecon Beacons sample and the rest which are all lowland yews is clear, a difference of approximately 20% can be observed across the means. The sample sizes, while statistically significant are too low for us to wish to apply the whole difference to the critical girth measures for Veteran and Ancient at present. More information from varied upland sites is needed to give us a clearer picture, and for now half of the difference is applied to the critical girth measures on those upland yews with measurable boles.

Cliff yews are a separate issue from upland yews in general, they cannot be categorised using a girth based method. The methodology relating to cliff yew individuals and communities is described in 17 Unclassifiable by girth – cliff yews

# 10 Ring Counts

A-rc V-rc Annual growth rings counted on a broken, cut or bored bole radius

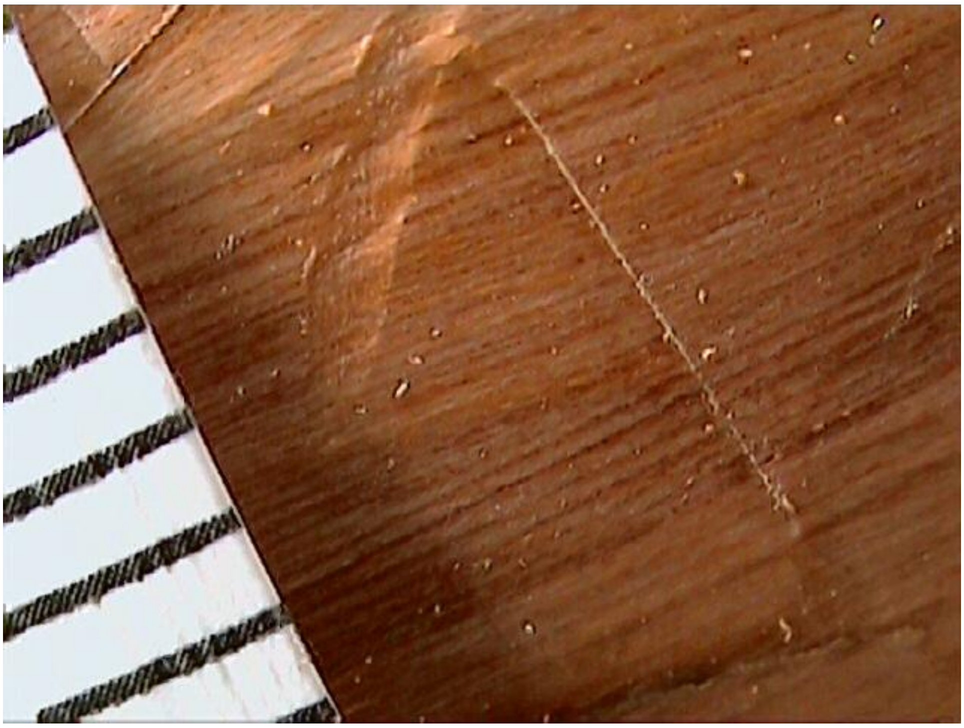
Using ring counts on a standing yew to find an approximate age.

Example: Borrowdale, one of Wordsworth's "Fraternal Four".

Pictured below is part of the largest yew of the "Fraternal Four". A fallen section of bole from about 2.5 metres above ground level presents an opportunity to study ring density.

On the pictured section 224 rings were found on an 8 cm radius. The (minimum) girth of the yew at just above the highest ground point was 680 cm. (It is 752 cm at 60 cm from ground according to the AYG website) 680 cm is the correct girth to use for aging, being the minimum on an uneven bole.

The wood surface of the bole section is cleaned with a very sharp chisel. (Experienced well-prepared tool users only. Chisels can cause fatal wounds, especially if the injured person is alone and/or a long way from a hospital). A macro photograph is taken against a known scale. The surface is shot in macro until the entire surface to be ring counted is photographed. The count is taken in situ, and repeated later from photographs for comparison. Living wood and cambium are never disturbed.



*The ring density against a 1mm scale (macro).*

A very rough aging using these evidences works thus: the yew radius is approximately 100 cm. The radius unaccounted for is almost 90 cm, or a notional girth of 565 cm. A yew of this (notional) girth would typically be approximately 700 years old, plus 10% for altitude and exposure allowance = 770 years. Add the 224 rings found, and we get an age of nearly 1,000 years. Inaccuracies include the fact that the bole may not be original at this height above ground, and also the girth measure is somewhat lower at the point the count was taken than the girth measure from the point which was used for calculation. An approximate minimum age of 1,000 years appears to be correct however.

It is safe to class the yew as A-rc without further investigation, although the further line of reasoning exists as a cross-check: the critical bole girth for yews which are in upland areas is set to 6.3 metres (see below) and the yew exceeds this girth. Interestingly these results approximately accord with work done by the dendrologist A. Moir (16) who also found the yew to be 1,000 years old or more. The classification of the yew should be A-alt,rc.

Ring counting as a way of learning the age of a yew is fraught with problems. If a ring count is not complete then there is always the possibility that the sample one has investigated is not representative of the whole yew. Yew trees are highly sensitive to their growing conditions and to their own physical condition and can explode within two seasons from about 0.1 of a millimetre to over twenty times that in annual radial increment. The evidence for this statement is illustrated below. In order to use ring count data to categorise yews Ancient or Veteran, a large proportion of the age must be found and ring counted on a single measured radius. Typically bole counts under 125 annual rings (25% of the critical age) will be insufficient to use as data for assessing the likely age of Veteran individuals.

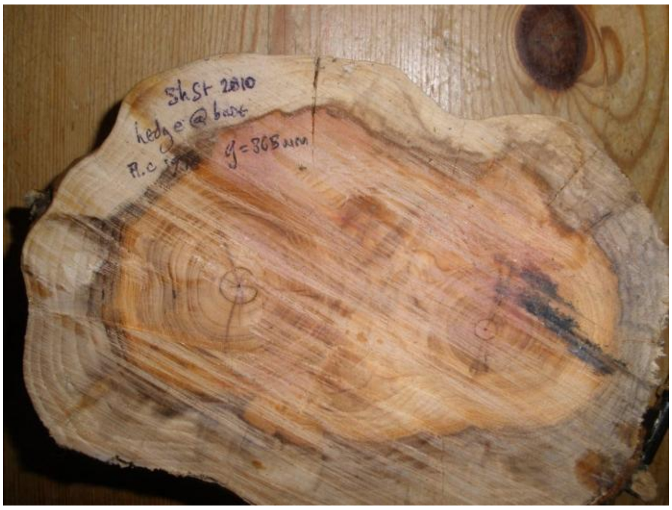
Ring counts on branch material give a minimum age for the whole yew, but as yews seem to re-grow their canopies over a 250-400 year cycle, original branches on very large yews are unlikely to exist. A branch count will not give the age of a yew.

<u>A small study follows, which illustrates a ring counting method, and some of its legitimate uses, conclusions and results.</u>

Digitally magnified annual growth ring counts

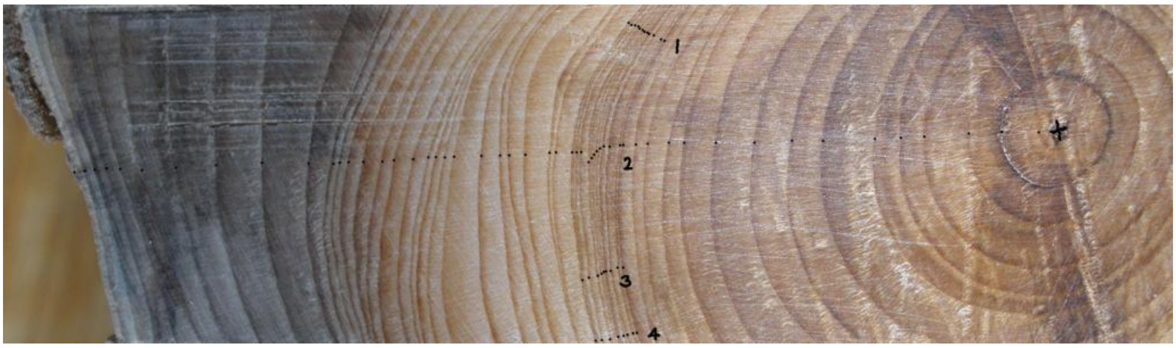
An example of ring counting and broad increment analysis relating to growing conditions and events, showing the interesting features often found in hedged and topiarised yew, and also showing the method used in counting rings and recording the essential data.

*A sample from the base of a dead hedging yew. (Nr. Maidenhead 2010).*



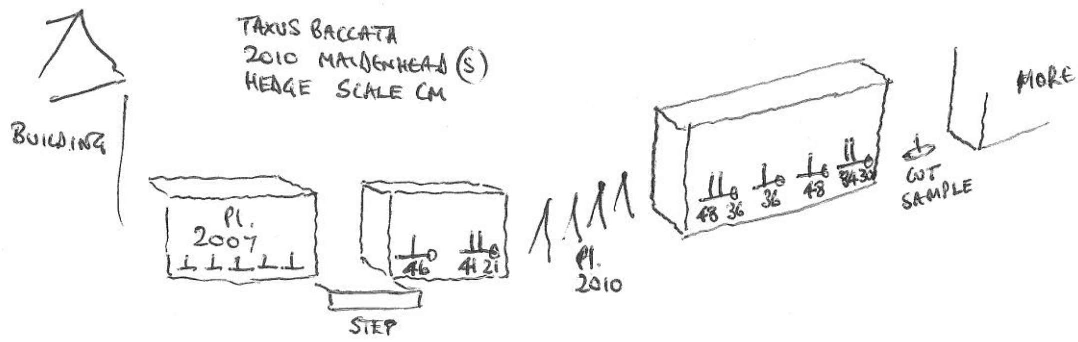
Yew. Killed 2007. Girth 368 mm, base. 49-53 annual rings at the base.

*Below, the horizontal right hand radius (38mm) rotated through 180deg, and marked out as it was ring counted. The pictured Magnification is x4. The count and ring marking were done at x20 magnification using a digital paint programme. The wood surface was prepared with three grades of cut: chainsaw - wood rasp - fine emery paper. The surface was photographed using a super macro setting at 8 megapixels in natural sunlight. An extreme magnification of the dense ring band is also shown below on page 31.*




The history of this hedge is evident from the sample plant shown, which died about 2007 when it was heavily cut back along with its contemporaries which happily do survive.

The remaining yews have been measured at the base for comparison purposes, and to establish the range of girth that they present.

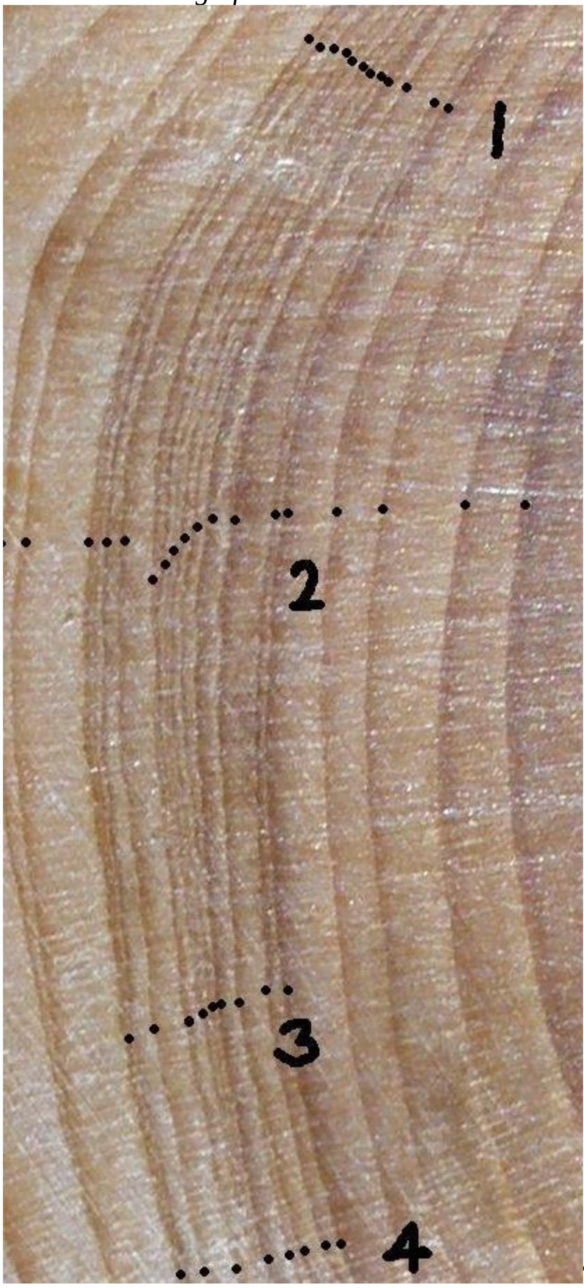



*Field note sketch of hedging at a Maidenhead site (site-S). The inverted T shape indicates a bole, more than one upstroke signifies more than one bole at ground level. The number at the end of the horizontal stroke (here invariably 0) shows measure height above ground. The number(s) below the horizontal line show the girth(s).*

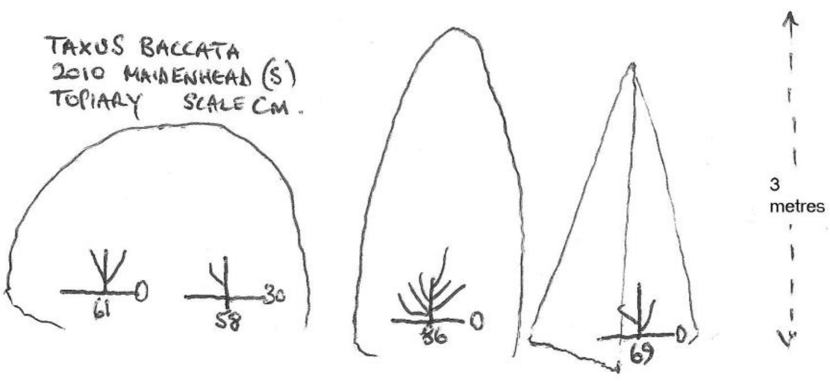
As one can see from the ring widths, reading the rings left to right, yew responds dramatically to varying treatment. The outer ten rings show some very fast growth, the time during which the hedge was allowed to grow unchecked. The inner rings show a denser band about 1 cm wide and containing 18 annual increments. This density is considerable, but quite typical of yew that is closely trimmed but well grown. The inner part of this set of rings represent the period when the hedge was filling out, vigorously growing upwards and filling gaps with foliage. That period lasted about 5 years. Then there is an extremely dense (crisis) band of 8 to 12 rings. Four counts were done on the crisis section (which measures 1.5mm across) yielding: count 1: 12, count 2: 12, count 3: 9 count 4: 8 rings. These rings represent the time when the yew was planted and was struggling to establish itself in the rather poor sandy surface layer of soil. The inmost 10 rings show the speed at which the young yew was grown in the nursery where it was produced, and the growth decline as the rings approach the crisis band probably represent the time when the hedge had just been planted and was still being watered and fertilised. This treatment failed to establish the hedge properly because the soil is heath land sand containing hard core and metallic rubbish. The sampling cut was made at 5 cm from the base of the dead stem, so the top of the cutting that this yew was grown from would be just under this level. If it was grown from a seedling, the plant would take two years to grow to 5 cm at the fastest possible nursery rate.

The age of the remaining hedge plants is 49-53 years, plus 3 years since the yew's death about 2007, plus the minimum 2 years for the seedlings or cuttings to establish, so a total age of 54-58 years in 2010. Judging by the ring evidence the yews were planted as a hedge 44-48 years ago in about 1965. It is known from selective felling of other species that the garden was extensively planted about 1960, including a completely ring counted Magnolia *grandiflora*. This circumstance is a useful cross-check on the ring count evidence, as is the existence of two young yews and three topiarised yews that may be of the same planting.

*Crisis band: Magnification x15*



This photograph is 1 cm high in scale.




Topiary on the same site.

Finding an age for all the yews on the site

In order to be sure that the yews on the site are a single planting, some comparisons have to be made. The way the data we have acquired is used can be summarised as follows:

Prediction
Assuming an age of 55 years old for all the yews examined, we want to find a graduation of growth rates because of varying treatment of the yew plants. The lowest growth rate will be expected in the hedging, the highest in the free growing yews. The rate shown by the free growing yews should match that found for the youngest population in Table 5: *Mean Graduated Total Girth Increase by Age*, (above on p. 26) which is 1.3cm.

***Table 6****: Rates of growth and treatment predictions and outcomes*

| Yew form | N= | Prediction | Actual mean growth rate, girth, cm/year |
|---|---|---|---|
| Free growing | 2* | 1.3 | 1.4 |
| Topiarised | 3* | Lower | 1.2 |
| Hedged | 7 | Still lower | 0.8 |
| | | | |

**The sample size is not statistically significant and so this is an illustrative comparison*

The mean growth rate of the free growing yews matches the prediction from the chart very closely.

There is indeed a graduation of girth increase rates as predicted, although the difference between the topiary and the free growing yew is quite small. Either large topiary is relatively unaffected by clipping in the earlier years of growth, having sufficient canopy to allow the bole to develop almost normally, or the topiary was planted a few years earlier than the other yews. This researcher is inclined to the former view, and considers that the girth increase rate of the topiary will soon start to drop off as the Constant Annual Increment phenomenon described by John White (12) starts to show its effects.

The evidence suggests that all these yews; the hedging, topiary, and the two free growing individuals, were planted together as a ten year old batch in or around 1965.

# 11 Current Growth Rates

A-cgr V-cgr Current growth rates

A clear idea of the current rate of bole increase can be useful in aging yews in two ways. Firstly the data from many such yews can be used to create a clear picture of typical growth rates of yews in various conditions and sizes and states. Secondly the results from an individual yew can be used to obtain information about how the yew is responding to current measurable conditions, and thus to decide whether it is genetically or otherwise different in growth rate from the mean. The technique is the only method we have at present for systematically identifying very slow growing intact yews which are Ancient or Veteran, but are below the critical girth for these categories and have no historical references. At the moment current growth rates are mainly used as supporting evidence for other categories, no Veteran or Ancient yews are yet classified on this basis alone. It is hoped that in the near future a lot of data will become available which will change the situation.

The best way of illustrating the non-invasive method which is being developed for finding current growth rates is to include extracts from an ongoing report, showing the development of the technique since 2003.

## Measuring the Ankerwyke yew to find the current growth rate

1st August 2003. Updated 17th September 2008, updated 11th July 2010.

Toby Hindson and Lesley Elphick.

Ankerwyke yew grows near the banks of the Thames at Ankerwyke, Runnymede. It was measured at ground level by Troy and Christison in 1877 described in Lowe (7) and measured 7620 mm expressed in whole feet (25) in the original reference. The tree has grown about 208 mm from 1877 to 2010, an average annual girth increase rate over the period of 133 years of 2 mm. The current growth rate is to be measured following Troy and Christison's measure as far as possible.

In 2003 the tree measured **7790 mm** (306.7 inches) girth at and near the base; the tape measure used was an Am-Tech Fibergl ass (sic) 30M/100ft measuring tape. Stock code: P1850, Bar Code 5032759017812.

UPDATE1. In September 2008, a repeat re-measure was made by the same researchers. 4 measures were taken, and the two lowest were identical at 7822 mm. The girth increase was 32 mm in 5 years. Annual girth increase rate for period 6 mm. The tape measure was a CK 10 metres No.3561.

By 2008 we had realised that a single measure was insufficient to ensure accuracy, and decided to repeatedly measure until the lowest possible girth value stabilised.

 2008

UPDATE 2, July 2010. Repeat measures were made by the same researchers. 6 remeasures were taken at base. As usual, they decrease constantly until stabilizing at the correct figure. Measures in the order taken (mm): 7852, 7844, 7832, **7828**, 7832, **7828.** The two lowest were averaged (they were identical) and used for data. The weather was sunny and hot. The bole increase since 2003 was 38 mm so the annual growth rate for the 7 year period was 5 mm. The tape measure was a CK 10 metres No.3561.

By 2010, after work on other yews such as the specimen at West Tisted we had realised that we needed more than 4 measures in order to achieve a stable minimum. None of the above results are strictly valid. Valid results will be obtained when we have repeated the same method. It is clear that this method should be as per the 2010 visit, and is as follows:

1 A stable run must always be used, i.e. a route around the yew where the tape rests easily and does not slip up or down. Minimum girth is usually best.

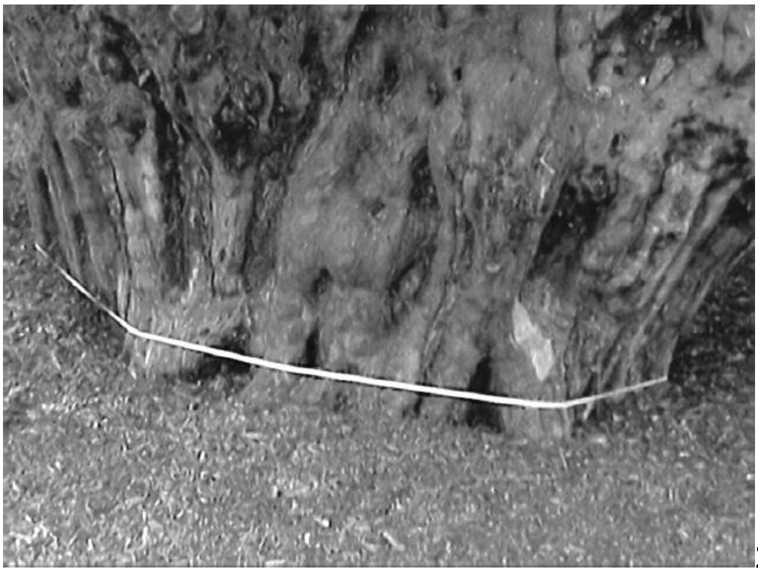
2 The initial tape run has to be recorded photographically so that the measure can be repeated more easily and accurately in future. Stills like the one below (valid for repetition of this study) are sufficient for the work.

Here is a succession of images (2003) of the run of tape at Ankerwyke, working clockwise.


2003/1


2003/2


2003/3


2003/4


2003/5

3 Working the tape measure
The tape seems to take time to come to rest. About 5mm is removed from the measure if the tape is worked by sliding it gently back and forth a little (a foot or less) round the measured circumference, and then keeping gentle pressure on it for a minute or so. "Settling the tape in" is how I would describe it. The slack is probably being taken up rather than there being a stretching of the tape. Either way, one is ensuring the repeatability of the measure.

4 Number of measures
Six measures should be taken, and the lowest two averaged to give the bole girth. The tape should be wound up after each measurement, and re-run around the yew on each new attempt. All measures taken should be recorded and kept as part of the field note data.

5 Unquantified variables
Things to try and control include heat, moisture on the bole, and human error due to discomfort. The 1st of August was pleasant. The tree was measured on a warm, dry, sunny evening, (about 20 degrees) the soil being damp under the litter after a few days rain. The bark of the tree was dry. Researchers should try to work in similar and preferably comfortable weather conditions on each measuring session.

6 Excessive human activity around the base of a tree will cause harmful soil compaction. Activities like this form of measuring should be carried out as seldom as possible, no less than 2 or 3 year intervals are recommended.

7 Some researcher has selfishly been knocking three inch nails into the living cambium of yew trees in order to get a stable re-measure point; the practice has been noted all over the place, including Sussex, multiple sites in Herefordshire, Berkshire etc. We wish this researcher to stop the practice, which we regard as wholly unacceptable and inappropriate. No injury must be done to the yew being measured as a matter of good practice and principle. Leaving nails sticking out of tree boles is an unsafe and unsightly practice, too.

## 12 Accidental Sampling of a single age group

A-smp V-smp A number of yews planted at the same time, one felled and ring counted

Examples of yews aged by the happenstance that a contemporaneous individual has been felled do exist, for instance at Bridge Sollars (10) where a line of yews have been dated as a 1700 CE planting by ring counting two fallen and cut individuals from that line.

Older examples that are Veteran or Ancient have not yet been found, unless we consider that the felled yew CC467r, which began growing in about 1380 is an age exemplar for the other oldest specimens at Cherkley Court. There is a reasonable case to argue. Lowe provides data for three urn shaped yews growing here in 1890, with bases measuring 13 feet 8 inches, 13 feet 7 inches and 13 feet 4 inches respectively at that time. CC467r was certainly one of these specimens, and had grown approximately two feet in girth at the base since it was measured in 1890.

We can fairly conclude that the oldest of the remaining yews are of a similar age, especially in view of the rumour that in the 14th century the land here was planted with yew intended for bow making. That reference is well worth following up and verifying, because CC467r and its fellows are very likely of that planting.

A methodology example for finding contemporaneous stands of yew is given in the section Ring Counts.

# 13 Layers

A-lay V-lay Proven natural layer(s) of an Ancient or Veteran yew

This category is simple in principle, all separately rooted parts of the yew share its classification if they are no longer attached to the originating yew, or if they are attached but deemed ready to grow independently if they became detached. Some layers have few features that can be used as evidence of their provenance, however, and proving that such detached layers are part of an older bole can be problematic.

The subject of layering and identifying genetically identical yews may well be a fruitful field for scientists who wish to get involved in classifying yews. For instance it would be excellent to be able to find genetically identical individuals in groups, proving the existence of Veteran and Ancient groves that could not otherwise be classified.

Russell Ball informs me that DNA testing is now commonly used in subsidence cases involving trees, and has become relatively inexpensive. Use of this technique is a clear way forward in the discovery of separated layers, and the confirmation of suspected groves and fragment groups.

The Veteran yew in Langley Park (2006), showing the old bole and attached layers.

The main bole of the yew is classed as V-g, the layers are V-lay or may be classed V-lay (g).

Groves

It is possible for a ring of layers to form around a central originator bole. These layers may then grow branches into the ground and form still more new individuals. Such a mass of stems is still one yew, the youngest boles at the outside, the most ancient at the centre. We know of few authenticated examples of a very large grove of this sort, but that may be because up until now there has been no way of gathering proof of the phenomenon unless the boles are still attached by the layering branches. We can be quite certain that the virgin forest that sprung up after the last ice age 10,000 years ago contained many such groves and the finding of any remnants of these trees would be an astounding achievement.

Layer types and stages

Layers are not necessarily Veteran or Ancient. Yews branches can root into the ground at any stage; for example, at Alice Holt in 1996 the author noted layered branches that were separated by felling from a yew aged about 150 years. To be classified, the original bole has to be (or to have been) classifiable.

There are stages of branch layering; in the picture of the yew at Langley Park above all the stages are visible. The first stage is the grounded branch, which is not a layer proper because it has no root. It therefore has no separate classification. Branches which may have rooted but are still visibly attached to the main bole likewise have no separate classification, with the exception of the “hull and mast” shape to the left of the photograph above. The grounded and rooted branch has produced reverted vertical bole material from the differentiated branch material. A new yew bole is forming, and is classifiable.

Undifferentiated branch material, called an “orphan branch” (visible on the far right of the picture) which is no longer visibly attached to the originating bole can also be classified. If the attaching branch is dead or rotting away, or is significantly lower in girth than the layer where it arises from the ground then the layer can be considered detached for practical purposes.

# 14 Propagated yews from Ancient and Veteran stock

A-prop V-prop Cutting taken from a known Ancient or Veteran yew

The Yews for the Millennium yew at Chiddingstone Kent in 2010.

*This is what successfully grown Yews for the Millennium cuttings look like at present.*

Information about which cutting belongs to which yew needs propagating almost as much as the yews themselves. Ten years on there is no public information on the subject in the church or labelling for this yew, including details of the yew it originated from. We hope and assume that the information is safely held by The Conservation Foundation. If not, then recoverable details should be collected as a matter of urgency. They will be added to the AYG database under the entries for the parent yews.

Note the growth pattern of the young yew. The open "goblet" style of growth indicates that the cutting was taken from differentiated branch material; there is no growing point which will form a single upright bole. The yew will revert in time, however, in the same way that a layer reverts when it eventually starts to grow upwards from a grounded branch.

## 15 Internal stem position.

A- inp V-inp internal stem position

Usually, the position and configuration of internal stems in the hollows of yews is of no particular consequence in aging them, although it may give insights into the process of hollowing. An internal stem which strikes straight down into a narrow rotten core at the heart of the yew where the pith has rotted out will be at or near the centre of the hollow space inside the bole. Linton yew is an example. At Ankerwyke there are large, wandering serpentine root structures, which show that the yew had a large, stable bulk of rotten material present within it when the internal stems began growing.

*The wandering internal root system at Ankerwyke 2010 forms startling images*

When the yew is damaged, however, and the internal stem stands outside the remaining girth of the bole, that stem can help show where the original bole ran. The configuration of the internal stem(s) now becomes crucial to any investigation of the extent of the old bole. A single approximately vertical internal stem probably rooted into the pith region of the yew, and in that case the centre of the internal stem represents the centre of the yew where it meets the ground. A notional girth is calculated by assuming that the existing yew radius continued all the way round the tree centring on the base of the internal stem.

Where multiple stems exist, wandering after the fashion of Ankerwyke, a different criterion is applied. The internal root system is assumed to have filled the available space inside the yew, the total girth being calculated by cloaking the space occupied by the tangle of roots with a thickness of bole suggested by the existing bole radius remainder. A variation of this system is also used for yews with single internal stems which do not seem to have been central inside the bole. Often in this case it is obvious that the hollow was on one side of the yew, and the existing bole thickness is inappropriate to apply. A standard 30 cm “cloak of shell” around the stem is then used to calculate notional girth.

Conundrums.

Pictured below, this pair of structures represents a puzzle. They are attached to the outer bole of the well-known Ancient yew at Corhampton, on the church facing side. The bole on this section otherwise flows up in an unbroken urn type configuration. It seems that this part of the tree once rooted into the ground here. Was the soil built up around the side of the yew? Were these internal stems once, which are now isolated by the complete regeneration of a new bole? This researcher is inclined to the former opinion, but puzzling structures like these abound on very old yews, raising all sorts of questions. A yew at Merrow down (author) has produced external roots at 1 metre from the ground; they are growing into rotted leaves that have caught in dead epicormic* growth on the bole. We will watch these roots with interest to see how they develop. These examples are meant to illustrate the difficulty and some of the pitfalls in interpreting unusual root growths on yew.

*Corhampton yew 2008*

*An epicormic growth is a shoot growing from a bud originating underneath the bark of the bole, exposed root, or branch of the yew.

# 16 Internal stem girth allowance

A- ins V-ins internal stem girth

When an internal stem grows very large, it may have an impact on the development of the bole proper, the wood that the yew allocates to its development may have been diverted from outer bole development. Mike Turner, an Oxford educated scientist created this equation and proof for us in 1999 (pers. comm.). It quantifies bole girth loss where wood that would have been used for bole development is diverted to internal stem development.

CROSS SECTIONAL AREA OF INTERNAL STEM $= \pi r^2$

CIRCUMFERENCE OF INTERNAL STEM $= 2\pi r$

$$\text{So} \quad A = \frac{C^2}{4\pi}$$

AREA OF INCREMENTAL ANNULUS

$$= \pi (R+S)^2 - \pi r^2$$

$$= \pi (2RS + S^2)$$

$$R = \frac{G_0}{2\pi} \qquad R+S = \frac{G_1}{2\pi} \qquad S = \frac{G_1 - G_0}{2\pi}$$

$$A = \pi \left( \frac{G_0}{\pi} \frac{G_1 - G_0}{2\pi} + \frac{(G_1 - G_0)^2}{4\pi^2} \right)$$

$$= \frac{1}{4\pi} \left( G_1^2 - G_0^2 \right)$$

$$G_1^2 = G_0^2 + C^2 + C_1^2 + C_2^2 \text{ etc.}$$

$G_1$ = Notional girth of tree
$G_0$ = Measured girth of tree
$C$ = Measured girth of internal stem
$C_1$ = girths of further internal stems.

The last equation in the series above is the one we use; the square of $G_1$ which is the notional girth of the whole yew bole is equal to the square of the measured girth of the yew $G_2$ plus the squares of the girths of each of the internal stems, $C_0$ $C_1$ etc. So we total the squares of the girths of the bole and all the bole associated structures on the yew, and find the square root of the sum. The result is the notional girth of the yew.

The Soberton yew is a real example. It was 688 cm in girth at the minimum point when killed by topping ($G_0$). It had lost part of its north side, but it is not known whether any girth was lost as a result. That makes it Veteran, almost but not quite Ancient by our classification. The yew also had an internal stem 185 cm in girth ($C_0$). To find the notional girth of the yew, we square these two measured girths and add the results together.

688 x 688 = 473344 185 x 185 = 34225 473344 + 34225 = 507569
Square root of 507569 = 712
The notional girth of the yew ($G_1$) is 712 cm, and it is confirmed Ancient.

# 17 Unclassifiable by Girth- Cliff Yews

A-clif V-clif Yew growing in cliff or extreme cliff-like situation

A specie as complex as the yew is bound to have exceptions to every possible rule. Cliff yews are a particularly difficult class to categorise and age by our method because the method is girth- based, and the cliff yew can seldom be girthed. The advice of a number of able and experienced cliff yew researchers has been sought.

The experts are: David Alderman, Paul Greenwood, Tim Laurie and Rob McBride.

Assessment and categorisation of Ancient, Veteran and Notable cliff yew specimens will be carried out by these experts and their associates. Works done by Toby Hindson and Tim Laurie are reported below, giving an insight into, and illustrating some of the difficulties presented by this class of yew.

*Kingsdale, Twistleton Scar in North Yorkshire during 2009. Above, a yew sculpted against the cliff to take advantage of the wind voids. Below, a fallen and weathered stem sample from the same yew against a mm scale. There were 85 rings in a 34 mm radius. The widest was 0.8 mm; the narrowest was 0.2 mm. Approximately 60% of the original radius remains in a fit state to study.*

Cliff yew evidence

Brief notes on a case study 2009

The yews on Twistleton Scar are classic examples of low growth rate individuals, and are impossible to girth primarily because of their habit but also because of their location; they can only be reached for close inspection by experienced climbers with appropriate equipment.   Amateur attempts at reaching these yews will be unsuccessful and may easily result in death.

The yews are extremely slow growing, and of very substantial age, the weathered and centrally rotted partial radius pictured above was from a stem that must have died over 40 years ago, and will have taken considerable time to grow to the point at which it was sampled.   It was unlikely to have been a part of the original growth; yews like this constantly loose and renew branch material by re-sprouting from wind fractured branch stumps, and from the stool that protrudes from the rock face.   It is unlikely that any part of the yew is original except the root system and the stool.   The yew's shape is dictated by the shape of the cliff, and its wind currents.   Where the cliff forms a shape that makes a "harbour" or calm void where yew material can survive and grow, the yew takes advantage.   Beyond that sheltered space the living material cannot survive and branches which overgrow into the path of the wind during a run of mild seasons are torn off in due course by high winds.

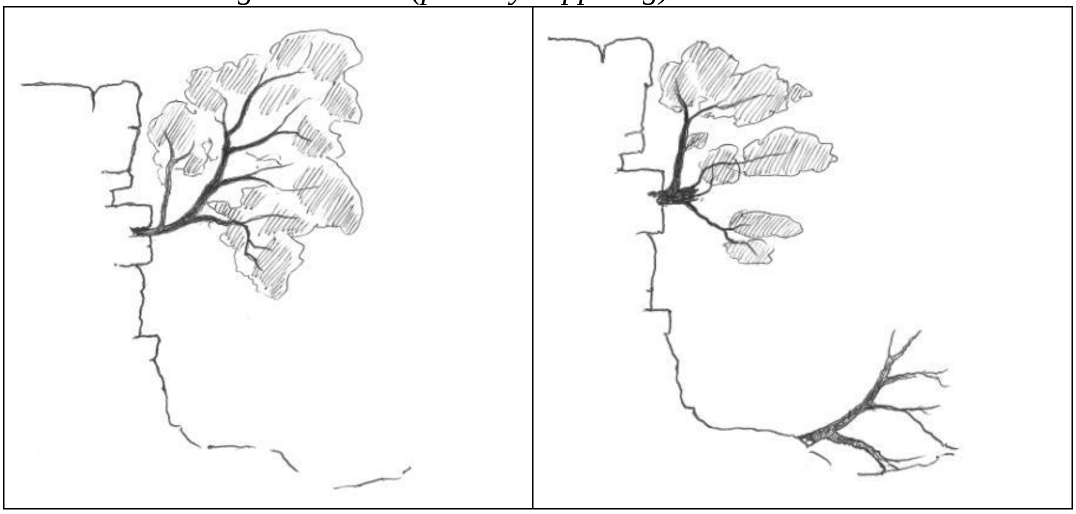
We have no idea how old the pictured individual is, and probably never will, however in order for this particular yew to take advantage of the available wind void space on the cliff by trial and error, and given that the conditions are extreme, thus causing a very low growth rate; we place the yew in the Veteran category at least.   We hope that a way can be found to age the yews here more accurately, as some of them may well be Ancient.   At present, ways of looking at the effect of the yew on the rock formation is being tentatively assessed as a possible way forward in aging.

## A basis for cliff yew categories

Written in collaboration with Timothy Laurie of Swaledale and Arkengarthdale Archaeology Group, quotations from his writing in personal correspondence are in *"italics and quotations."* Tim has produced the insights into the processes involved in cliff yew development described and illustrated here.

Some stages in the development of cliff yews.

*Snow/wind damage to maiden (primary coppicing)*

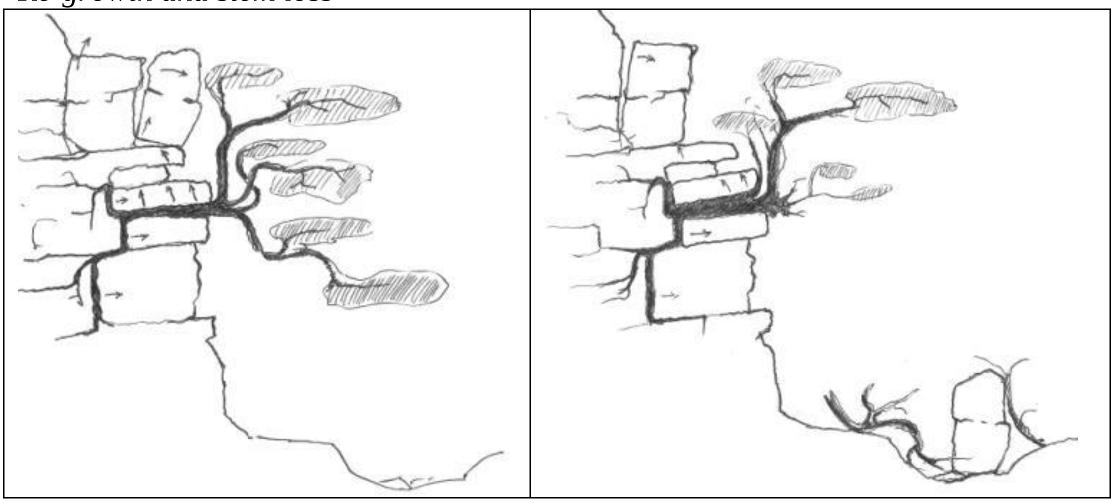


*Maiden* *Coppice*

Maiden: A single stem with few signs of damage and subsequent re-growth.

Coppice: The maiden yew has been broken and may be regenerating, but has not yet produced substantial new stem material. A coppice may also be an unbroken yew which has grown multi stemmed in the first instance.

*Re-growth and stem loss*



*Secondary Coppice* *Veteran/Ancient Coppice*

Secondary Coppice

The diagram shows interaction with the cliff face, root activity and rock fall damage. Snow and wind damage still occur.

In a secondary coppice the stem material is mature, and growing from a stool which shows evidence that previous wood loss or death, and regeneration of canopy has occurred, for instance dead yew stem material at the cliff base, and broken stem bases on the yew stool. There is likely to be root damage to the cliff face.

Veteran/Ancient Coppice

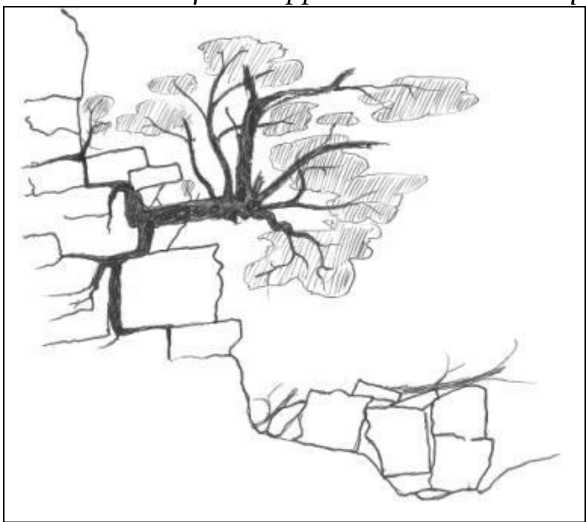
The root material is more or less substantially exposed because of damage to the rock face caused by root activity. The roots grow horizontally under the surface of the cliff face as well as into the cliff as shown in the cross sectional diagram. There may be epicormic growth on the roots. The outermost projection of the stool shows signs of substantial stem loss, and may have rotten zones on it. The stool centre may have “retreated” from its original point of issue from the rock because of continual breakage and re-growth of outermost parts of the tree.

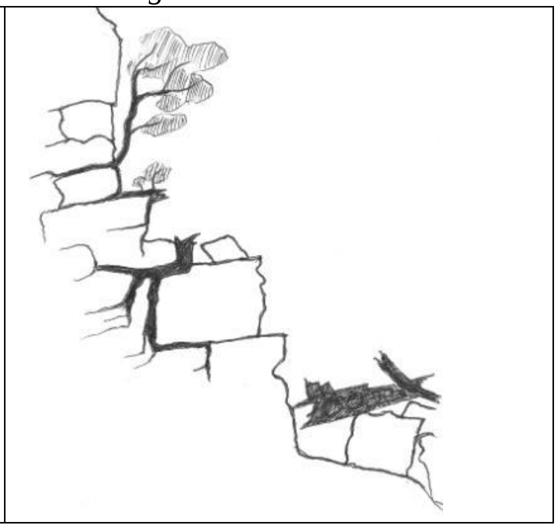
Petrified root systems

*“David Alderman has made the point that the presence of exposed petrified root systems is diagnostic of great age... the presence of this feature is a criteria for the designation Ancient to cliff yews when present. Petrified roots are not however to be considered as a precondition to the designation 'Ancient', rather as a supporting feature 'when present'.”*

The petrified root is composed of weathered dead material, appearing the same as the preserved dead regions of bole found on the famous bristlecone pines in the Nevada desert. A structure like this will be of substantial size.

*Destruction of the coppice stool and subsequent root regeneration*





*Exposed Root Shank (exaggerated)* *Root System Regeneration*

Exposed root Shank

Root shanks may be cylindrical bundles of fused root, or plate formations that show the former shape of the confining rock strata, or they may be trunk-like, possibly with tell-tale minor roots growing away from them, or distortion from the confinement of the original rock fissures. Unlike the petrified root material they have some living cambium. As a rule of thumb the harder and less fissured the rock face material, the older a yew of this sort is likely to be.
*"...the controlling factor on the life expectancy of cliff yews appears to be related to the mechanical strength of the rock face footing of the tree. Yew (and ash) roots have the capacity to completely destabilise a cliff face and when heavy snow fall increases the tree load substantially the tree falls away from the cliff taking a fair amount of the cliff with it."*

Root Regeneration

*"... there are very clear examples of yews on cliffs which are conjoined by connecting roots which were once within the rock face -now exposed at the surface."*

Proven clones of old cliff yews exist, some still attached by root sections at some distance from the original yew. These specimens are categorised as part of the original tree whether the original bole still exists or not, and are Veteran or Ancient in the same way. All are at least Notable.

Small living sections of Ancient cliff yews will, all being well, continue to grow and become large specimens.

*"This residue of the original tree can now continue to grow to the maximum dimension and weight that the mechanical strength of the rock face will allow and then again fall leaving a section of tree..."*

Classification

As aging is very difficult or near impossible at present, the cliff yews will be classified Notable, Veteran or Ancient according to the expert's view of the time span taken to go through the various described growth and bio-geological processes relevant to the particular individual. A target age of 500 years is used for Veteran, and a target age of 800 is used for Ancient, but a balance of probability philosophy is applied rather than the scientific proof requirement needed elsewhere in the protocols system. The category Notable is applied according to the judgement of the individual researcher.

Site Classification

Because cliff yews are almost invariably part of a community of vegetation, and because the geology of the cliff is fundamental to an understanding of the growth processes of its yews, we agree with Tim Laurie's assertion that cliff yews should be considered within the context of a site record. An example of one of Tim's site records follows, and is commended to other researchers as a useful, flexible and simple recording format. The example below is very heavily edited to show the format on a single page. The full content of this record, which runs to over 1,000 words, can be found on the Swaledale and Arkengarthdale Archaeology Society website.

# Swaledale Ancient Trees and Woodland HER

## **SITE** record form: ELL.S1: Extract for illustration.

| | |
|---|---|
| **SWAAG Site Record Number:** | |
| **Site Ref:** | **ELL.S1** |
| **Location, Civil Parish and Site Name:** | **Ellerton Abbey CP. Ellerton Scar. See photos ELL.1.01-04...** |
| **NGR:** | **SE085,966 (West)...** |
| **Surveyor and Survey Date:** | **Tim Laurie 28.05.2010** |
| **Site Access:** | **The northern boundary of the Army Range runs along the top of Ellerton Scar...on private land, no public...** |
| **Site Elevation m AOD:** | **Elevations (indicative):**<br>**Top of Scar:** 320m OD.<br>**Top of talus slope below Scar:** 300m OD... |
| **Site Geology and Morphology:** | **Site Type:**<br>**a) Limestone cliff formed from massively bedded strata of...** |
| **Site Description:** | **Ellerton Scar is** rarely visited and probably relatively unknown to the visitor and Swaledale resident alike, in truth the jungle of Borneo is probably more familiar to the general public than is the yew woodland... |
| **Aspect** | **Aspect:** Ellerton Scar is aligned on a South West-North East axis and is fully exposed to the prevailing winds ... |
| **Common Species Present:** | **Face of the Scar:** Species rich L**imestone ashwood** with much ash, yew, and wych elm (mostly dead but with many young regenerating shoots from old stumps) hazel, elder, rowan, sallow **(see photo ELL.S1.9),** ... |
| **Notable trees** | **Prostrate or dwarf (alpine) juniper, *Juniperus communis ssp nana...*** Two shrubs on top of detached limestone stack, central section. **(See photo ELL.S1.10, 11).** If confirmed.... 4. Yews with enlarged and convoluted root systems. **See photo ELL.S1.17** |
| **Death and birth: Regeneration** | **Many Wych elms have been lost however regeneration from the elm base stumps does occur. Yew seedlings have not been recorded on the Scar or scree so far.** |
| **Additional Notes:** | |
| **Site Image Number(s)** | **Site Image Description(s):** |
| **1) ELL.S1.1** | The Scar, view eastward from kame terrace. |
| **2) ELL...** | Etc... |
| **View Additional Images:** | |
| **5) ELL.S1.5** | The uppermost fringe of the cliff. Rowan, note destabilisation of rock face by roots. West Section. |
| **ELL.S1.5A** | The uppermost fringe of the cliff. Ash and yew. Dwarf Juniper (J. comm. ssp. nana) on isolated stack. West Section. |

SITES:
Each site has a unique Site Code derived from the Parish Code, the letter S (for Site) and a sequence number e.g. Parish Code.S+sequence number. For example sites 1 and 2 in Muker parish would have codes: MUK.S1 and MUK.S2 respectively. It is this code that links Site and Tree records.
Site Images are numbered in the format: *Site Code.sequence number*. For example images 1 and 2 for the second Muker site would have image numbers: MUK.S2.1 and MUK.S2.2 respectively.

## 18   Further Work

Although the Protocols cover a great deal of ground, there is a huge amount of work still to do.   Particularly, analysis of dated avenues needs to continue, so that the universal curve in Chapter 2 can be refined.    As much data as possible from felled, girthed and ring counted yews must be gathered from various parts of the UK and Ireland, so that the geographical application can be further verified.   Almost every chapter offers a “hook” for further investigation.

A particularly important field, as yet a blank canvas for researchers, is the genetic typing of slow and fast growing yews.   We hope that the genes or gene combinations for various growth patterns can be found, so that very slow growing types can be identified.   The low girth yews which are Veteran and Ancient could then be identified, classified, and protected.

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