

Tree rings: a climate record of the past (teachers' notes)

Level

This activity provides an example of one technique that scientists use to study the way the Earth's climate has changed over time.

English National Curriculum reference: 4.3.2p

It works most effectively for 14-16 year-olds but with a little simplification, or shortening, can work well with 12 and 13 year-olds too.

Topic

Tree growth can be affected by **climatic cycles** and **seasonal cycles**. The width of a **tree ring** shows the amount of growth that has taken place during one year and thus indicates the growing conditions for that year. When the conditions are good the tree grows faster and so lays down more tissue in the year, resulting in a wider growth ring. Poor conditions mean slower growth, less tissue laid down and consequently a narrower ring.

Description

In this activity students learn about how tree rings provide a record of past growing conditions and, by inference, climate. They use this principle to work out how cores from three different trees (three strips of paper marked with stripes to represent rings) fit together to represent a longer period of time and then use this composite record to plot a graph of changing growing conditions / climate.

Context

Students doing this activity should already be familiar with the processes of **photosynthesis** and the conditions necessary for plant growth. They might have carried out experiments on factors affecting the rate of photosynthesis / growth in previous lessons (eg the concentration of carbon dioxide, temperature, light availability). Most students will have seen the sawn-off end of a tree trunk and attempted to work out the tree's age by counting the rings. But tree rings tell us much more than the age of individual trees. They provide a year-by-year record of changing climate that can be extended back over centuries, reaching back beyond the beginning of the historical climatic record. This makes them valuable tools (along with other proxy records of past climate) for identifying whether current trends in climatic change are within the natural, pre-industrial, range of climate variability or outside it, and for dating past climatic changes very precisely.

Teaching points

Tree rings form because during each growth season new water and food conducting cells (tracheids) are added around the perimeter of the tree trunk. Cells in the spring growth tend to be larger with thinner walls than the previous set of cells produced at the end of the previous summer. Over the course of the growing season, successive rings of cells become smaller with increasingly thick walls. In winter, growth ceases and no new cells are laid down. Then when the new growing season begins, thin-walled large cells form again producing a clear line between the old wood and the new wood because of the difference in texture.

Tree rings provide a record of past climate because their width is determined by tree growth rate, which in turn is determined by environmental conditions. Since one ring is produced every year (usually) the ages of the climatic events can be worked out

very precisely by counting back. Records from young trees, old trees, house and ship timbers and fossil trees can be tied together by identifying sections with the same sequence of climatic events – the records overlap in time where the climatic patterns they record match up. This allows **dendroclimatologists** to push back the year-to-year record of climatic conditions to long before the start of instrumental record-keeping.

Apparatus and materials

Pencil

3 paper strips representing cores taken from trees (see Figure 1 and Figure 1 in the students' material)

Pupil worksheets

Scissors

Ruler

Sticky tape

Coloured pencil

Cut cross-section of tree (ask local forest ranger) or a tree stump outside

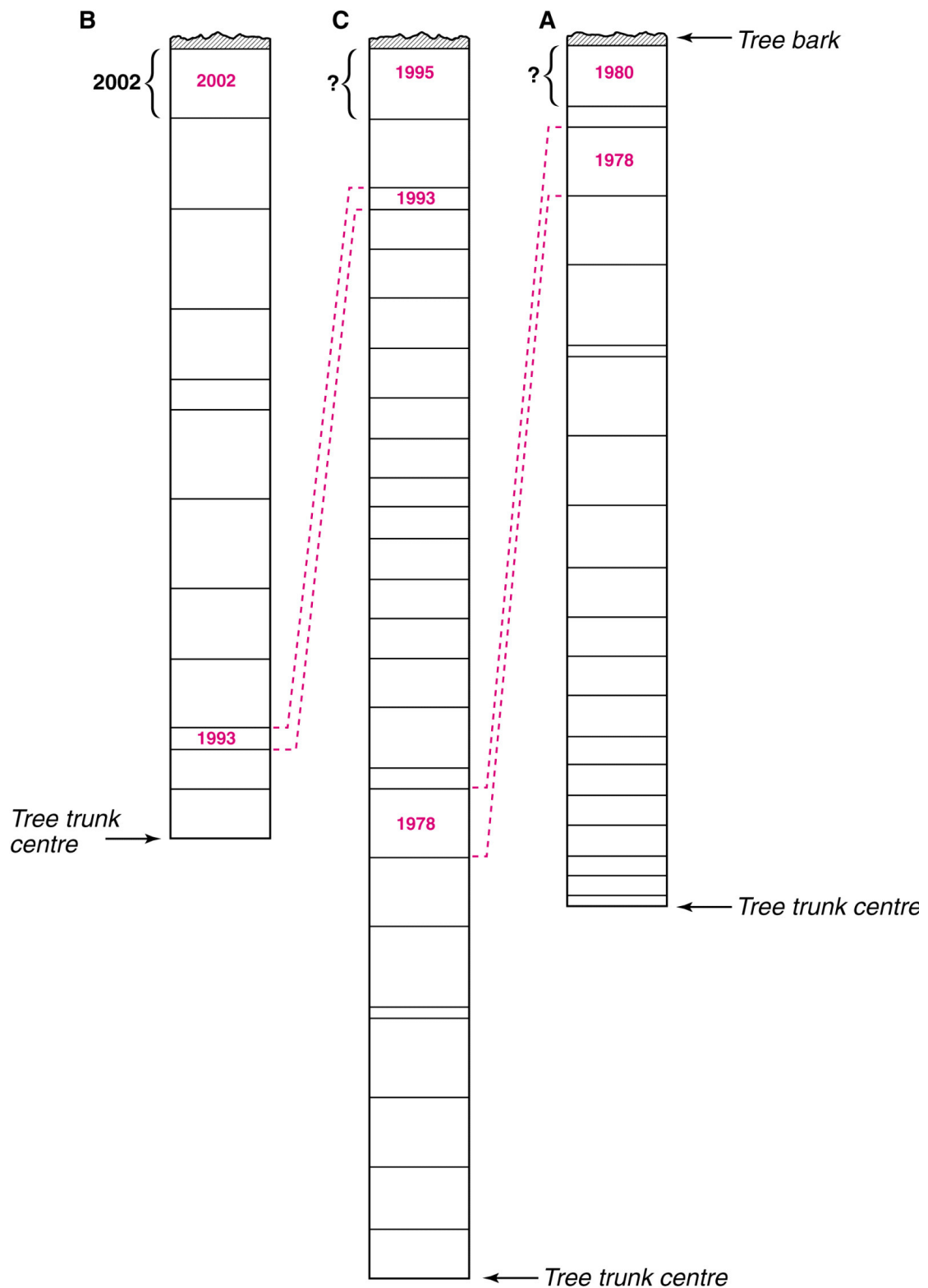


Figure 1 Simulated tree cores

Activity

Introduction

Hold up (or project on to wall) a picture of an old tree: this tree could preserve a hundred years (possibly more) of climatic history.

Ask students what affects the growth of a tree during a growing season. Here revise factors affecting photosynthesis *ie* temperature, light, carbon dioxide concentration, water availability.

Consider the growth rings on the tree cross-section, picture or stump outside. Ask students how they think they form, what they represent, what they might be useful for *etc.*

Explain that scientists (**dendroclimatologists**) can get a sample of the tree's growth rings by drilling a borehole into the tree (right to the middle) and extracting a core. You could demonstrate the principle with an apple or a potato and a corer.

Main activity

This section gives the students the opportunity to sample the techniques involved in reconstructing climatic history from tree rings.

Students work in groups using the pupil worksheet. The teacher should talk them through it first.

Students are given a set of three prepared strips of paper – they represent cores taken from three different trees (a living tree sampled in 2002, a fallen tree and a tree used to build a log cabin) from the same woodland. Show how each rod or strip of paper represents a core of wood taken from a tree trunk with one end representing the centre of the tree and the other representing the bark on the outside. The youngest wood is under the bark.

Using the simulated core samples, students can work out the age of each tree when the core was taken (in the latter two cases, when the tree died) and record them in a table like Table 1.

Tree sample	Number of rings (= age in years)
A	20
B	12
C	25

Table 1 The ages of different trees

By looking at the ring patterns of the simulated cores, students can line up all three samples to find how much time all three tree samples span together. They could colour the overlapping sections so that they don't lose track. The core samples were taken from trees whose ages 'overlap'. Given that the trees are of the same species and all grew under similar conditions the tree-rings will therefore be the same distance apart in the same year. With this information it is possible to match up the rings as shown in red in Figure 1 and count the rings to give the two 'unknown' growth-years. The diagrams for each sample can be cut out and laid side by side to see this more clearly.

Pupils should then measure the width of each tree ring, for each core sample, and record them in a table such as Table 2. (Grey indicates sections where two strips overlap.) There is no need to record the overlapping sections twice. Plot the ring-width data (on the y-axis) against time (on the x-axis). They should plot 2002 on the left (conventional for **palaeoclimatic** data). This will give a graph like Figure 2.

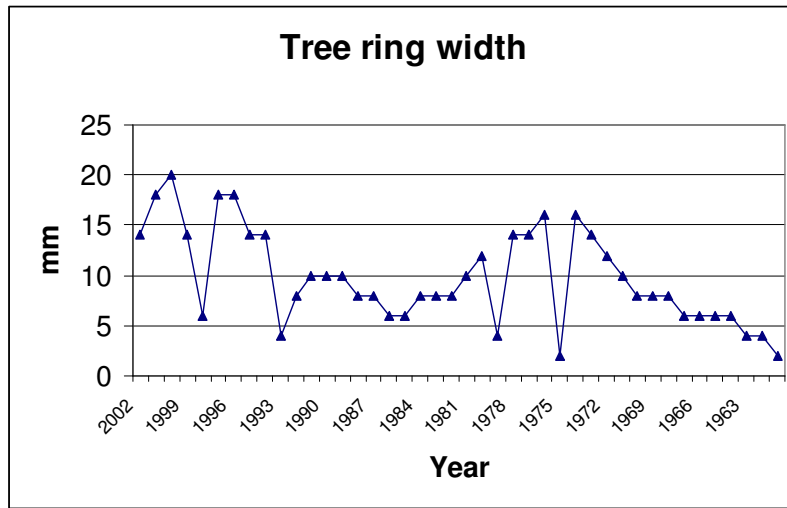


Figure 2 Graph of tree ring width against year

Year	Tree ring width / mm
2002	14
2001	18
2000	20
1999	14
1998	6
1997	18
1996	18
1995	14
1994	14
1993	4
1992	8
1991	10
1990	10
1989	10
1988	8
1987	8
1986	6
1985	6
1984	8
1983	8
1982	8
1981	10
1980	12
1979	4
1978	14
1977	14
1976	16
1975	2
1974	16
1973	14
1972	12
1971	10
1970	8
1969	8
1968	8
1967	6
1966	6
1965	6
1964	6
1963	4
1962	4
1961	2

Table 2 The widths of tree rings

Then they should consider these questions:

- Q 1. Compare the ring for the year you were born with the ring for 2002. How do they compare? Note down any similarities or differences. What might have caused these?
- Q 2. What does your graph of tree-ring width against time represent? = *Growing conditions: wider rings represent better growing conditions, ie warmer and wetter. Narrower rings represent worse growing conditions, ie cooler and drier. Hence, it provides a broad record of climatic conditions between 2002 and 1961.*
- Q 3. Give a brief and general description of how the climate changed during the period that your tree samples represent.
- Q 4. How could we obtain climatic information further back in time than tree rings provide? = *Ice cores can give climatic information back to over thousands of years, sediment cores from the ocean bed can give climatic information over millions of years, rocks give climatic information spanning hundreds of millions of years.*
- Q 5. If carbon dioxide levels are rising and global warming continues, what differences would you expect to see in the tree rings between the modern ones and those laid down in 100 years time? = *Future rings would be wider.*

Conclusion

As a class, consider other factors that may have influenced growth. For example fires, pollution, erosion, landslides. Also consider some of the problems with matching up samples from different trees: certain factors influencing tree growth may be very local in effect. A landslide or erosion for example might only affect one tree in a woodland, so it might give a narrow ring for a year when other trees just a little bit further away have a wide ring.