Introduction to Crossdating

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Dendroecology Pre-session

1444 fire scar
Tree-ring crossdating: An annually precise paleo dating method

Other paleo dating methods:

• Relative
  
  **Stratigraphic** – older layers buried beneath younger layers (geologic context), but can’t assign accurate age

• Radiometric - based on radioactive decay
  
  **Radiocarbon** $^{14}C$ – can provide dates for ~ last 50,000 years, but has **error of decades to centuries**. *Calibrated with tree-rings due to atmospheric variations of $^{14}C/^{12}C$ geographically and through time.*
Shared pattern of ring growth makes crossdating possible

- *Quercus* (oak) timbers from locations in Ireland up to 200 km apart. Note similarity of patterns - marked year is AD 1580

Baillie, 1982
Definition: “Crossdating is the recognition of the same ring pattern in different trees, so that the actual growth date of any one ring of the pattern is the same in the different trees and one may carry a chronology across from tree to tree.”
A.E. Douglass (1941) – Journal of Forestry

• Revolves around pattern recognition
• Three basic techniques:
  1. Graphical techniques (skeleton plot)
  2. Statistical techniques
  3. Memorization techniques
Example of matching ring-width patterns

Plate VII.—Study in crossdating. Display of JCD signatures from different localities.
Crossdating

Two techniques:

- Skeleton plots (common in the U.S.)
- Alignment plots (common in Europe)
Crossdating can be used to extend a chronology back in time by overlapping older and older samples and matching growth patterns.
How is cross-dating between different trees (and even between species) possible?

1. Tree (ring) growth cannot proceed faster than is allowed by the most limiting factor to the physiological processes of ring formation.

2. If trees have the same limiting factor, the pattern of year to year variation in ring properties will reflect the variation in the limiting factor. Hence they will show similar growth patterns.

3. For example: tree rings from dry regions often reflect variations in moisture availability, and those from cold regions reflect growth season temperature.
1750AD ring-width “signature”

1747 wide - 1748, 1750, 1752 small
Why is this ring pattern replicated throughout the SW?

Limiting factor for tree (ring) growth in these semi-arid montane forests is predominantly \textit{winter precipitation} and …

Winter storms are geographically widespread throughout the SW:

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{B_Calibration_Period_Precipitation.png}
\caption{B. Calibration Period Precipitation}
\end{figure}

\textit{r}^2 = 0.74

Salzer & Kipfmueller 2005
A low value on the graph below indicates small rings on average in that year, a high value, big rings.

Hughes and Brown, 1992

Figure 3. Ring-width indices for Camp Six (CS), Giant Forest (GF), and Mountain Home (MH) from A.D. 1500 to 1800.
Why do sequoias have synchronous small or missing rings?

Most of the time the tree rings are not much affected, but, sometimes, the soil gets dry enough to limit growth throughout the region.

Hughes et al., 1990
Larch trees at 70 degrees North also show strong cross-dating. Why?
So you just count the rings, right?

Missing Rings

Four missing rings from 1893 – 1905!
Other challenges for crossdating

False rings

Juniper spp.
Skeleton plots

• Simple graphical representation of the ring width pattern in a sample (focusing on narrow rings)
Skeleton plots

• “This count of small rings then is turned into a skeleton plot….these deficient rings expressed in vertical lines from the base of a long paper strip, the length of line being greater for more deficiency and specially long or dotted for absences. These can easily be compared together for the satisfactory relative place of each specimen and a composite made that can be compared with a master chart if one has been made.”

A.E. Douglass. 1946. PRECISION OF RING DATING IN TREE-RING CHRONOLOGIES. University of Arizona Laboratory of Tree-Ring Research Bulletin No. 3.

Figure 1.—Above, skeleton count; below, skeleton plot. (Carn. Inst. Wash. Publ. 289, Vol. III, 1936, p. 24.)
Skeleton plotting – uses

1. **Quick** way to find dates of wood at a site with an existing chronology
2. To develop a **master chronology** at a new site
Skeleton plotting online tool developed by Dr. Paul Sheppard:
http://www.ltrr.arizona.edu/skeletonplot/introcrossdate.htm
Now everyone gets to make their own skeleton plots
Skeleton plot required elements

- On the far left side: name ("E.Q. Margolis"), date, sampleID, and radius (e.g., "A")
- 5 spaces in: Inner ring "Flag" and inner ring descriptor ("pith" or "Inc."). Flag filled if pith, open if Inc.
- "0", "10", "20", …… every 10 squares on top of plot
- Final ring "Flag," filled if complete, unfilled if incomplete.
- Final ring descriptor: (Inc., or Complete, Bark).
- Descriptors on special rings (e.g., Big ["B"],False ["Fls"], Frost["Frst"], Injury ["Inj"], or Locally Absent ["LAb"])
Final Quote from A.E. Douglass

“The most efficient and at the same time the most convincing method of crossdating is by that of memory, which develops on examining scores of specimens of approximately the same age in which similar patterns are identified in the great majority of case.” (1941)

Final Final Quote from Rex Adams

“Surface, surface, surface”
• ZMT = Zuni Mtns
• All species collected from same area so they experienced the same climate and therefore should crossdate
Plot 2 radii for each piece (A & B)

If it looks like a ring, then it’s a ring
Skeleton plots

- Put **at least one real calendar date** on the finished skeleton plot.
- This makes it easy to transfer the dates to the wood.
- Ideally you mark the inner and outer ring dates (and maybe key small rings).
<table>
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<th>SPECIMEN ID</th>
<th>Species</th>
<th>Site ID</th>
<th>ZMT</th>
<th>BLF</th>
<th>Collection date</th>
<th>Sample type: cores ✓ Xsections ✓ Other</th>
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<td>B</td>
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</tbody>
</table>

Remarks, comments, observations: micro rings, absent rings, etc.

Frost rings: 1945, 1950, 51, 67, 79
Building a composite master chronology