

SUPPLEMENTARY MATERIALS

**TRICYCLE: A UNIVERSAL CONVERSION TOOL FOR DIGITAL
TREE-RING DATA – SUMMARY OF DENDRO DATA FORMATS**

PETER W. BREWER*, DANIEL MURPHY

The Malcolm and Carolyn Wiener Laboratory for
Aegean and Near Eastern Dendrochronology
B48 Goldwin Smith Hall
Cornell University
Ithaca NY 14853. USA

and

ESTHER JANSMA

Faculty of Geosciences
Utrecht University
Utrecht. The Netherlands

Cultural Heritage Agency
Rijksdienst voor het Cultureel Erfgoed (RCE)
Amersfoort. The Netherlands

*Corresponding author. Email: p.brewer@cornell.edu

Contents

Introduction	4
1 Belfast Apple	5
2 Belfast Archive	7
3 Besançon	9
4 CATRAS	11
5 Comma Separated Values	15
6 Corina Legacy	17
7 DendroDB	20
8 Heidelberg	22
9 Microsoft Excel 97/2000/XP	26
10 Microsoft Excel 2007	28
11 Nottingham	29
12 ODF Spreadsheet	31
13 Oxford	32
14 PAST4	35
15 Sheffield	39
16 Topham	42
17 TRiDaS	43
18 TRIMS	47
19 Tucson	48
20 Tucson Compact	52
21 VFormat	54
22 WinDENDRO	57

References

Introduction

This is a supplementary document to the Brewer *et al.* (2011) article published in *Tree-Ring Research*. This document contains a summary of the dendro data formats supported by the TRiCYCLE[†] software and libraries as of May 2011. Many of these formats have never been formally published or documented. Much of the information containing in this document has been obtained via personal communications with developers and knowledgeable users and by the study of example data files. It is therefore possible that there may be errors and omissions. The TRiCYCLE software is under active development so support for additional formats may be included in the latest release. An up-to-date version of this summary is available as an appendix to the TRiCYCLE manual. See <http://www.tridas.org/tricycle> for further details.

Where practical, this document includes examples of each format. These are included for illustrative purposes only. A number of these files have been truncated to enable them to be included, so they may not be valid as they are presented. All examples are either fictitious or heavily modified so should not be considered real data.

[†]TRiCYCLE is a portmanteau of the words TRiDaS (acknowledging the importance of the data standard to the tool—see Jansma *et al.* (2010) for more information) and recycle (to highlight the process of making data reusable).

Format 1

Belfast Apple

Format name	Belfast Apple
Other name(s)	None known
Type	Text file
Extension(s)	Various (typically txt and dat)
Read/write support	Read and write
Reference implementation	No original software is known to exist so TRiCYCLE is proposed as the reference implementation
Data / metadata	Data only with comment
Calendar type	n/a
Absolute dating support	No
Undated series support	Yes
Relative dating support	No
Multi series support	No
Original designer	John Pilcher

1.1 Description

Belfast Apple is a simple text file format (see also Belfast Archive) originating from the Queens University Belfast lab and originally designed for use on an Apple II computer. This format is not known to be actively used but a large amount of data (especially at Belfast) is archived in this format.

- Line 1 - name of the site or object the data refers to.
- Line 2 - identifier for the sample the data refers to.
- Line 3 - number of data values in the file
- Lines 4+ - line feed delimited data values as integers in 1/100th mm
- Final line contains a comment typically starting with 'COMMENT -'

1.2 Example file

```
1 EXAMPLE SITE
2 A1805
3 106
4 188
5 165
6 184
7 112
8 103
9 111
10 239
11 226
12 132
13 143
14 146
15 140
16 100
17 176
18 139
19 124
20 115
21 78
22 80
23 156
24 75
25 110
26 80
27 130
28 83
29 157
30 99
31 115
32 102
33 110
34 108
35 87
36 135
37 107
38 96
39 70
40 128
41 119
42 86
43 101
44 106
45 129
46 88
47 101
48 151
49 106
50 97
51 110
52 97
53 91
54 93
55 100
56 124
57 99
58 134
59 125
60 105
61 96
62 107
63 142
64 100
65 COMMENT -- PB 15--NOV--99
```

Format 2

Belfast Archive

Format name	Belfast Archive
Other name(s)	None known
Type	Text file
Extension(s)	Various (typically arx, txt and dat)
Read/write support	Read only
Reference implementation	No original software is known to exist so TRiCYCLE is proposed as the reference implementation
Data / metadata	Data with limited metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Martin Munro

2.1 Description

Belfast Archive is a simple text file format based on the original Belfast Apple format at the Queens University Belfast lab. It shares the same features as Belfast Apple but with the addition of a number of metadata fields at the end of the file.

- Line 1 - name of the site or object the data refers to.
- Line 2 - identifier for the sample the data refers to.
- Line 3 - number of data values in the file
- Lines 4+ - line feed delimited data values as integers in 1/100th mm
- The lines "[[ARCHIVE]]" and "[[END OF TEXT]]" denote the start and finish of the metadata section

The metadata section contains the following lines:

- Line 1 - start year as an integer.
- Line 2 - unknown
- Line 3 - Double representing the resolution of data values e.g. .1= 1/10ths mm, .01 = 1/100th mm, .001 = microns etc
- Line 4 - unknown

- Line 5 - unknown
- Line 6 - unknown
- Line 7 - title of the data series
- Line 8 - unknown
- Line 9 - unknown

2.2 Example file

```
1 EXAMPLE SITE
2 1
3 176
4 342
5 338
6 334
7 409
8 362
9 308
10 360
11 264
12 325
13 318
14 51
15 48
16 47
17 60
18 49
19 48
20 "[[ARCHIVE]]"
21 1277
22 9177
23 .01
24 1.035795
25 0.212144
26 BOB 25/03/95
27 EXAMPLE SITE #01
28 Pith F Sap 32
29 ""
30 "[[ END OF TEXT ]]"
```


Format 3

Besançon

Format name	Besançon
Other name(s)	SYLPHE
Type	Text file
Extension(s)	txt
Read/write support	Read and write
Reference implementation	Not known
Data / metadata	Data and some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	No
Multi series support	Yes
Original designer	Georges Lambert

3.1 Description

The Besançon format is most commonly used in a number of French laboratories. The format allows for multiple series in the same file. Each series (or element block in Lambert's notation) is made up of a header line, optional metadata and a data block each of which are delimited by a line feed.

The header line begins with a dot character, then one or more spaces, then an element name (without spaces) followed by a space and any number of ignored characters.

The metadata fields are space or line feed delimited. Each field is recorded using a key of three letters. The format allows for the full spelling out of the field if preferred, but it is the first three letters that are read by software so LON is the same as LONGEUR. Some fields are 'unimodal' in that their presence is all that is required e.g. CAM means that cambium was observed. Other fields are 'bimodal' which means they require a value to be associated with them. In this case the field key is followed by a space and then an integer or string value e.g. POS 1950. The accepted metadata fields are as follows:

LON Number of data values

POS The temporary first ring date given relatively to a group

ORI The year for the first ring

TER The year for the last ring. Should be the same as ORI + LON

MOE Pith present

CAM Cambium present

AUB Number of the first sapwood ring

All other information in the metadata block should be ignored. This feature is often used to allow the inclusion of multi-line comments.

The data block begins with the marker line VAL (like metadata keys, subsequent characters are ignored so sometimes the rest of this line is used for comments). Subsequent lines contain integer values delimited by a space or line feed. Missing rings are marked with a comma character and the end of the data is marked with a semicolon.

3.2 Additional information

- There is nothing in the specification to say what precision the data values should be in. Following conversations with users it appears that Besançon files are mostly 1/100th mm but this is not always the case. Some files include a Précision field, but this is not documented or standardised.
- There are a number of additional fields that are commonly used but which do not appear in the format specification. These are also supported by the DendroFileIOLib

ESP Species

ECO Bark present

3.3 Example file

```

1 . abc22/43
2 Lon 129
3 Esp quercus sp Nat lambris
4 Precision 1/100
5 Moelle non presente
6 Aub 0
7 valeurs
8 149 119 156 146 170 187 197 146 191 177
9 137 108 160 108 120 177 136 174 190 109
10 189 176 170 162 114 126 133 152 146 127
11 119 131 146 133 147 82 57 77 77 82
12 96 49 97 76 88 82 72 83 81 90
13 85 87 78 104 111 132 141 105 104 120
14 111 121 115 89 94 88 90 115 111 106
15 107 120 80 92 98 84 97 82 100 86
16 99 65 85 113 90 82 57 57 99 94
17 95 105 120 110 93 96 131 133 123 122
18 113 119 95 127 88 104 , , ,
19 , , , , , , , , ;

```

Format 4

CATRAS

Format name	CATRAS
Other name(s)	None known
Type	Binary
Extension(s)	cat
Read/write support	Read and write
Reference implementation	CATRAS
Data / metadata	Data and some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	No
Multi series support	No
Original designer	Roland Aniol

4.1 Background

The CATRAS format (Aniol, 1983) is the only known binary dendro data format. As such it can't be read by a simple text editor, and can't be imported by spreadsheet or database programs. The format was designed by Roland Aniol for use in his program of the same name. The binary nature of the format means the files are typically much smaller than text files containing similar data. The closed nature of the format originally meant that users were tied to the application. The fact that users can't manually edit the file means that the validity of files is not a problem like it is with most other dendro formats.

The format was originally decoded in the early 1990's and permission was granted by Aniol for a converter to be included in Henri Grissino-Mayer's CONVERT5 application. Subsequently others have independently released application and code that can read CATRAS files to a greater or lesser extent.

Following its original release in 1983, CATRAS was updated several times, the most recent version (v4.42) was released in 2010. The code in DendroFileIOLib is based in part on Matlab, Fortran and C code of Ronald Visser, Henri Grissino-Mayer and Ian Tyers.

4.2 Reading byte code

Reading byte code is more complicated than reading text files. Each byte is 8-bits and therefore can represent up to 256 values. Depending on the type of information each byte contains, the bytes are interpreted in one of four ways:

4.2.1 Strings

Some of the bytes in CATRAS files contain character information. In this case each byte represents a letter. In java an array of bytes can be directly decoded into a string.

4.2.2 Integers

As a byte can only represent 256 values, whenever an integer is required it is stored as a byte pair. Each byte pair consists of a least significant byte (LSB) and a most significant byte (MSB). The order that they appear in files typically varies between platforms and is known as 'endianness'. As CATRAS solely runs on Microsoft (x86) processors we can safely assume that all CATRAS files will be using little-endian (i.e. LSB MSB). The counting in a byte pair therefore works as follows:

Value	LSB	MSB
1	1	0
2	2	0
3	3	0
...
256	0	1
257	1	1
258	2	1
...

A byte pair can therefore store $256 \times 256 = 65536$ values (more than enough for most number fields).

4.2.3 Real numbers

Statistical values—such as arithmetic mean, standard deviation, first-order autocorrelation, and mean sensitivity—are given for all the ring widths and optionally for the ring widths in a restricted part of the series. The real numbers are given in standard format defined by the IEEE 754 Standard for Floating-Point Arithmetic.

4.2.4 Categories

Categories are typically recorded as single bytes as most categories have just a few possible values. They can therefore be conceptualized as being integers where 0=first option, 1=second option etc. The exception to this is for species because there are more than 256 species. In this case, a byte pair is used in exactly the same way as described for integers above. The only problem for species is that the codes are unique to each laboratory and refer to values enumerated in a separate '.wnm' file. Without this dictionary the species code is of little use.

4.2.5 Dates

The date of the creation of the series and the date of the last amendment to the series are stored as three single bytes each, one for day, one for month, and one for year. The year is stored with an offset of 1900. Therefore numbers from 1 to 100 belong to the 20th century (calendar year 1901 to 2000) and numbers from 101 to 200 belong to the 21st century (calendar year 2001 to 2100).

4.3 Metadata

The first 128 bytes contain the file header information and the remainder of the file contains the ring-width data and sample depth data (if series is a chronology). If a series is only partly suitable for further analysis then this is indicated in bytes 49–52. The quality code at position 58 is an overall rating for the series. This helps to exclude poor series from analyses other than dating.

4.4 Data

The remaining bytes in the file contain the actual data values stored as integer byte pairs. All data are stored in multiples of 128 bytes. If the number of data bytes given in the header at position 45–46 is not a multiple of 128 the file is padded with extra bytes accordingly. Padded bytes should be ignored.

4.4.1 Ring widths

Ring widths are stored in hundredths of a millimetre in the same order as the tree had been grown. When working with archaeological or geological wood it might occur that a particular ring is damaged and therefore its width cannot be determined precisely. To indicate that fact and to exclude this particular ring from further calculations its measured width is stored negative. In the CATRAS program a negative ring width will be taken into account neither in the calculation of tree curves and chronologies nor in the statistics or in comparisons with other series.

4.4.2 Chronologies

Chronology files are indicated at position 84 in the file header and contain additional data in respect to raw data files. After the block of ring width data three additional data blocks follow. Firstly the number of ring widths averaged at a particular position follows (the sample depth). Then the number of series with the same trend between subsequent ring widths at a particular position follows. Then the number of series with the opposite trend between subsequent ring widths at a particular position follows. All data blocks are stored in multiples of 128 bytes. If the number of data bytes given in the header at position 45–46 is not a multiple of 128 each block is padded with extra bytes accordingly. Padded bytes should be ignored.

Bytes	Data type	Field	Description
1–32	C	Series name	
33–40	C	Series code.	Must be upper case and match file name.
41–44	C	File extension	
45–46	I	Series length	
47–48	I	Sapwood length	
49–50	I	First valid ring	Used if a portion of the series is unreliable
51–52	I	Last valid ring	Used if a portion of the series is unreliable
53	B	Scope	1=pith; 2=waldkante; 3=pith to waldkante; 4=bark; 5=pith to bark
54	B	State of last ring	0=last ring complete; 1=last ring only early wood
55–56	I	First ring	Calendar year of first ring: 0=not dated; <0=B.C.; >0=A.D.
57	B		Number of valid characters in series name
58	B	Quality code	0=not known; 1=very good . . . 5=uncertain
59–60	I	Species code	Requires an associated catras.wnm file
61–63	D	Creation date	DMY, Y offset 1900
64–66	D	Last updated	DMY, Y offset 1900
67	B	Real number format	normally 1=IEEE
68	B	Type of series	0=ring widths; 1=early wood widths; 2=late wood widths
69–81			Reserved
82	C	Special sources	A=averaged; D=digitized; E=extern; H=manual input
83	B	Protection	0=no protection; 1=not to be deleted; 2=not to be amended
84	B	File type	0=raw; 1=tree curve; 2=chronology
85–88	C	Creator	Initials of creator
<i>Statistics for total series</i>			
89–92	R		Arithmetic mean
93–95	R		Standard deviation
96–100	R		First-order autocorrelation
101–104	R		Mean sensitivity
105–106	I		Number of rings for mean
107–108	I		Number of rings for autocorrelation
<i>Statistics for restricted part of series</i>			
109–112	R		Arithmetic mean
113–116	R		Standard deviation
117–120	R		First-order autocorrelation
121–124	R		Mean sensitivity
125–126	I		Number of rings for mean
127–128	I		Number of rings for autocorrelation

Table 4.1: Summary of the metadata portion of CATRAS files. Data types are: strings (C); integers (I); real numbers (R); binary categories (B); and dates (D). Bytes 89–128 contain descriptive statistics for the file. Bytes 89–108 concern the entire series, and bytes 109–128 a subset of the series where some poor quality data (defined in bytes 49–52) have been excluded.

Format 5

Comma Separated Values

Format name	Comma Separated Values
Other name(s)	CSV
Type	Text file
Extension(s)	Various (typically txt or csv)
Read/write support	Read and write
Reference implementation	n/a
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	No
Original designer	n/a

5.1 Description

Comma separated values format is a simple text format for representing tabular data. It is not specific to dendrochronology data and is supported by most spreadsheet and database applications. Data is delimited into columns using a comma character to indicate cell boundaries.

Support for CSV files in TRiCYCLE is limited to a particular layout of data. The expected layout is the same as for Excel and ODF spreadsheet files:

- Row 1 - Header names for each column
- Column A - Year values
- Column B+ - One column for each series containing data values. Cells are left empty if no data is available for a series because it does not extend to a particular year. Data must be continuous for each series, so missing/unmeasured rings should be included as zero.

5.2 Example file

```
1 Year , MySample1 , MySample2
2 500 , 0.33 ,
3 501 , 0.26 , 0.26
4 502 , 0.2 , 0.2
5 503 , 0.14 , 0.14
6 504 , 0.08 , 0.08
7 505 , 0.02 , 0.02
8 506 , 0.2 , 0.2
9 507 , 0.14 , 0.14
10 508 , 0.08 , 0.08
11 509 , 0.2 ,
12 510 , 0.33 ,
13 511 , 0.08 ,
14 512 , 0.33 ,
15 513 , 0.22 ,
```


Format 6

Corina Legacy

Format name	Corina Legacy
Other name(s)	Corina
Type	Text file
Extension(s)	Various including raw, rec, ind, cln, sum)
Read/write support	Read and write
Reference implementation	Corina
Data / metadata	Data and some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	Yes
Multi series support	No
Original designer	Robert 'Mecki' Pohl

6.1 Description

The Corina Legacy format is the file format used by the Corina software prior to version 2, when it transferred to using TRiDaS. The format was originally designed for use with the MS-DOS version of Corina but was also used as the native file format in the later Java versions (up to and including v1.1).

A Corina file contains yearly data (ring-width and number of samples for that year), some fixed metadata, and optionally weiserjahre data and a listing of element samples (for summed samples).

The title comes first, on a line by itself, followed by a blank line. The title is repeated later, so this is only to make it easier for people or external programs to read the title.

The *metadata section* comes next. The syntax is ;TAG value. Tags are all uppercase. Their order is fixed. Some values are terminated by a newline, others by the next semicolon. Valid tags, and their internal names are:

- ID - 8 character ID used when exporting to Tucson format
- NAME - Name of the series
- DATING - Either R (relative) or A (absolute)
- UNMEAS_PRE - Number of unmeasured rings towards the pith
- UNMEAS_POST - Number of unmeasured rings towards the bark

- FILENAME
- COMMENTS, COMMENTS2 etc - Free text comments
- TYPE - either C (core), H (charcoal) or S (section)
- SPECIES
- SAPWOOD - Count of sapwood rings
- PITH - either P (present), * (present but undateable), or N (absent)
- TERMINAL - either B (bark), W (waney edge), v (near edge), vv (unknown)
- CONTINUOUS - referring to the outer ring, either C (continuous), R (partially continuous) or N (not continuous)
- QUALITY - either + (one unmeasured ring), ++ (more than one unmeasured ring)
- FORMAT - either R (raw) or I (indexed)
- INDEX_TYPE - type of index used
- RECONCILED - Y or N indicating whether the series has been reconciled against another series

The *data section* comes next and this always starts with the line ;DATA and for reasons lost in time there are nine spaces afterwards.

Data lines come in pairs, the first line containing the year and data values, the second containing the sample depth/count for each value. For reasons unknown, the first and last data line pair have a slightly different syntax to the others.

- First data line begins with a space and an integer for the first year in the line. There then follows 9 spaces followed by the integer data value for the first ring. The remaining data values (often less than a full decades worth) on that line follow as integers left padded by spaces to take up 6 characters.
- The sample depth line that pairs with this follows next starting with 16 spaces, followed by the sample depth value enclosed in square brackets. The remaining sample depth values follow in square brackets left padding with spaces to take up 6 characters.
- Next comes the first normal data line. This begins with a space, followed by an integer year value. The data values follow as integers left padded by spaces to take up 6 characters. A data line has a decades worth of data values.
- Next comes the normal sample depth line. It begins with 7 spaces followed by each of the sample depth values enclosed in square brackets and left padded with spaces up to 6 characters.
- Data lines continue in pairs until the last line is reached. This is the same as a normal data line except it includes an extra data value 9990 as a stop marker. This data line may have less than a full decade of values.
- The final sample depth line is the same as normal except it is shifted left by 4 characters. A sample depth value is also included for the dummy 9990 stop marker year.

Following the data block there is a blank line and two option blocks of data that are only included if the file is a chronology file.

The next block of information in a chronology file is denoted by a line ;ELEMENTS. The following lines contain the file names of the data files that have contributed to the creation of the chronology.

Following this is an optional block denoted by the line ;weiserjahre followed by the weiserjahre data. Each weiserjahre data line begins with a space followed by an integer year value for the first year in the line. The weiserjahre value is left padded with spaces to fill 6 characters and the value itself is written as X/Y where X is the number of samples that show an upward trend in width; and Y is the number of samples that show a downward trend in width. The weiserjahre value is forward facing so the value for ring 1001 shows the trend between ring 1001 and 1002. There is therefore one less weiserjahre value in the final row than there are ring-widths.

The final line of Corina data files contains the author's name preceded by a tilde.

6.2 Example file

```

1  Trebenna , Byzantine Fortress , NW tower 1AB
2
3  ;ID 907010;NAME Trebenna , Byzantine Fortress , NW tower 1AB;DATING R;UNMEAS_PRE 1;UNMEAS_POST 1
4  ;FILENAME G:\DATA\TRB\TRB1AB.SUM
5
6
7  ;TYPE S;SPECIES Juniperus sp.;FORMAT R;PITH +
8  ;TERMINAL vv;CONTINUOUS N;QUALITY +
9  ;RECONCILED Y
10 ;DATA
11  1001          125  219  207  139  62  107  29  91  65
12              [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]
13  1010  71  132  74  150  75  156  122  81  46  57
14              [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]
15  1020  147  78  89  126  73  121  67  71  64  129
16              [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]
17  1030  149  155  122  126  53  136  90  65  100  67
18              [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [1]  [2]
19  1040  67  101  132  102  40  67  42  36  62  29
20              [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]
21  1050  30  44  46  40  34  61  55  29  44  63
22              [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]
23  1060  62  38  22  26  26  28  37  21  21  27
24              [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]
25  1070  17  18  50  21  33  12  17  16  27  20
26              [2]  [2]  [2]  [2]  [2]  [2]  [2]  [2]  [1]  [1]
27  1080  18  11  9  8  9990
28              [1]  [1]  [1]  [1]  [1]
29
30 ;ELEMENTS
31 G:\DATA\TRB\TRB1A.REC
32 G:\DATA\TRB\TRB1B.REC
33 ;weiserjahre
34  1001  1/0  0/1  0/1  0/1  1/0  0/1  1/0  0/1  1/0
35  1010  1/0  0/1  1/0  0/1  1/0  0/1  0/1  0/1  1/0  1/0
36  1020  0/1  1/0  1/0  0/1  1/0  0/1  1/0  0/1  1/0  1/0
37  1030  1/0  0/1  1/0  0/1  1/0  0/1  0/1  1/0  0/1  1/1
38  1040  2/0  2/0  0/2  0/2  2/0  0/2  0/2  2/0  0/2  2/0
39  1050  2/0  1/1  0/2  0/2  2/0  0/2  0/2  2/0  2/0  1/1
40  1060  0/2  0/2  2/0  1/1  2/0  2/0  0/2  1/1  2/0  0/2
41  1070  1/1  2/0  0/2  2/0  0/2  2/0  1/1  1/0  0/1  0/1
42  1080  0/1  0/1  0/1
43 ~ Unknown User

```

Format 7

DendroDB

Format name	DendroDB
Other name(s)	None known
Type	Text file
Extension(s)	dat
Read/write support	Read only
Reference implementation	DendroDB website
Data / metadata	Data and some structured metadata
Calendar type	Astronomical
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Simon Brewer

7.1 Description

The DendroDB format is an export file format produced by the [DendroDB website/database](#). There is no known software that can natively read DendroDB files so a ‘writer’ for this format has not been developed.

The format is self-explanatory, beginning with a copyright line, followed by 7 metadata lines, then the data itself. There are eight possible data variables: Total width; Earlywood width; Latewood width; Min. Density; Max. Density; Earlywood density; Latewood density; Average density. Ring width data is provided in microns but the units for density measurements are not document.

As of Feb 2011, the DendroDB database does not contain data prior to 441AD so handling of BC/AD transition has not been tested. The DendroDB web interface suggests that BC dates should be entered as negative integers, but it also allows request for data from year 0. This suggests the database uses an Astronomical calendar and this is how the DendroIOLib treats it.

7.2 Example file

```
1 Data downloaded from DendroDB. Please acknowledge authors
2 Site: Example site
3 Contact: A N Other
4 Species: Larix sibirica
5 Parameter: Latewood width
6 Latitude: 53.25
7 Longitude: 57.35
8 Elevation: 1670
9 Tree Core Year Latewood width
10 1 1 1648 16
11 1 1 1649 21
12 1 1 1650 8
13 1 1 1651 10
14 1 1 1652 6
15 1 1 1653 8
16 1 1 1654 11
17 1 1 1655 13
18 1 1 1656 9
19 1 1 1657 10
20 1 1 1658 10
21 1 1 1659 4
22 1 1 1660 5
23 1 1 1661 7
24 1 1 1662 4
25 1 1 1663 8
26 ...
```

Format 8

Heidelberg

Format name	Heidelberg
Other name(s)	TSAP, FH
Type	Text file
Extension(s)	fh
Read/write support	Read and write
Reference implementation	TSAP-Win
Data / metadata	Data and extensible metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	Yes
Multi series support	Yes
Original designer	Frank Rinn

8.1 Description

The Heidelberg format (Rinn, 2008) is the native file format for Rinntech's TSAP-Win software. It supports metadata in the form of keyword-value pairs. There are more than 140 standard keywords specified in the documentation, but users can extend these with their own. This makes the format extremely flexible, but the absence of any checking of data types (strings, numbers categories etc) and no method of validation means that there can be problems interpreting metadata entries.

Heidelberg files can store one or more series in a single file. Each series is represented by a header and a data block.

The header block begins with a line `HEADER:.` This is followed by lines of metadata, with one field on each line, in the format `keywords=value` much like a standard Windows INI file. As mentioned previously there are a number of predefined keywords, all of which are outlined here:

- AcceptDate
- Age
- AutoCorrelation
- Bark
- BHD
- Bibliography
- Bibliography[n]
- BibliographyCount
- Bundle
- CardinalPoint
- ChronologyType
- ChronoMemberCount

- ChronoMemberKeycodes
- Circumference
- Client
- ClientNo
- Collector
- Comment
- Comment[n]
- CommentCount
- Continent
- CoreNo
- Country
- CreationDate
- DataFormat
- DataType
- DateBegin
- Dated
- DateEnd
- DateEndRel
- DateOfSampling
- DateRelBegin[n]
- DateRelEnd[n]
- DateRelReferenceKey[n]
- DateRelCount
- DeltaMissingRingsAfter
- DeltaMissingRingsBefore
- DeltaRingsFromSeedToPith
- Disk
- District
- EdgeInformation
- EffectiveAutoCorrelation
- EffectiveMean
- EffectiveMeanSensitivity
- EffectiveNORFAC
- Key
- EffectiveNORFM
- EffectiveStandardDeviation
- Eigenvalue
- Elevation
- EstimatedTimePeriod
- Exposition
- FieldNo
- FilmNo
- FirstMeasurementDate
- FirstMeasurementPersID
- FromSeedToDateBegin
- GlobalMathComment[n]
- GlobalMathCommentCount
- GraphParam
- Group
- HouseName
- HouseNo
- ImageCellRow
- ImageComment[n]
- ImageFile[n]
- ImageCount
- ImageFile
- Interpretation
- InvalidRingsAfter
- InvalidRingsBefore
- JuvenileWood
- KeyCode
- KeyNo
- LabotaryCode
- LastRevisionDate
- LastRevisionPersID
- Latitude
- LeaveLoss
- Length
- Location
- LocationCharacteristics
- Longitude
- MajorDimension
- MathComment
- MathComment[n]
- MathCommentCount
- MeanSensitivity
- MinorDimension
- MissingRingsAfter
- MissingRingsBefore
- NumberOfSamplesInChrono
- NumberOfTreesInChrono
- PersId
- Pith
- Project
- ProtectionCode
- Province
- QualityCode
- Radius
- RadiusNo
- RelGroundWaterLevel
- RingsFromSeedToPith
- SampleType
- SamplingHeight
- SamplingPoint
- SapWoodRings
- Sequence
- SeriesEnd
- SeriesStart
- SeriesType
- ShapeOfSample
- Site
- SiteCode
- SocialStand
- SoilType
- Species
- SpeciesName
- StandardDeviation
- State

- StemDiskNo
- Street
- Timber
- TimberHeight
- TimberType
- TimberWidth
- TotalAutoCorrelation
- TotalMean
- TotalMeanSensitivity
- TotalNORFAC
- TotalNORFM
- TotalStandardDeviation
- Town
- TownZipCode
- Tree
- TreeHeight
- TreeNo
- Unit
- UnmeasuredInnerRings
- UnmeasuredOuterRings
- WaldKante
- WoodMaterialType
- WorkTraces

The meaning of many of these keywords is fairly self-explanatory but others are a little more obscure. As there is no data typing or validation the format of the contents of these fields cannot be predicted. This is particularly a problem when trying to compare fields such as Latitude, Longitude and FirstMeasurementDate, but is especially a problem when comparing files produced in different labs.

The header section is followed by a data section denoted by a line containing the keyword DATA: followed by the type of data present which can be one of Tree; HalfChrono; Chrono; Single; Double; Quad. Tree, HalfChrono and Chrono are the original keywords supported by early versions of TSAP but these are now deprecated in preferences of the more generic Single, Double and Quad terms. The terms Single, Double and Quad are largely interchangeable with Tree, HalfChrono and Chrono respectively, but not completely. Double can refer to both Tree and HalfChrono format data. When the newer terms are used, the header keyword DataFormat is used to record whether the data is equivalent to Tree, HalfChrono or Chrono.

Single format - data is typically used for storing raw measurement series. Each data line contains 10 data values each being a left space padded integer taking up 6 characters. Any spare data values in the final data line are filled with zeros. Alternatively it appears that TSAP-Win also accepts this data section as single integer values one per line.

Double format - data is for storing data with sample depth information - typically chronologies. Like the single format section, data is stored as 10 integer values, each taking up 6 characters and left padded with spaces. The values are in pairs of ring-widths and sample depths, therefore five rings are stored per line.

Quad format - data is for storing chronologies with sample depth as well as data on how many of the constituent series increase and decrease. This format therefore requires four numbers for each data point: ring-width; sample depth; increasing series; decreasing series. Numbers are stored as integers, left space padded as before, but this time only using 5 characters not 6. Four data points are included on each line, therefore this means there are 16 numbers per row and each row is 80 characters long.

8.2 Example file - raw series

```

1  HEADER:
2  DateEnd=-66
3  KeyNo=27
4  Project=Growth studies
5  Length=103
6  Location=Example site
7  Species=PISY
8  SapWoodRings=14
9  WaldKante=WKF
10 State=Colorado
11 PersId=FR
12 KeyCode=271017
13 Country=USA
14 DateOfSampling=19950506
15 TreeNo=5
16 CoreNo=1
17 Exposition=North-West
18 CreationDate=19970526
19 SoilType=Sand
20 DATA: Tree
21   125  130   99  120  115  145  151  130  135  151
22   200  190  151  170  170  174  170  200  210  130
23   180  197  210  160  180  155  180  199  140  150
24   146  140  145  150  155  110  115  113  120  130
25   110  120  150  120  120  110  115  160  160  145
26   135  145  125  115  145  149  120  150  160  99
27   110  75  70  82  96  90  120  151  155  130
28   132  133  149  110  130  120  128  118  125  115
29   95  90  110  98  80  85  97  88  70  100
30   90  70  80  90  85  78  95  84  70  90
31   80  75  70  0  0  0  0  0  0  0

```

8.3 Example file - chronology

```

1  HEADER:
2  KeyCode=ABCK0530
3  DataFormat=HalfChrono
4  SeriesType=Mean curve
5  Length=60
6  DateBegin=987
7  DateEnd=1046
8  Dated=Dated
9  Location=Example site
10 Species=QUSP
11 GlobalMathCommentCount=0
12 ImageCount=0
13 CommentCount=0
14 BibliographyCount=0
15 DATA: Double
16   125  1  125  2  264  2  206  2  115  2
17   111  2  188  2  308  2  197  2  419  2
18   238  2  227  2  279  2  293  2  271  2
19   309  2  170  2  204  2  163  2  175  2
20   164  2  211  2  134  2  141  2  107  2
21   72  2  74  2  91  2  110  2  47  2
22   87  2  87  2  35  2  47  2  80  2
23   66  2  38  2  82  2  78  2  65  2
24   63  2  76  2  67  2  91  2  73  3
25   39  3  41  3  78  3  57  3  54  3
26   41  3  39  3  52  3  53  3  43  3
27   48  3  32  3  32  3  48  3  59  3

```

Format 9

Microsoft Excel 97/2000/XP

Format name	Microsoft Excel 97/2000/XP
Other name(s)	Binary Interchange File Format, BIFF
Type	Binary file
Extension(s)	xls
Read/write support	Read and write
Reference implementation	Microsoft Excel
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Microsoft

9.1 Description

The Excel file format is a widely used format for storing spreadsheet data. It is a proprietary binary format created by Microsoft but supported by many spreadsheet and statistical applications. It is not to be confused with the Office Open XML format which was introduced by Microsoft with MS Office 2007 and typically has the file extension `xlsx`.

Although Excel files can contain multiple sheets in a workbook, only the first sheet is considered. Like the CSV and ODF Spreadsheet formats, support for Excel files is limited to a particular layout or style of spreadsheet. The layout of the data sheet should be as follows:

- Row 1 - Header names for each column
- Column A - Year values
- Column B+ - One column for each series containing data values. Cells are left empty if no data is available for a series because it does not extend to a particular year. Data must be continuous for each series, so missing/un-measured rings should be included as zero.

9.2 Example file

	A	B	C
1	Year	MySample1	MySample2
2	1954	0.33	
3	1955	0.26	0.26
4	1956	0.2	0.2
5	1957	0.14	0.14
6	1958	0.08	0.08
7	1959	0.02	0.02
8	1960	0.2	0.2
9	1961	0.14	0.14
10	1962	0.08	0.08
11	1963	0.2	
12	1964	0.33	
13	1965	0.08	
14	1966	0.33	
15	1967	0.22	
16			

Format 10

Microsoft Excel 2007

Format name	Microsoft Excel 2007
Other name(s)	Office Open XML Spreadsheet, OOXML, OpenXML
Type	XML file
Extension(s)	xlsx
Read/write support	Read and write
Reference implementation	ISO 29500
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Microsoft

10.1 Description

This is the new XML file format introduced by Microsoft with Excel 2007. Unlike the binary format used by the previous version of Excel, this format is an open standard. However, it should not be confused with the OpenDocument Format standard that was developed by the OASIS consortium.

The layout of the data sheet should be just as for the Excel 97/2000/XP format:

- Row 1 - Header names for each column
- Column A - Year values
- Column B+ - One column for each series containing data values. Cells are left empty if no data is available for a series because it does not extend to a particular year. Data must be continuous for each series, so missing/un-measured rings should be included as zero.

See the screenshot in the Microsoft Excel 97/2000/XP format to see how an example of how the spreadsheet should look.

Format 11

Nottingham

Format name	Nottingham
Other name(s)	Nottingham Laboratory format
Type	Text file
Extension(s)	txt
Read/write support	Read and write
Reference implementation	Unknown
Data / metadata	Data only
Calendar type	n/a
Absolute dating support	No
Undated series support	Yes
Relative dating support	No
Multi series support	Yes
Original designer	Cliff Litton

11.1 Description

The Nottingham format was designed by Cliff Litton. It is a simple text format with no support for metadata.

Line 1 contains a series name and an integer indicating how many data values there are in the file. Subsequent lines contain the data represented as 1/100th mm integers in twenty columns seemingly in either 4 characters or 3 characters + 1 space.

There is no known reference implementation for this format and few known examples of data so little is known about how it should handle unusual situations such as negative values, values >999 etc.

11.2 Example file

1	ABCD01	176																		
2	342	338	334	409	362	308	360	264	325	318	134	151	219	268	290	222	278	258	173	198
3	294	202	170	176	172	121	87	130	114	108	170	135	131	126	87	100	86	104	103	127
4	112	94	96	120	168	149	119	124	79	67	88	90	93	77	49	42	53	38	57	43
5	50	41	56	66	62	55	55	45	47	63	58	60	44	45	49	50	62	61	43	54
6	91	60	56	43	52	51	65	68	55	44	41	75	94	78	63	69	58	75	55	47
7	58	46	62	45	52	50	77	50	63	75	77	64	66	57	80	57	78	65	68	75
8	65	98	85	82	119	89	85	87	83	108	129	123	160	117	129	121	88	69	97	77
9	96	106	71	89	50	65	133	89	88	50	60	95	95	91	102	158	83	55	98	70
10	45	46	40	36	64	58	52	58	56	94	51	48	47	60	49	48				

Format 12

ODF Spreadsheet

Format name	ODF Spreadsheet
Other name(s)	ODF, ODS, OpenDocument Spreadsheet, OpenOffice.org Spreadsheet,
Type	XML file
Extension(s)	ods
Read/write support	Read and write
Reference implementation	ISO/IEC 26300:2006
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	OASIS consortium

12.1 Description

The OpenDocument Format (ODF) spreadsheet format is an XML-based specification developed by the Organization for the Advancement of Structured Information Standards (OASIS) consortium. It should not be confused with the similarly named Office Open XML format developed by Microsoft. The ODF spreadsheet format is an open standard which can be read by most modern spreadsheet applications including MS Excel, OpenOffice.org and Google Docs.

Support for ODF spreadsheets in TRiCYCLE is necessarily limited to a particular layout of spreadsheet:

- Row 1 - Header names for each column
- Column A - Year values
- Column B+ - One column for each series containing data values. Cells are left empty if no data is available for a series because it does not extend to a particular year. Data must be continuous for each series, so missing/un-measured rings should be included as zero.

Please see the Excel section for a screenshot of how an ODF spreadsheet should look.

Format 13

Oxford

Format name	Oxford
Other name(s)	Dan Miles Format, English Heritage Format
Type	Text file
Extension(s)	Various including dan, ddf but often none
Read/write support	Read and write
Reference implementation	Various English Heritage applications
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	Yes
Multi series support	No
Original designer	Ancient Monuments Laboratory of English Heritage

13.1 Description

The Oxford format seems to be only currently used in the Oxford Dendrochronology Laboratory. It was designed in the 1980s for use with a number of DOS based applications for the English Heritage Ancient Monuments Laboratory. It is still actively used by the Oxford Lab with these programs and a number of newer Windows applications.

The file is a text file format containing two header lines following by a block of data values and an optional block of count/sample depth values. Some files also contain a number of comment lines at the end of the file.

Line 1 contains the following fields:

- Char 1 - Apostrophe
- Chars 2-8 - Series name
- Char 9-10 - spaces
- Char 11 - <
- Chars 12-15 - First year in sequence (when series is securely dated). Year should be left padded with spaces if less than 4 characters.
- Char 16 - hyphen
- Chars 17-20 - Last year in sequence (when series is securely dated). Year should be left padded with spaces if less than 4 characters.

- Char 21 - space
- Char 22+ - Description - typically name of site/building etc
- Final char - optional apostrophe

Line 2 contains:

- Integer number of years
- Comma
- Integer start year

The start year on line 2 and the first year on line 1 will be the same for securely dated series. When the series is tentatively or relatively dated the first year (and/or) the last year on line 1 will be left blank. For undated series the start year is set to 1001.

The data lines follow the two header lines. These typically contain 10 data values per line, but there can be more (if rings have been added) or less e.g. last line. The values are in 1/100th mm integers and can only contain three digits (e.g. max 999 1/100th mm). Data values are space delimited. Some example files contain values that are left padded with zeros if the value is on 1 or 2 characters wide (e.g. '025' rather than '25').

Following the data values there should be an empty line followed by an optional sample count/depth block. The count block is formatted in largely the same way as the data values block. The values are stored in columns 2 characters (rather than 3 characters) wide. Like the data values, the count values are space delimited integers, typically (but not always) 10 per line.

The file is terminated with 0, 1 or 2 free-text comment lines. A number of Oxford data files have been seen that terminate with the ASCII control character referred to variably as 'SUB', 'SUBSTITUTE' or 'CTRL+Z' (represented in Unicode as character dec 26 - hex 1A). It is not clear whether this is necessary for any particular programs to function.

13.2 Limitations

- Only holds whole ring-width data
- Does not cope with data values >999 1/100th mm
- Does not cope with chronologies of >99 samples
- Does not allow dates before 1AD

13.3 Example file

```
1 'ABCD      <1850-1925> A Fictious site - abcd1 abcd2'  
2 75,1850  
3 422 582 355 266 225 271 361 235 387 395  
4 794 611 446 248 277 359 111 226 189 711  
5 464 172 190 239 128 153 234 828 207 157  
6 768 180 178 168 204 163 160 255 166 136  
7 182 201 142 188 223 186 150 135 134 666  
8 191 122 223 555 123 126 108 133 137 134  
9 161 222 93 100 132 104 86 277 101 141  
10 185 151 261 110 145  
11  
12 1 2 2 2 2 2 2 2 2 2  
13 2 2 2 2 2 2 2 2 2 2  
14 2 2 2 2 2 2 2 2 2 2  
15 2 2 2 2 2 2 2 2 2 2  
16 2 2 2 2 2 2 2 2 2 2  
17 2 2 2 2 2 2 2 2 2 2  
18 2 2 2 2 2 2 2 2 2 2  
19 2 2 2 2 1
```

Format 14

PAST4

Format name	PAST4
Other name(s)	P4P PAST4 Project File
Type	Text file
Extension(s)	p4p
Read/write support	Read and write
Reference implementation	PAST4
Data / metadata	Data and some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Bernhard Knibbe

The PAST4 format (Knibbe, 2008) is the native file format for SCIEM's PAST4 software. It is a hybrid XML file, containing most metadata in structured XML but some metadata and all data as plain text. It is unique amongst dendro data formats in that it contains not only data and metadata but also settings information for the PAST4 software such as details on what colours to use in graphs, which series should be displayed on screen etc. The general structure of a P4P file is as follows:

- Project header (required)
- Settings (optional)
- Groups (required, repeatable)
- Records (required, repeatable)

The root XML tag for the file is <PAST_4_PROJECT_FILE>. Inside this is the <PROJECT> tag which contains the following attributes:

- ActiveGroup - Zero based index specifying which group is active
- EditDate - Date the file was last edited
- Groups - Number of groups within this project
- Locked - Either TRUE or FALSE indicating whether a password is required to open the file
- Name - Name of the project
- Password - Password used to lock the project
- PersID - Abbreviation of the authors name
- Records - Number of records in the project
- Reference - Zero based index indicated which is the reference series (-1 if none selected)

- Sample - Zero based index indicating which is the selected sample (-1 if none selected)
- Version - Version number for this PAST4 format. At the time of writing only one version exists (400).

Of these fields only Name, Groups and Records are mandatory. The project tag can also contain a `<![CDATA[` tag which allows the storing of a project description in plain text.

Next comes the `<SETTINGS>` tag. This is one very large XML tag with many attributes controlling the what PAST4 should display the data. The contents of this tag are optional and are therefore irrelevant for the transfer of dendro data.

Next comes one or more `<GROUPS>` tags. A group is an arbitrary collection of series, perhaps representing a number of measurements of a single object, or perhaps an administrative collection of series. Groups can be nested in a hierarchy, but rather than use the hierarchical nature of XML files, the format instead lists all groups side-by-side and maintains the relationships through the use of an 'owner' attribute containing the index of the parent group. This arrangement means that any changes to the hierarchy, or the deletion of a group requires all indices to be carefully updated to avoid corrupting the file. The group tag has the following attributes:

- Name - Name of the group
- Visible - Either TRUE or FALSE indicating whether the group should be shown in graphs
- Fixed - Either TRUE or FALSE indicating whether the group can be moved
- Locked - Either TRUE or FALSE. If locked the group can be used in the calculation of further mean values.
- Changed - Internal TRUE or FALSE value for keeping track of changes
- Expanded - TRUE or FALSE value indicating whether the group should be expanding in the project navigator window
- UseColor - TRUE or FALSE value for is content should be displayed in color
- HasMeanValue - TRUE or FALSE indicating if the group has a dynamic mean value
- IsChrono - TRUE or FALSE indicating if the group mean is calculated with sample depth information
- Checked - TRUE or FALSE indicating if the group is locked and checked
- Selected - TRUE or FALSE indicated in the group is selected in the project navigation window
- Color - 24bit integer indicating the RGB color value for the group using Borland format
- Quality - Integer value describing the quality of the group mean
- MVKeycode - String code for the group. If empty the Name field is used
- Owner - Integer pointing containing the index of the parent group if this group is in a hierarchy. If its a top level group it should be -1.

As with the project tag, the group tag can also contain a `<![CDATA[` section for storing a plain text description of the group.

The final tag type in the file is the `<RECORDS>` tag. These contain the actual data series and most of the metadata. Like group tags, records tags are placed side-by-side in the file and are placed into the group hierarchy by the use of the 'owner' attribute. In addition, the tag also has the following attributes:

- Keycode - Name of the series
- Length - Integer for the number of rings
- Owner - Integer index to the group to which this record belongs
- Chrono - TRUE or FALSE indicating whether this record has density information
- Locked - TRUE or FALSE indicating in the record can be moved
- Filter - TRUE or FALSE indicating if an indexing function is applied to the data
- FilterIndex - Integer index for the filter used
- FilterS1 - Parameter 1 for the filter
- FilterS2 - Parameter 2 for the filter
- FilterB1 - Additional filter parameter
- FilterWeight - Additional filter parameter
- Offset - Position of the first ring
- Color - 24bit RGB color for record in Borland format

- Checked - TRUE or FALSE indicating if the record is selected for use in the dynamic group mean
- !VShift - Temporary integer value added to data value to shift vertically in graphs
- IsMeanValue - TRUE or FALSE indicating if this is a dynamic mean value
- Pith - TRUE or FALSE
- SapWood - Integer storing the number of sapwood rings
- Location - String location information
- Waldkante - String description of presence of waney edge
- FirstValidRing - Integer indicating which ring is the first valid ring. If >0 then some rings are discarded
- LastValidRing - Integer indicating which ring is the last valid ring. If >0 then some rings are discarded
- UseValidRingsOnly - TRUE or FALSE - internal use only
- Quality - Integer indicating the quality of the record

The record tag then contains a <HEADER> tag with a <! [CDATA [section which includes additional free-text header information. There are no requirements as to how information should be laid out in this field however many users seem to adopt the Heidelberg style of keyword=value.

Next comes the <DATA> tag which is empty except another <! [CDATA [section. This is where the actual ring-width data is stored. Each data value is recorded on a separate line (using CR LR line breaks). Each line contains the following six tab delimited fields:

- Ring width as a floating point number
- Sample depth
- Number of sample increasing
- Latewood percentage as a floating point value 0-1 (0 if not known)
- Duplicate/backup ring-width value to store the original ring-width value. If an index is applied the ring-width value in column 1 is altered.
- Comment string about this particular ring

14.1 Dating

PAST4 contains an option for enabling/disabling the year 0 but it does not record within the data file whether the option was set when the file was created. By default the year 0 is disabled therefore the library treats PAST4 files as if they use the Gregorian calendar but it is possible that files were in fact created with the Astronomical calendar in mind.

14.2 Example file

```

1 <?xml version="1.0"?>
2 <PAST_4_PROJECT_FILE>
3   <PROJECT Name="title0" Version="400" Locked="FALSE" Password=""
4     CreationDate="04/05/2006 2:13:51 PM" EditDate="09/01/2010 13:02" ActiveGroup="0"
5     Reference="-1" Sample="-1" PersID="investigator0" Groups="2" Records="3">
6 <![CDATA[description0
7 ]]></PROJECT>
8 <SETTINGS/>
9 <GROUP Name="title1" Visible="TRUE" Fixed="FALSE" Locked="FALSE" Changed="FALSE"
10   Expanded="TRUE" UseColor="TRUE" HasMeanValue="FALSE" IsChrono="FALSE"
11   Checked="FALSE" Selected="FALSE" Color="0" MVKeycode="" Owner="-1">
12 <![CDATA[]]></GROUP>
13 <GROUP Name="Unnamed Group" Visible="TRUE" Fixed="FALSE" Locked="FALSE" Changed="FALSE"
14   Expanded="TRUE" UseColor="TRUE" HasMeanValue="FALSE" IsChrono="FALSE" Checked="FALSE"
15   Selected="FALSE" Color="0" MVKeycode="" Owner="-1"><![CDATA[]]></GROUP>
16 <RECORD Keycode="title6" Length="4" Owner="0" Chrono="FALSE" Locked="FALSE" Filter="FALSE"
17   FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE" FilterWeight="" Offset
18   ="0"
19   Color="0" Checked="FALSE" VShift="0" IsMeanValue="0" Pith="FALSE" SapWood="0"
20   Location="locationComment1" Species="Quercus" Waldkante="" FirstValidRing="0"
21   LastValidRing="0" UseValidRingsOnly="FALSE">
22 <HEADER><![CDATA[ Unit=1/100th millimetres
23 ]]></HEADER>
24   <DATA><![CDATA[123      1      1      0      123
25 123      1      1      0      123
26 125      1      1      0      125
27 ]]></DATA>
28 </RECORD>
29 <RECORD Keycode="title6" Length="4" Owner="0" Chrono="FALSE" Locked="FALSE" Filter="FALSE"
30   FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE" FilterWeight="" Offset
31   ="0"
32   Color="0" Checked="FALSE" VShift="0" IsMeanValue="0" Pith="FALSE" SapWood="0"
33   Location="locationComment1" Species="QUSP" Waldkante="" FirstValidRing="0"
34   LastValidRing="0" UseValidRingsOnly="FALSE">
35 <HEADER><![CDATA[ Unit=1/100th millimetres
36 ]]></HEADER>
37   <DATA><![CDATA[123      1      1      0      123
38 123      1      1      0      123
39 125      1      1      0      125
40 ]]></DATA>
41 </RECORD>
42 <RECORD Keycode="Unnamed series" Length="2" Owner="1" Chrono="FALSE" Locked="FALSE"
43   Filter="FALSE" FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE"
44   FilterWeight="" Offset="0" Color="0" Checked="FALSE" VShift="0" IsMeanValue="0"
45   Pith="FALSE" SapWood="0" Location="" Species="" Waldkante="" FirstValidRing="0"
46   LastValidRing="0" UseValidRingsOnly="FALSE">
47 <HEADER><![CDATA[ Unit=Wierd units
48 ]]></HEADER>
49   <DATA><![CDATA[96      1      1      0      96      fire_damage; fire_damage;
50 34      1      1      0      34      fire_damage; fire_damage;
51 ]]></DATA>
52 </RECORD>
53 </PAST_4_PROJECT_FILE>

```

Format 15

Sheffield

Format name	Sheffield
Other name(s)	D Format
Type	Text file
Extension(s)	d
Read/write support	Read and write
Reference implementation	Dendro for Windows
Data / metadata	Data and some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	Yes
Multi series support	No
Original designer	Ian Tyers

15.1 Description

Sheffield format (Tyers, 1999) is a dendro specific text file designed by Ian Tyers for his Dendro for Windows application. It is probably most widely used in the UK but is also used in continental Europe as well as New Zealand.

The format contains both data and some structured metadata with each field/value stored one per line. The order of fields is fixed so missing data must be indicated by the use of a question mark. The data present on each line is as follows:

1. Site name/sample number - Free form text not including , " () up to 64 characters
2. Number of rings - Whole positive number
3. Date type - Single character; A = absolute date, R = relative date
4. Start date - Whole number (can be negative). If absolute year then add 10000 to value so 1AD = 10001
5. Raw data type *or* Mean data type
 - Single character; R = annual raw ring-width data (NB earlier versions used some other codes here for species e.g. ABEFPSU these are all interpreted as equivalent to R)
 - Single character; W=timber mean with signatures, X=chron mean with signatures, T = timber mean, C = chron mean, M = un-weighted master sequence
6. Raw sapwood number *or* mean number of timbers/chronologies
 - Whole positive number or 0

- Whole positive number
7. Raw edges inf. *or* Mean chronology type
 - Single character; Y = has bark, ! = has ?bark, W = terminal ring probably complete (i.e. possibly Winter Felled), S = terminal ring probably incomplete (i.e. possibly Summer Felled), B = has h/s boundary, ? = has ?h/s boundary, N = has no specific edge, (NB but may have sap), U = sap/bark unknown, C = charred outer edge, P = possibly charred outer edge
 - Single character; R = raw unfiltered data, 5 = 5 year running mean, I = indexed data, U = unknown mean type
 8. Author and comment - Free form text not including , " () up to 64 characters
 9. UK National grid reference - 2 characters +even no of digits up to 14 characters in all, ? = not known e.g. TQ67848675
 10. Latitude and longitude - Either decimal format e.g. 53.382457;-1.513623 or previously N51^30 W1^20
 11. Pith - single character; C = centre of tree, V = within 5 years of centre, F = 5-10 years of centre, G = greater than 10, ? = unknown
 12. Cross-section code - Two character code; first character, A = whole roundwood, B = half round, C quartered, D radial/split plank, E tangential/sawn plank. second character, 1 untrimmed, 2 trimmed, X irregularly trimmed. or, X = core /unclassifiable, ? unknown/unrecorded
 13. Major dimension - whole number in mm, 0 if unrecorded or mean
 14. Minor dimension - whole number in mm, 0 if unrecorded or mean
 15. Unmeasured inner rings - single character+whole number; use pith codes + number of rings or, H = heartwood, N = none
 16. Unmeasured outer rings - single character+whole number; use edges code + number of rings except that S = sapwood with no edge and V is the spring felling equivalent other codes are, H = heartwood with no edge, N = none
 17. Group/Phase - free form text not including , " () up to 14 characters
 18. Short title - free form text not including , " () up to 8 characters
 19. Period - single character; C = modern, P = post medieval, M = medieval, S = Saxon, R = Roman, A = pre Roman, 2 = duplicate e.g. repeat measure, B = multiperiod e.g. long master, ? = unknown
 20. ITRDB species code - 4 character code - refer to ITRDB species codes
 21. Interpretation and anatomical notes - ? =no interpretation/notes. The interpretation and the anatomical notes can be in any order but each must consist of three parts, a single character A or I for anatomy or interpretation, a separator , for interpretations the date of the start, for anatomy the ringno, a separator , for anatomy the anatomical code for interpretations P for plus, 0 for felled and a number for the length of the range, where more than one record is present these are separated by , there must not be a terminal separator and each record must consist of the tree parts. The anatomical codings can be anything of a single character but supported usage is based on Hans-Hubert Leuschners anatomical codes; D = Density Band, R = Reaction Wood, L = Light Latewood, H = Dense Latewood, F = Frost Ring, K = Small Earlywood Vessels - oak, G = Great Latewood Vessels - oak, T = Wound Tissue, N = Narrow Latewood, A = Light Latewood End, P = Narrow and Light Latewood, Q = Narrow and Dense Latewood
 22. Data type - single character; D = ring widths, E = early-wood widths only, L = late-wood widths only, R = late+early wood widths (i.e. reverse of normal rings), I = minimum density, A = maximum density, S = early, late; (i.e. sequentially and separately), M = mixed (?means of others)

The remaining lines contain the data:

- For each width (equivalent to the value of length) the individual increments etc. if a C X T or W type mean. No negatives or zeros
- Check field - Single character H
- For each width the individual weightings of the mean sequences. If an X or W type mean. No negatives or zeros.
- Check field - Single character R
- For each width the number of individual series with rising values. No negatives or zeros.
- Check field - Single character F
- For each width the number of individual series with falling values. No negatives.

15.2 Dating

The format copes with the problem of the non-existent year 0AD/BC by adding 10000 to all year values. Therefore:

Year	Value in file
1AD	10001
1BC	10000
9999BC	2
10000BC	1

15.3 Example file

```
1 Ship wreck 4 timber mean
2 170
3 A
4 10784
5 W
6 4
7 R
8 made PB 22/6/2004
9 ?
10 ?
11 ?
12 ?
13 0
14 0
15 N
16 N
17 A
18 Example
19 M
20 QUSP
21 ?
22 D
23 391
24 454
25 309
26 314
27 270
28 273
29 229
30 319
31 267
32 276
33 128
34 163
35 221
36 269
37 214
38 201
39 218
40 199
41 198
42 209
43 156
44 177
45 ...
```

Format 16

Topham

Format name	Topham
Other name(s)	Instrument format
Type	Text file
Extension(s)	txt
Read/write support	Read and write
Reference implementation	Not known
Data / metadata	Data only
Calendar type	n/a
Absolute dating support	No
Undated series support	Yes
Relative dating support	No
Multi series support	No
Original designer	John Topham

16.1 Description

The Topham format is probably the most simplistic of formats consisting of just a column of decimal data values and no metadata whatsoever. Each data value is a decimal ring width in millimetres.

16.2 Example file

```

1 3.42
2 3.38
3 3.34
4 4.09
5 3.62
6 3.08
7 3.60
8 2.64
9 3.25
10 3.18
11 3.42
12 3.38
13 ...

```

Format 17

TRiDaS

Format name	TRiDaS
Other name(s)	Tree-Ring Data Standard, TRiDaS XML
Type	Text file
Extension(s)	xml
Read/write support	Read and write
Reference implementation	TRiCYCLE
Data / metadata	Data and structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	Yes
Multi series support	Yes
Original designer	Esther Jansma, Peter Brewer and Ivo Zandhuis

17.1 Description

TRiDaS (Tree-Ring Data Standard see <http://www.tridas.org>) is a data format designed by over 80 dendrochronologists, computer scientists and users of dendrochronological data from a variety of associated fields as part of the DCCD project and the Dendro Data Standard forum. It is designed to accurately represent any dendro data and metadata and it is hoped over time the dendro community will accept TRiDaS as the de facto standard for all dendro data.

The format uses extensible markup language (XML) which means the standard can be extended and evolve as future needs change. The format is structured around the eight data entities described below:

A project is defined by a laboratory and encompasses dendrochronological research of a particular object or group of objects. Examples include: the dating of a building; the research of forest dynamics in a stand of living trees; the dating of all Rembrandt paintings in a museum. What is considered a “project” is up to the laboratory performing the research. It could be the dating of a group of objects, but the laboratory can also decide to define a separate project for each object. Therefore, a project can have one or more objects associated with it.

An object is the item to be investigated. Examples include: violin; excavation site; painting on a wooden panel; water well; church; carving; ship; forest. An object could also be more specific, for example: mast of a ship; roof of a church. Depending on the object type various descriptions are made possible. An object can have one or more elements and can also refer to another (sub) object. For instance a single file may contain three objects: an archaeological site object, within which there is a building object, within which there is a beam object. The

list of possible object types is extensible and is thus flexible enough to incorporate the diversity of data required by the dendro community. Only information that is essential for dendrochronological research is recorded here. Other related data may be provided in the form of a link to an external database such as a museum catalogue.

An element is a piece of wood originating from a single tree. Examples include: one plank of a water well; a single wooden panel in a painting; the left-hand back plate of a violin; one beam in a roof; a tree trunk preserved in the soil; a living tree. The element is a specific part of exactly one object or sub object. An object will often consist of more than one element, e.g., when dealing with the staves (elements) of a barrel (object). One or more samples can be taken from an element and an element may be dated using one or more derivedSeries.

A sample is a physical specimen or non-physical representation of an element. Examples include: core from a living tree; core from a rafter in a church roof; piece of charcoal from an archaeological trench; slice from a pile used in a pile foundation; wax imprint of the outer end of a plank; photo of a back plate of a string instrument. Note that a sample always exists and that it can either be physical (e.g. a core) or representative (e.g. a picture). A sample is taken from exactly one element and can be represented by one or more radii.

A radius is a line from pith to bark along which the measurements are taken. A radius is derived from exactly one sample. It can be measured more than once resulting in multiple measurementSeries.

A measurementSeries is a series of direct, raw measurements along a radius. A single measurementSeries can be standardised or a collection of measurementSeries can be combined into a derived- Series. The measurements themselves are stored separately as values.

A derivedSeries is a calculated series of values and is a minor modification of the “v-series” concept proposed by Brewer *et al.* (2010). Examples include: index; average of a collection of measurementSeries such as a chronology. A derivedSeries is derived from one or more measurementSeries and has multiple values associated with it.

A value is the result of a single ring measurement. Examples include: total ring width; earlywood width; latewood width. The values are related to a measurementSeries or a derivedSeries. In case of a measurementSeries the variable and its measurement unit (e.g. microns, 1/100th mm etc) are recorded as well.

For a full description of the standard see Jansma *et al.* (2010).

17.2 Example file

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <tridas xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3   xsi:schemaLocation="http://www.tridas.org/1.2.1 ../dev/sourceforge/tridas/XMLSchema/1.2.1/
4   tridas-1.2.1.xsd"
5   xmlns="http://www.tridas.org/1.2.1" xmlns:xlink="http://www.w3.org/1999/xlink">
6 <project>
7   <title>Aegean Dendrochronology Project</title>
8   <identifier domain="dendro.cornell.edu">C</identifier>
9   <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
10  <lastModifiedTimestamp certainty="exact">1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
11  <type>Dating</type>
12  <description>Our key long-range goal is to build long multi-millennial scale tree-ring
13    chronologies in the Aegean and Near East that will extend from the present to the
14    early Holocene to cover, broadly speaking, the last 10,000 years of human and
15    environmental history. Our raison d'etre is to provide a dating method for the study
16    of history and prehistory in the Aegean that is accurate to the year. This kind of
17    precision has, up to now, been lacking in ancient studies of this area. Indeed, few
18    archaeological problems stimulate as much rancor as chronology, especially that of
19    the Eastern Mediterranean. The work of the Aegean and Near Eastern Dendrochronology
20    Project aims to help to bring some kind of rational and neutral order to Aegean and
21    Near Eastern chronology from the Neolithic to the present. </description>
22  <laboratory>
23    <name>Malcolm and Carolyn Weiner Laboratory for Aegean and Near Eastern
24      Dendrochronology</name>
25    <address>
26      <addressLine1>B48 Goldwin Smith Hall</addressLine1>
27      <addressLine2>Cornell University</addressLine2>
28      <cityOrTown>Ithaca</cityOrTown>

```

```

27         <stateProvinceRegion>NY</stateProvinceRegion>
28         <postalCode>14853</postalCode>
29         <country>USA</country>
30     </address>
31 </laboratory>
32 <category>Archaeology</category>
33 <investigator>Peter I Kuniholm</investigator>
34 <period>1976–present</period>
35 <reference>reference1</reference>
36 <object>
37     <title>White Tower, Thessaloniki</title>
38     <identifier domain="dendro.cornell.edu"
39         >28acb483-f337-412f-a063-59d911c37594</identifier>
40     <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
41     <lastModifiedTimestamp certainty="exact">1997-02-01T14:13:51.0Z</
42         lastModifiedTimestamp>
43     <type normalStd="Corina Dictionary" normalId="4" normal="Building">Building</type>
44     <description>The White Tower of Thessaloniki was originally constructed by the
45         Ottomans
46         to fortify the city's harbour.</description>
47     <coverage>
48         <coverageTemporal>Ottoman</coverageTemporal>
49         <coverageTemporalFoundation>Stylistic</coverageTemporalFoundation>
50     </coverage>
51     <location>
52         <locationGeometry xmlns:gml="http://www.opengis.net/gml">
53             <gml:Point srsName="urn:ogc:def:crs:EPSG:6.6:4326">
54                 <gml:pos>40.6263 22.9485</gml:pos>
55             </gml:Point>
56         </locationGeometry>
57         <locationPrecision>20</locationPrecision>
58         <locationComment>Thessaloniki, Greece</locationComment>
59     </location>
60 </object>
61 <object>
62     <title>Fourth floor</title>
63     <type>Floor</type>
64     <element>
65         <title>C-TWT-65</title>
66         <identifier domain="dendro.cornell.edu"
67             >89dbd409-03a3-42a0-9391-62c6be7009ad</identifier>
68         <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
69         <lastModifiedTimestamp certainty="exact"
70             >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
71         <type normalStd="Corina Dictionary" normalId="3" normal="Rafter">Rafter</type>
72         <description>15th Rafter from the south</description>
73         <taxon normalStd="Catalogue of Life Annual Checklist 2008" normal="Quercus"
74             normalId="49139">Quercus sp.</taxon>
75         <dimensions>
76             <unit normalTridas="metres"/>
77             <height>1</height>
78             <width>1</width>
79             <depth>1</depth>
80         </dimensions>
81         <authenticity>Original</authenticity>
82     </element>
83     <sample>
84         <title>C-TWT-65-A</title>
85         <identifier domain="dendro.cornell.edu"
86             >ff688357-b2d4-4394-a21a-90696cd4558c</identifier>
87         <createdTimestamp certainty="exact"
88             >1997-02-01T14:13:51.0Z</createdTimestamp>
89         <lastModifiedTimestamp certainty="exact"
90             >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
91         <type normal="Corina Dictionary" normalId="1" normalStd="Section"
92             >Section</type>
93         <samplingDate certainty="exact">1981-07-25</samplingDate>
94         <state>Dry</state>
95         <radius>

```

```

92 <title>C-TWT-65-A-B</title>
93 <identifier domain="dendro.cornell.edu"
94 >5b7baa8b-cd4e-4b3b-88fa-82939420e544</identifier>
95 <createdTimestamp certainty="exact"
96 >2006-05-04T18:13:51.0Z</createdTimestamp>
97 <lastModifiedTimestamp certainty="exact"
98 >2006-05-04T18:13:51.0Z</lastModifiedTimestamp>
99 <woodCompleteness>
100 <pith presence="absent"/>
101 <heartwood presence="incomplete"/>
102 <sapwood presence="complete"/>
103 <bark presence="present"/>
104 </woodCompleteness>
105 <measurementSeries>
106 <title>C-TWT-65-A-B-A</title>
107 <identifier domain="dendro.cornell.edu"
108 >8c50234e-8eda-41bb-b578-01cc881d1eal</identifier>
109 <createdTimestamp certainty="exact"
110 >1997-02-01T14:13:51.0Z</createdTimestamp>
111 <lastModifiedTimestamp certainty="exact"
112 >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
113 <analyst>Laura Steele</analyst>
114 <dendrochronologist>Peter I Kuniholm</dendrochronologist>
115 <measuringMethod normalStd="Corina Dictionary" normalId="1"
116 >Measuring platform</measuringMethod>
117 <interpretation>
118 <firstYear suffix="AD">1254</firstYear>
119 <statFoundation>
120 <statValue>8.3</statValue>
121 <type>t-score</type>
122 <usedSoftware>Corina 2.10</usedSoftware>
123 </statFoundation>
124 <deathYear suffix="AD">1535</deathYear>
125 <provenance>Possibly from the region of Serres</provenance>
126 </interpretation>
127 <values>
128 <variable normalTridas="Ring width"/>
129 <unit normalTridas="1/100th millimetres"/>
130 <value value="54"/>
131 <value value="111"/>
132 <value value="71"/>
133 <value value="40"/>
134 <value value="56"/>
135 </values>
136 </measurementSeries>
137 </radius>
138 </sample>
139 </element>
140 </object>
141 </object>
142 </project>
143 </tridas>

```

Format 18

TRIMS

Format name	TRIMS
Other name(s)	None known
Type	Text file
Extension(s)	rw
Read/write support	Read and write
Reference implementation	
Data / metadata	Data only
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	No
Multi series support	No
Original designer	Unknown

This is a simple data only text file format. These files were originally produced using the Henson rotary micrometer measuring stages but have largely been phased out.

- Line 1 - Initials of user that created the series
- Line 2 - Date the file was created in dd/MM/YY format
- Line 3 - Year of first data value (0 treated as undated series)
- Line 4+ - Space character followed by an integer data value in 1/100th mm
- Final line - Space character + 999 denoting end of series.

18.1 Example file

```

1 pb
2 05/10/94
3 1816
4 169
5 96
6 165
7 85
8 139
9 87
10 112
11 ...
12 999

```

Format 19

Tucson

Format name	Tucson
Other name(s)	Decadal, RWL, CRN, ITRDB, Time series format, TSF
Type	Text file
Extension(s)	Various including tuc, rwl, dec, crn
Read/write support	Read and write
Reference implementation	COFECHA
Data / metadata	Data with some structured metadata, however, standardisation of metadata is very poor resulting in metadata often being little more than free text comments
Calendar type	Astronomical
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Richard Holmes

19.1 Description

The Tucson format is perhaps the most widely used dendro data format. Unfortunately it seems there was never definitive documentation. Support for the format has been incorporated into a number of dendro applications but without format documentation there are variations in these implementations resulting in quite a lot of subtle differences in files. The often tight association between the Dendro Program Library (DPL) and the ITRDB means that perhaps the most definitive documentation for the format is the ITRDB website.

The Tucson format is best considered as covering two different sub-formats which are often referred to by their file extensions (RWL and CRN). RWL files are used for storing ring-width data, whereas CRN files are used for storing chronologies.

The ITRDB website includes detailed information on how to include structured metadata in Tucson format files. Unfortunately there are no tools for creating and/or validating Tucson files so the vast majority of files circulating in the community today (including those in the ITRDB) do not adhere to these standards.

19.2 RWL files

Tucson RWL files begin with three lines of metadata. Strictly these lines should contain structured metadata, but with no software to assist in this, users either only partially stick to these rules, or reject them entirely instead using the three lines as free-text comment lines. The metadata should be set out as follows:

- Line 1 - Chars 1-6 Site ID
- Line 1 - Chars 10-61 Site Name
- Line 1 - Chars 62-65 Species Code followed by optional ID number
- Line 2 - Chars 1-6 Site ID
- Line 2 - Chars 10-22 State/Country
- Line 2 - Chars 23-30 Species
- Line 2 - Chars 41-45 Elevation
- Line 2 - Chars 48-57 Lat-Long in degrees and minutes, ddmm or dddmm
- Line 2 - Chars 68-76 1st and last Year
- Line 3 - Chars 1-6 Site ID
- Line 3 - Chars 10-72 Lead Investigator
- Line 3 - Chars 73-80 comp. date

Then follows the data lines which are set out as follows:

- Chars 1-8 - Series ID - the series ID should be unique in the file so that it is clear where one series ends and another begins when multiple series are present in the same file.
- Next 4 chars - Year of first value in this row.
- Ten data values consisting of a space character and 5 integers. The file and last data line for a series may have less than 10 data values so that the majority of lines begin at the start of a decade.

The final data value should be followed by a stop marker which is either 999 or -9999. When a stop marker of 999 is used this indicates that the integer values in the file are measured in 0.01mm (1/100th mm) units, whereas if a -9999 stop marker is used the units are 0.001mm (microns). The stop marker is therefore used to indicate the end of the data series and the units the data are stored in.

There appears to be no official specification as to how missing rings should be encoded, but the standard notation seems to be to use -999 or 0.

19.3 CRN files

Tucson CRN files are used to store chronology data. In addition to each data values they also have space for a sample depth or count value to record how many values were combined to give each data value. CRN files should strictly begin with the same 3 header lines that are described above for RWL. Like RWL files the specification is often partially adhered to and at times ignored completely.

The data lines for CRN files are quite different to RWL:

- Chars 1-6 - Series ID
- Next 4 chars - Year of first value in this row.
- Ten data value blocks consisting of four integer characters for the data value, then a space, then two integer characters for sample depth.

The stop marker in a CRN file should be 9990.

19.4 Workarounds and quirks

- No information was given as to how to handle the non-existent year 0AD/BC. For data files with years all in the AD period, this is not a problem. Most dendro software seem to treat year numbers in Tucson files as using the 'Astronomical Calendar' whereby 1 = 1AD, 0=1BC, -1=2BC etc. This goes against what most dendrochronologists assume (and do) when using Tucson files. For instance most people that work entirely in the BC period use negative integers to represent BC years e.g. -5 as 5BC. With no clear specification and different people interpreting the format in different ways, there is no way of being certain what data negative year numbers in Tucson files mean.
- Tucson format places a restriction of just four characters to the year values. This means that strictly the earliest value a Tucson file can represent is -999. Some users work around this by steeling the last character of the series ID to give them five characters for the year. For example: ABCDEFG-9999. This conversely limits the series ID to 7 characters. To add to the confusion, other users have been known to add an arbitrary number (e.g. 5000) to all year numbers to overcome this problem.
- The fact that 999 is used as the stop marker for series in 1/100th mm means that Tucson files cannot store a ring value of 9.99mm. In the unlikely event that a sample should have this large a ring, it should be rounded up or down to 998 or 1000.
- Some programs appears to add padding values after the stop marker to fill the rest of the 10 data values in the row.
- Some data files seem to use 9990 as a stop marker
- Some files appears to use a full-stop character to indicate empty data values after the stop marker.
- Data values in RWL files are space delimited, however some programs use tabs instead.
- When reading Tucson files, COFECHA and ARSTAN ignore all lines that do not match the standard data line format. As such, some users have used this to enable them to include multiple comment lines in their files.
- The ITRDB documentation says they should be recorded as DDMM or DDDMM, but this along with sign (N,S,E,W,+ or -) would require 11 characters, when the Tucson specification only allows for 10. Perhaps this was due to an assumption that all places would be in the northern hemisphere? This has resulted in a large amount of variation in the way that coordinates are recorded making it extremely difficult to parse them without error. Here are some examples (including some that use 11 chars not 10):

```

- 4652N01101E           - 4652-01101
- +4652-01101           - 465201101
- N4652E01101          - 4652 01101

```

19.5 Example file - raw series

1	107	1	OBERGURGL									
2	107	2	AUSTRIA	NORWAY	SPRUCE	6726	4652N01101E	1911	1959			
3	107	3	GIERTZ					08	76			
4	107011	1911	78	93	43	100	93	110	135	115	102	
5	107011	1920	92	125	110	135	98	80	75	125	102	110
6	107011	1930	105	105	95	120	135	140	110	120	130	135
7	107011	1940	120	130	130	165	135	145	155	160	88	135
8	107011	1950	140	150	140	130	115	130	130	110	110	135
9	107011	1960	125	120	135	160	15	102	105	135	105	140
10	107011	1970	120	115	100	110	110	999				
11	107012	1862	450	580	550	480	620	420	390	420		
12	107012	1870	360	370	300	360	470	460	410	430	510	500
13	107012	1880	500	510	500	410	380	430	340	380	350	400
14	107012	1890	290	260	270	320	340	370	330	310	240	170
15	107012	1900	280	300	300	310	350	400	300	280	280	180
16	107012	1910	190	290	270	210	230	300	220	360	240	260
17	107012	1920	200	270	250	230	270	210	160	210	220	200
18	107012	1930	170	250	200	130	140	210	210	180	190	180
19	107012	1940	170	180	190	190	190	200	190	180	110	180
20	107012	1950	220	230	180	220	200	240	220	210	240	999

19.6 Example file - chronology

1	107089	1	Antalya , Elmali Isletmesi	CDLI									
2	107089	2	Turkey Cedar	1800M	3640	02955	1370	1988					
3	107089	3	Peter I. Kuniholm										
4	1070001370	567	11115	1 798	11105	11407	1 398	1 436	1 543	1 490	1 225	1	
5	1070001380	127	1 39	1 29	1 69	1 178	1 445	1 227	1 510	11020	11120	1	
6	1070001390	1390	11310	1 979	11585	11111	1 444	1 214	1 520	1 275	1 224	1	
7	1070001400	153	1 371	1 567	1 711	1 835	1 687	1 322	1 291	1 291	1 218	1	
8	1070001410	168	1 378	1 557	1 410	1 315	1 202	1 531	1 765	1 797	1 840	1	
9	1070001420	440	1 774	1 946	1 838	1 397	1 380	1 206	1 510	1 695	1 521	1	
10	1070001430	461	1 978	1 967	1 857	1 978	1 733	1 522	1 333	1 577	1 477	1	
11	1070001440	730	1 752	1 932	1 955	1 898	1 629	11170	1 738	1 920	1 363	1	
12	1070001450	863	1 896	1 965	1 390	1 172	1 126	1 69	1 209	1 313	1 883	1	
13	1070001460	1255	11220	11364	11035	11364	11282	11364	11611	11369	11273	1	
14	1070001470	1797	12035	11821	11927	11819	11807	11464	21421	21009	21089	2	
15	1070001480	1042	21040	21404	2 955	21291	2 982	21186	21042	2 728	2 781	2	
16	1070001490	800	21040	2 503	2 869	21387	21365	21574	21591	22178	21594	3	
17	1070001500	1629	31282	31126	31409	31433	31406	31239	31479	3 990	31063	3	
18	1070001510	1026	31035	31175	31217	31500	31358	31171	31140	31005	31340	3	
19	1070001520	1225	31164	31283	31496	31439	31603	31335	3 982	3 973	31147	3	
20	1070001530	1086	31146	41403	41454	41209	41451	41292	4 964	41003	41289	4	
21	1070001540	895	4 951	4 745	4 835	4 800	41182	4 952	41097	4 973	4 973	4	
22	1070001550	1158	41370	41245	41392	41215	41047	51133	5 847	5 961	51295	5	
23	1070001560	1287	51082	5 899	51012	51195	51409	51107	5 962	5 970	51031	5	
24	1070001570	990	51028	51206	51092	51414	51209	51090	51265	51261	51019	5	
25	1070001580	791	5 995	5 956	5 933	61144	61022	61001	61007	61097	61290	6	
26	1070001590	1263	6 902	71002	71151	71032	8 968	8 592	8 940	8 936	81131	8	
27	1070001600	1098	81128	81334	81255	91136	91097	101273	101075	10 952	10 897	10	
28	1070001610	915	10 991	10 735	10 708	10 627	10 848	101010	10 872	10 959	101138	10	
29	1070001620	1173	101122	101191	101146	10 928	10 820	10 935	10 741	10 812	101126	10	
30	1070001630	1123	10 781	101111	101054	101275	101052	101068	101049	101016	10 970	10	
31	1070001640	1093	101159	101023	101159	101060	101117	101314	10 843	101057	101040	10	
32	1070001650	1030	101268	10 971	101059	101078	101170	101159	101388	101194	101260	10	
33	1070001660	917	101222	101052	101165	101325	101608	101161	121181	12 931	12 992	12	
34	1070001670	750	12 675	12 614	12 638	12 624	12 600	12 506	12 681	12 887	12 708	12	
35	1070001680	797	12 940	12 955	12 886	12 878	12 970	12 916	12 861	12 861	121021	13	
36	1070001690	928	13 961	131043	13 936	13 939	131003	13 619	13 846	13 838	13 822	13	
37	1070001700	717	13 699	14 746	14 900	141022	14 781	14 968	141028	141051	141341	14	
38	1070001710	980	14 817	14 718	14 642	14 554	14 589	14 637	14 677	16 710	16 877	16	
39	1070001720	930	16 931	16 718	16 721	16 616	16 576	16 519	16 790	161046	161067	16	
40	1070001730	1047	171141	181080	181128	181144	181112	191066	191252	19 971	191076	19	
41	1070001740	1284	191242	191001	191145	191219	191162	19 576	20 979	231148	231062	23	
42	1070001750	1119	231255	231267	231352	231397	231487	231116	231092	231150	23 938	23	
43	1070001760	1118	241240	241258	241023	24 971	241071	241124	241225	241135	241114	24	
44	1070001770	1072	241171	24 853	24 964	241075	24 820	241154	241059	241270	241022	24	
45	1070001780	1098	24 903	241038	241147	241141	241162	24 782	241221	241424	241208	24	
46	1070001790	974	241265	241256	241281	241166	241580	24 889	24 955	241158	241101	24	
47	1070001800	949	24 990	24 813	24 758	24 821	24 914	24 889	24 999	24 991	241163	24	
48	1070001810	1068	241184	24 852	24 870	241037	241070	241132	241047	24 978	24 852	24	
49	1070001820	839	241063	241045	24 957	24 958	24 997	24 841	241209	241053	241013	24	
50	1070001830	920	241103	241151	241166	24 850	24 962	24 944	24 871	24 989	24 906	24	
51	1070001840	697	24 973	24 779	24 647	24 689	24 731	24 981	24 709	24 949	24 580	24	
52	1070001850	619	24 345	24 545	24 688	24 723	241046	24 738	24 785	24 742	24 815	24	
53	1070001860	842	241015	24 888	24 884	24 792	24 594	24 902	24 885	24 841	24 770	24	
54	1070001870	822	24 710	24 838	24 783	24 697	24 768	24 515	24 670	24 855	24 793	24	
55	1070001880	1021	25 932	25 799	25 902	251038	251017	25 739	25 750	25 963	251149	25	
56	1070001890	798	24 871	24 870	24 625	24 772	24 827	241046	241182	24 701	24 704	24	
57	1070001900	977	241237	241249	241162	241118	241007	241271	241123	241116	241045	24	
58	1070001910	1167	24 827	24 482	24 952	241370	241260	24 783	241169	241096	241108	24	
59	1070001920	1387	241484	241293	241182	241282	241527	241261	241146	24 920	24 859	24	
60	1070001930	1235	241335	24 799	24 819	241000	24 763	241111	241019	24 916	241252	24	
61	1070001940	1537	241387	231217	23 929	23 685	23 894	231106	231123	231089	23 896	23	
62	1070001950	1384	231172	231151	231130	231244	231187	231118	231144	231268	231245	23	
63	1070001960	1547	231015	231208	231203	231109	23 602	23 690	23 684	23 901	23 968	23	
64	1070001970	963	231095	231368	231069	231084	21 936	191146	191362	191288	191572	19	
65	1070001980	1034	19 870	191186	191047	19 968	191089	191272	191231	191083	189990	0	

Format 20

Tucson Compact

Format name	Tucson Compact
Other name(s)	Compact
Type	Text file
Extension(s)	rwm
Read/write support	Read and write
Reference implementation	Various DPL programs including FMT
Data / metadata	Data only
Calendar type	Astronomical
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Richard Holmes

20.1 Description

The Tucson Compact format was design by Richard Holmes for use with a number of the applications in the Dendro Program Library (DPL). Holmes designed it as a space saving alternative to the standard Tucson format at a time when disk space was expensive. The format never really caught on, perhaps due to the complexity and variability of the format.

The key feature of Tucson Compact format is the inclusion of a code that describes the layout of the data within the series. This code means that only the required amount of space is allocated to each data value in the text file with little wastage. No space is provided for metadata.

Tucson Compact files can contain one or more series of data so the description of a data series below can be repeated multiple times in a single file. All lines should be 80 characters long and the first line of a series is denoted by a tilde (~) in the final column. This meta line contains four fields:

- Chars 0-9 = number of data values terminated with =N
- Chars 11-19 = start year terminated with =I
- Chars 21-68 = series title
- Chars 69-79 = fortran format descriptor
- Char 80 = Tilde marker

The Fortran format descriptor in the example below is `-2(26F3.0)`. The constituent parts are as follows:

- `-2` = this is the scaling factor for the data values. In this case $-2 = 10^{-2} = 0.01$. Please note that in the Convert5 program this scaling factor is only read once in the first header line so files with multiple series each with different scaling factors will read incorrectly.
- `26F` = means there are 26 values in each line
- `3.0` = means that each data value should be read as 3 integer values

The example below therefore means there are 26 data values per line each consisting of 3 digits which should be interpreted by multiplying by 0.01 (i.e. values are in 1/10ths mm).

20.2 Example file

```

1      176=N      1277=I ABCD01                                -2(26F3.0)~
2 142338334409362308360264325318134151219268290222278258173198294202170176172121
3 87130114108170135131126 87100 86104103127112 94 96120168149119124 79 67 88 90
4 93 77 49 42 53 38 57 43 50 41 56 66 62 55 55 45 47 63 58 60 44 45 49 50 62 61
5 43 54 91 60 56 43 52 51 65 68 55 44 41 75 94 78 63 69 58 75 55 47 58 46 62 45
6 52 50 77 50 63 75 77 64 66 57 80 57 78 65 68 75 65 98 85 82119 89 85 87 83108
7 129123160117129121 88 69 97 77 96106 71 89 50 65133 89 88 50 60 95 95 91102158
8 83 55 98 70 45 46 40 36 64 58 52 58 56 94 51 48 47 60 49 48

```

Format 21

VFormat

Format name	VFormat
Other name(s)	OJ Format
Type	Text file
Extension(s)	Various depending on data type but commonly !oj
Read/write support	Read and write
Reference implementation	VFormat
Data / metadata	Data with some structure metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	No
Relative dating support	No
Multi series support	Yes
Original designer	Thomas Reimer and Hans-Hubert Leuschner

21.1 Description

A relatively extensive format which includes highly encoded header lines for metadata. VFormat files have an array of file extensions depending on the type of data the files contain.

VFormat files can contain multiple data series. Each series contains 2-4 header lines followed by a number of data lines. The metadata fields are encoded into the header lines in specific character positions. In line 1 the character positions are as follows:

- 1-12 = Series identifier. The series identifier also determines the filename. If there is just one series in the file then the series identifier will be the same as the filename. For files with multiple series, the filename will use characters 1-7 of the series identifiers that are the same throughout the file with the remaining (different) characters replaced by an underscore. The 8th character of the filename would contain a running number for files that would otherwise be named the same. The series identifier is made up of the following characters:
 - 1 = Code representing the project or country
 - 2 = Code representing the region of ecological area
 - 3-4 = Code number for sample site (optionally encoded using hexadecimal or hexatresimal to enable values greater than 99).
 - 5-6 = Series/tree number (optionally encoded using hexadecimal or hexatresimal to enable values greater than 99).

- 7 = Height code encoded as follows: 1 = 1m, 2=2m, 9=9m, A=10m, B=11m, S = Lumber height 30cm, T = breast height =130cm.
- 8 = Running number if several series have the same values in columns 1-7.
- 9 = Fixed as a dot character
- 10 = Either ! (single), % (partial), # (mean curves or chronologies)
- 11 = Code for statistical treatment. One of F (frequency filtered series); I (index); M (mean); O (original); P (pointer-year stat); Q (cluster-pointer-year stat); R (residual); S (moving deviation or variance); T (trend, fitted curve, model); W (wuchswert); X (series with standardized running mean and variance); Z (central moment, deviation or variance between several series).
- 12 = Code for the measured parameter. One of D (mean density); F (earlywood width); G (maximum density); J (ring width); K (minimum density); P (percentage latewood); S (width of latewood).
- 13-15 Measurement units
- 16-20 Length of series
- 21-24 Species either encoded using ITRDB taxon codes or by using the first two letters of the genus and species.
- 25-30 Year of the last ring
- 31-50 Description
- 51-58 Measurement date (ddMMyy or ddMMyyyy)
- 59-60 Initials of author
- 61-68 Last modified date (ddMMyy or ddMMyyyy)
- 69-70 VFormat version identifier (00,01 etc)
- 71-73 Estimated number of missing rings as the start of the series
- 74-75 Standard error of this estimate (. if unknown)
- 76-78 Estimated number of missing rings at the end of the series
- 79-80 Standard error of this estimate (. if unknown)

The second data line is a free text comment up to 80 characters.

VFormat files from version 10 onwards then contain a third header line. This contains 8 floating point numbers of 10 digits each. These represent:

- Longitude
- Latitude
- Altitude
- Height of the tree's measurement
- Four other user definable numbers

VFormat files from version 20 onwards contain a fourth header line. This is of the same format as line 3 but each of the values is user definable.

Following the 2-4 header lines come the data lines. These lines are made up of 10 data fields each containing 8 characters. Each data field is made up as follows:

- Two character code for validity and importance:
 - space = full validity
 - ! = not yet used
 - " = not yet used
 - # = not yet used
 - \$ = no validity for long-term evaluations
 - % = no validity for single-value evaluations
 - & = no validity except for cumulative stats
 - ' = no validity at all, unknown value

The second character is a pseudo-binary character used to define a weighting factor. For full details of the complex method for calculating this weighting factor see the VFormat documentation.

- One character user definable code for recording information about the data value

- Five digit floating point data value which is divided by 100 for interpretation

21.2 Example file

```

1 G1101020.!OJmm      81Qusp  1510FLA-02  32 /572                HL01.04.9002  810 10 .
2 G1101020.!OJ/S20102_0.!OJ/_
3      281      221      225      169      178      197      126      103      112      130
4      132      207      176      175      126      150      99      131      187      204
5      218      172      202      115      135      130      196      135      142      129
6      144      116      92      71      109      120      137      98      86      117
7      64      79      72      61      62      82      75      81      83      69
8      83      66      84      95      85      94      87      99      92      109
9      150      108      70      113      119      120      122      107      111      114
10     123      145      112      145      164      158      122      177      155      182
11     153
12 G1101050.!OJmm      121Qusp  1516FLA-05  13 /586                HL01.04.9002  1510 13 .
13 G1101050.!OJ/S20105_0.!OJ/_
14     448      286      341      213      346      371      745      719      580      466
15     487      353      279      323      422      436      351      238      135      172
16     179      210      277      145      165      261      263      190      194      183
17     127      110      144      189      135      154      217      110      115      99
18     106      101      106      198      191      185      185      160      112      152
19     93      95      83      176      165      193      139      101      93      113
20     85      145      174      157      132      130      74      52      114      138
21     174      132      144      125      83      124      118      127      150      189
22     152      133      117      91      104      96      56      90      130      126
23     103      163      92      103      174      99      117      85      123      116
24     147      127      145      133      155      144      114      115      121      111
25     174      113      112      89      99      130      111      104      164      110
26     139

```


Format 22

WinDENDRO

Format name	WinDENDRO
Other name(s)	None known
Type	Text file
Extension(s)	txt
Read/write support	Read only
Reference implementation	WinDENDRO
Data / metadata	Data with some structured metadata
Calendar type	Gregorian
Absolute dating support	Yes
Undated series support	Yes
Relative dating support	No
Multi series support	Yes
Original designer	Regent Instruments

22.1 Description

WinDENDRO format is a dendro text file format designed by Regent Instruments for their WinDENDRO software. Regent Instruments claims the format is proprietary. Although it is unclear whether such a claim is legally binding for a plain text file, the authors of DendroFileIOLib have decided to comply by not implementing a WinDENDRO format writer. However, in the interests of the dendro community and to ensure users can gain access to their data, DendroFileIOLib does include support for reading WinDENDRO format files.

WinDENDRO files differ from most other formats in that they contain a great deal of information specific to the image used to measure the sample. The WinDENDRO software allows users to measure ring widths from scans or photographs of samples rather than by using a traditional measuring platform.

WinDENDRO files are really just tab-delimited text files with data in columns in a specific order with a few additional header lines.

Line 1 should contain 8 tab-delimited fields

- Field 1 = WINDENDRO
- Field 2 = WinDENDRO file format version number, either 3 or 4
- Field 3 = Orientation of the data: R = in rows; C = in columns. All WinDENDRO files are in rows

- Field 4 = The column number where the data values begin. For version 3 files this is 13 and version 4 files this is 36
- Field 5 = The direction the data is recording in: P = pith to bark; B = bark to pith
- Field 6 = Whether the data is recorded incrementally (I) or cumulatively (C). WinDENDRO files are always incremental.
- Field 7 = Whether the bark width has been measured (Y or N). If yes, then there will be one more data value than there are rings
- Field 8 = RING

Line 2 contains the field names. For version 3 files these are:

- TreeName - The name of the tree being measured
- Path identification - ID of the path along which the series is measured
- Site identification - Name of the site from which the tree was taken
- YearLastRing - Year of the last ring in the series
- Sapwood - Distance (in mm) from the start of the sample to the start of the sapwood.
- Tree height - Height of tree in metres
- Tree age - Age of the tree. If unknown this should be 0, then it is assumed to be equal to the number of rings
- SectionHeight - Height up the tree in metres at which the sample was taken
- User variable - User defined variable - must be numerical
- RingCount - Number of rings the series contains
- DataType - Keyword indicating the type of data measured. This can be: RINGWIDTH; EARLYWIDTH; LATEWIDTH; EARLYWIDTH%; LATEWIDTH%; DENSITY; EARLYDENSITY; LATEDENSITY; MAX-DENSITY; MINDENSITY; RINGANGLE.
- OffsetToNext - The number of lines to skip to go to the next data line of the same type. For instance a file can contain earlywood and latewood data for multiple samples. If this is the case then each sample will have two rows, one for each variable, and the OffsetToNext field will be 1.

In addition to these fields, version 4 files also include the following:

- ImageName - The filename for the image used to do this analysis. If the image was taken directly from the scanner or camera then this field will be SCANNER
- Analysis Date Time - Date and time the measurements were initially saved to disk in format dd/mm/YYYY HH:mm
- Acquisition Date Time - Date and time the image file was acquired in format dd/mm/YYYY HH:mm
- Modified Date Time - Date and time the file was last modified in format dd/mm/YYYY HH:mm
- ImageSize H V NBits Channel - The image size in pixels followed by bits per pixel per channel (8 or 16), channel used for analysis (Grey, RGB, R G or B)
- CalibMethod XCal YCal EditedDendro - Method of calibration: Intr (Intrinsic); Obj (ObjKnownDiam). This is followed by the size of a pixel and Y or N indicating if the image has been edited in WinDENDRO
- ScannerCamera Make Model Software - Details about the imaging hardware
- LensFocLength [35mm] - The 35mm equivalent focal length of the imaging lens
- PathBegX BegY EndX EndY Width - The coordinates for the start of the path/radius followed by the path width
- RingBoundary AutoMan Meth Precise - Details about the path taken. Ring boundary - Tg (tangent to ring) or Perp (perpendicular to path); Detection method - A (automatic) or M (manual); Ring detection method - Int (intensity differences) or T&S (teach and show); whether the 'more precise detection' method is active (Y) or not (N)
- EarlywoodDef - Earlywood-latewood transition criteria
- DensActive Media Calib - Density Analysis active (Y or N); Density Media setting (F - negative file or photo, W wood direct xray, positive film or photo); Light calibration setting (Acq - after image acquisition, Man - manual; No - none)
- DensNSteps MatDens Interpol - Number of steps and the density of the step wedge used for calibration followed by the interpolation method used between steps: Lin (Linear) Spl (Spline)
- DensStepsThick - The thickness of each step of the wedge used for density calibration

- DensStepsLightInt - The light intensity of each step of the wedge determined during the light intensity calibration
- DensStepsWoodDens - Equivalent wood density of each step of the wedge determined during light intensity calibration
- DiskArea - Area of the sample
- DiskPerim - Perimeter of the sample
- DiskAvgDiam - Average diameter of the sample
- DiskFormCoef - Sample area form coefficient
- CompWoodArea - Total area occupied by the compression areas
- VoidArea - Total area occupied by the void areas
- PathLength - Length of radius measured

Lines 3+ contain the actual data and metadata, one line for each series. Following the 13 or 36 columns of metadata (depending on file version) there are x number of columns containing ring values. The values are recorded as floating point data. The units for these data values are: mm for widths; % for percentages; g/cm^3 for densities; radians for angles.

References

- Aniol, R., 1983 Tree-ring analysis using CATRAS. *Dendrochronologia* 1:45–53.
- Brewer, P., Murphy, D., and Jansma, E., 2011 TRiCYCLE: a universal conversion tool for digital tree-ring data. *Tree-Ring Research* 67(2):135–144.
- Brewer, P., Sturgeon, K., Madar, L., and Manning, S., 2010 A new approach to dendrochronological data management. *Dendrochronologia* 28(2):131–134.
- Jansma, E., Brewer, P., and Zandhuis, I., 2010 TRiDaS 1.1: The tree-ring data standard. *Dendrochronologia* 28(2):99–130.
- Knibbe, B., 2008 *PAST4 - Personal Analysis System for Treering Research software version 4.5*. SCIEM.
- Rinn, F., 2008 *TSAP-Win software*. Rinntech, Heidelberg.
- Tyers, I., 1999 *Dendro For Windows program guide*. ARCUS Report 500.