

TRiCYCLE Users Manual

Peter Brewer, Daniel Murphy and Esther Jansma

Version 0.2.1

Cornell University, Ithaca, New York
Cultural Heritage Agency (RCE/OCW), Amersfoort, The Netherlands

Contents

1. Acknowledgements	1
2. What is TRiCYCLE?	2
3. Installation	4
4. How to use TRiCYCLE	5
5. Options	7
5.1. Character sets	7
5.2. Metadata editor	8
5.3. Naming convention	8
5.4. Privacy options	9
6. Help and more information	10
References	11
A. Belfast Apple	13
A.1. Description	13
A.2. Example file	14
B. Belfast Archive	16
B.1. Description	16
B.2. Example file	17
C. Besançon	18
C.1. Description	18
C.2. Additional information	19
C.3. Example file	19
D. CATRAS	21
D.1. Background	21
D.2. Reading byte code	22
D.2.1. Strings	22
D.2.2. Integers	22
D.2.3. Real numbers	22
D.2.4. Categories	23
D.2.5. Dates	23
D.3. Metadata	23
D.4. Data	23
D.4.1. Ring widths	25
D.4.2. Chronologies	25

E. Comma Separated Values	26
E.1. Description	26
E.2. Example file	27
F. Corina Legacy	28
F.1. Description	28
F.2. Example file	31
G. DendroDB	32
G.1. Description	32
G.2. Example file	33
H. Heidelberg	34
H.1. Description	34
H.2. Example file - raw series	37
H.3. Example file - chronology	37
I. Microsoft Excel 97/2000/XP	39
I.1. Description	39
I.2. Example file	40
J. Microsoft Excel 2007	41
J.1. Description	41
K. Nottingham	42
K.1. Description	42
K.2. Example file	43
L. ODF Spreadsheet	44
L.1. Description	44
M. Oxford	45
M.1. Description	45
M.2. Limitations	46
M.3. Example file	47
N. PAST4	48
N.1. Dating	51
N.2. Example file	52
O. Sheffield	53
O.1. Description	53
O.2. Dating	55
O.3. Example file	55
P. Topham	57
P.1. Description	57
P.2. Example file	57
Q. TRiDaS	58
Q.1. Description	58
Q.2. Example file	59
R. TRIMS	63
R.1. Example file	63

S. Tucson	64
S.1. Description	64
S.2. RWL files	65
S.3. CRN files	65
S.4. Workarounds and quirks	66
S.5. Example file - raw series	67
S.6. Example file - chronology	67
T. Tucson Compact	69
T.1. Description	69
T.2. Example file	70
U. VFormat	71
U.1. Description	71
U.2. Example file	73
V. WinDENDRO	74
V.1. Description	74
W. Licenses	77
W.1. Apache 2.0 license	77
W.2. MIT License	80
W.3. ICU License	81
W.4. GNU Lesser General Public License LGPLv3	81
W.5. Common Development and Distribution License	84

1. Acknowledgements

Funding for the development of TRiCYCLE has been provided by NWO section Humanities through the DCCD project and through the various patrons of the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology.

We would like to thank the numerous contributors to the open source libraries used by TRiCYCLE and its associated libraries. We would also like to thank Lars-Åke Larsson, Rémi Brageu, Pascale Fraiture, Henri Grissino-Mayer, Patrick Hoffsummer, Bernhard Knibbe, George Lambert, Catherine Lavier, Hubert Leuschner, Martin Munro, Ian Tyers and Ronald Visser for assistance understanding many of the data formats implemented.

2. What is TRiCYCLE?

TRiCYCLE is a universal dendrochronology file format converter. It currently has support for reading and writing 22 different file formats:

Table 2.1.: Formats supported by TRiCYCLE

Format	Read support	Write support
Belfast Apple	✓	✓
Belfast Archive	✓	
Besançon	✓	✓
CATRAS	✓	✓
Comma Separated Values	✓	✓
Corina Legacy	✓	✓
DendroDB	✓	
Heidelberg	✓	✓
Microsoft Excel 97/XP/2000	✓	✓
Microsoft Excel 2007	✓	✓
Nottingham	✓	✓
ODF Spreadsheet	✓	✓
Oxford	✓	✓
PAST4	✓	✓
Sheffield	✓	✓
Topham	✓	✓
TRiDaS	✓	✓
TRIMS	✓	✓
Tucson	✓	✓
Tucson Compact	✓	✓
VFormat	✓	✓
WinDENDRO	✓	

TRiCYCLE extracts both data and any metadata present in files and converts them to the Tree-Ring Data Standard (TRiDaS) data model. As TRiDaS is capable of representing the full range of dendro data and metadata, it is then possible to write out the file to any one of the supported formats. Key features of TRiCYCLE are:

- Seamless support for units where possible
- Interpretation of all metadata
- Handling of different character sets and line feeds from different operating systems
- Comprehensive warning and exception system which provides detailed feedback when errors are detected in files

For a complete discussion of TRiCYCLE and its underlying libraries please see (Brewer et al., in review).

3. Installation

TRiCYCLE is a Java application and so can be installed on any modern operating system. To make installation more familiar though we have packaged it up into native installers for Windows, Mac OSX and Linux. Download the relevant package for your operating system from the SourceForge <http://tridas.sf.net> website.

Windows - Run the setup program and follow the steps. The program will be installed to your hard disk and shortcuts added to your start menu. If you do not have Java installed on your system or you do not have the required version the installer will provide you with assistance to do so.

Mac OSX - Open the .dmg file in Finder. Drag the TRiCYCLE.app file into your Applications folder, or wherever you'd like it installed. MacOSX comes pre-installed with Java so there is no need to install it separately.

Linux - An Ubuntu deb package is provided for TRiCYCLE. Install this package with your standard package manager (e.g. `sudo dpkg --install TRiCYCLE_X.X.deb`). It includes information on the required dependencies therefore it should install everything you need if you are running Ubuntu. On other distributions you may find that the dependencies do not install automatically and the TRiCYCLE installation fails. If this is the case you will have to install sun-java6-jre first manually.

4. How to use TRiCYCLE

The first step is to specify the format of your input file(s). Choose your input file format from the pull down list on the File List page. If you are uncertain what format your file is in, you can use Identify file format option in the help menu. Due to the fact that some formats are very similar, Corina may suggest the file is one of several formats. If this is the case you will need to either check the file format descriptions in the appendices, or try each format in turn.

The next stage is to specify the file(s) that you would like to convert. This can be done in a variety of ways:

- Click the browse button
- Use the File > Open menu
- Drag files onto the dialog box from your file manager (e.g. Finder on MacOSX, My Computer on Windows or Nautilus, Dolphin, Konqueror etc on Linux).

Once you have your list of files prepared you can then go to the Convert tab.

On the Convert page, the next thing you need to do is select the desired output format from the drop down list. Next, press the convert button and after a short delay your files should appear in the list below. At the bottom of the window, you'll see a summary showing how many files were processed, how many of the conversions failed and how many were converted successfully but with warnings.

The results of the conversion are shown in a tree view on the convert tab. Files that failed to convert are highlighted by a red cross along with a message explaining what went wrong. Each file that converted successfully and with no warnings is shown with a green tick icon below which are shown the output file or files. Depending on the input and output formats chosen, a input file may be converted into one or more output files as some formats can store just one series while others can store multiple series.

If there were warnings produced during the conversion process, then the file will be marked with a orange exclamation icon. Warnings can be associated with either the process of reading the input file, or writing the output file. They can also be related to a single series within the file or the input file as a whole. The warning messages are displayed to illustrate the context of the warning. Longer warnings will scroll of the edge of the window, but if you hover your mouse over the warning a tool-tip will show the entire message.

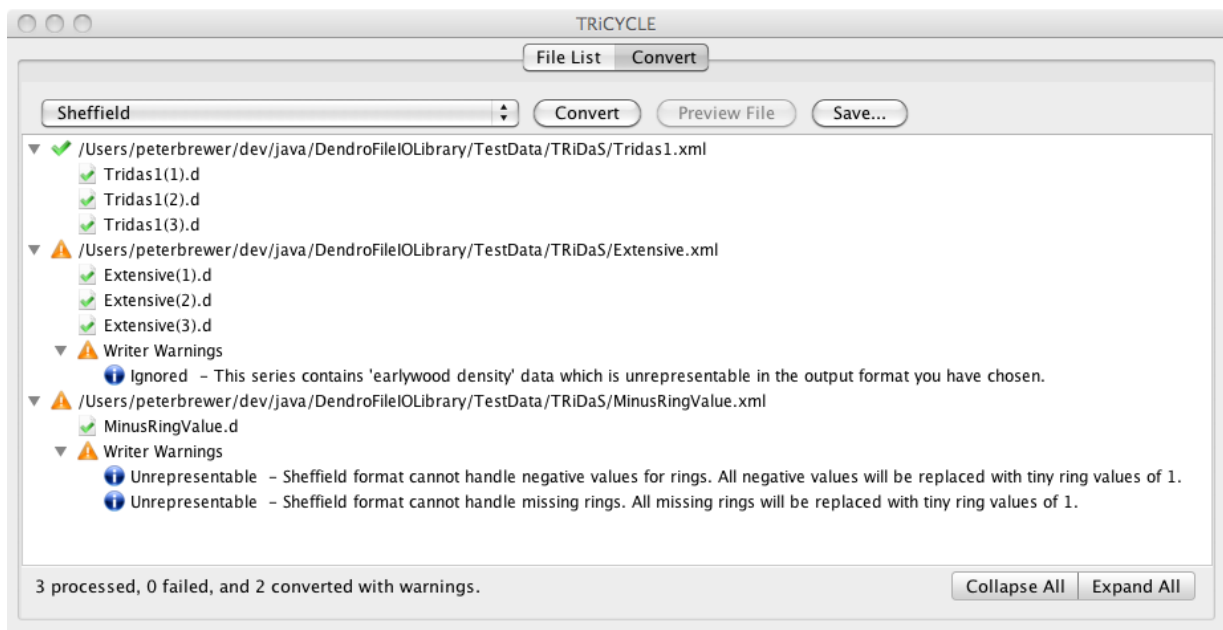


Figure 4.1.: Screen shot showing the conversion of three TRiDaS files into Sheffield format. The second and third files both include warnings that the Sheffield format is unable to fully represent all the data in the input files.

If you would like to preview the result of the conversion process you can double click on the output files and they will be displayed in a text viewer. This option is not, however, available for binary formats such as CATRAS and Excel.

Once you are happy with the results of the conversion you can save the files permanently to disk by pressing the save button. It will offer you the option of specifying which folder to save the files to.

5. Options

The options panel is available from the file menu. It is split into two sections: Reader config and Writer config.

5.1. Character sets

The character set can be set for both the file being read and the file being written. The character set is the system for pairing computer character codes with the character glyphs that we read. The widely used standard was originally ASCII, but this does not include diacritic characters, and characters specific to certain languages. There have since been many character encodings proposed (e.g ISO 8859-1 for Western Europe and ISO 8859-7 for Greece) as well as some that are specific to Windows and Mac operating systems (e.g. Windows-1252 and MacRoman). The character set that is becoming most widely used is Unicode UTF-8. This is capable of representing all 107,000+ distinct characters while remaining backwards compatible with ASCII for the 128 characters that it is able to represent.

If an incorrect character encoding is used to interpret a file, normally the majority of characters will display correctly (where the character sets share the same encodings) but more unusual characters will be displayed incorrectly - typically square boxes or question marks.

TRiCYCLE can use the NIO package to attempt to automatically detect which encoding a file is in. Unfortunately, there is no full-proof way to do this, so by default, this feature is turned off. If you are having problems with character encodings you may like to choose 'Automatic' in the charset box if you have no idea what character encoding your file is in.

The character encoding is set to the default for the operating system you are running. For instance on MacOSX this will be MacRoman and for Windows it will be Windows-1250. If you know your input file is in a different encoding you should set it in the input charset box. If your output file needs to be read on an operating system other than the one you are currently running, then you may like to override the writer charset. Please note that for certain writers, the character set used is part of the file specification (e.g. TRiDaS must be UTF-8). In this case your choice will be ignored.

The final complication with regards character sets is the line feed character(s). For historical reasons different operating systems use different characters to represent a new line.

Depending on the software that is used to read a file, this can cause problems. TRiCYCLE itself will automatically adapt to files with any type of line feed characters so reading files in TRiCYCLE will never be a problem. When writing out files, TRiCYCLE will use the default line feed for the operating system you are running, unless you choose a platform specific character set. For instance if you run TRiCYCLE on Windows and choose a MacRoman writing charset, TRiCYCLE will use Mac style line feeds.

5.2. Metadata editor

TRiCYCLE works by reading in a data file and translating it into the TRiDaS data model. TRiDaS has a rich array of fields to represent all manner of dendro data and metadata. Although most of these are optional, the TRiDaS specification requires that a handful of these are always filled in. Unfortunately many of the legacy data formats do not contain information for these mandatory fields, therefore TRiCYCLE must fill these with default values. You will most commonly see these defaults as 'Unnamed object' etc in your output file. The metadata editor enables you to override these default values.

Clicking on the reader metadata editor button in the options window will give a table of all the metadata fields that will be set automatically by TRiCYCLE along with their current values. You can change most of these with the exception of those that are required to be a controlled vocabulary. These will require a more complicated interface which we haven't had time to implement yet. The third column in the editor is a tick box to specify whether the value is overriding or not. If ticked, the value specified in this editor will be used regardless of whether a value can be extracted by TRiCYCLE from the input data files.

An identical editor is available for the writer. These are the default values used by the writer code for your chosen output format. For instance, TRiDaS does not require that a start year field be set (as in the case of relatively dated series), whereas some output formats do require such a field. If an input file does not contain start year information then some writers need to know which default value for start year to use. Like for the input metadata editor, you can set fields to 'overriding' which means they will be used regardless of whether this information is available in the input dataset.

5.3. Naming convention

Some file formats can contain just one data series while others can contain many. When converting from a multi-series format to a single series format this means that one input file is converted to multiple output files. The naming convention is used to determine how to name the output files. The naming convention relates to the filename itself and not the file extension. The file extension is specific to the output format chosen (e.g. Heidelberg files are .fh and TRiDaS files are .xml).

Numerical - This is the default naming convention. It uses the name of the input data file and appends an incrementing number if more than one output file is produced.

UUID - This gives all output files a random name based on Universally Unique Identifiers (UUIDs). This is a 36 character hexadecimal code which due to the astronomically large number of possible combinations is guaranteed to be universally unique. A typical filename will look like: 550e8400-e29b-41d4-a716-446655440000.

Hierarchical - This uses the hierarchical structure of the TRiDaS data model to provide a meaningful name for the output file. It joins together the title of each entity in the file beginning with the project name through to the series name. For files that contain multiple series, the name will contain details of all the entities shared by all the series in the file. For example, if a file contains several series from the same sample, then the file name will be projectTitle-objectTitle-elementTitle-sampleTitle. If the file contains several series from different samples of the same object, then the file would be projectTitle- objectTitle. If multiple output files end up with the same name then like the numerical convention described above, the files will have an incremental number appended to the end. Unfortunately, most input data files do not contain rich name information so files end up being called unnamedProject-unnamedObject-unnamedElement etc. This convention is therefore more appropriate when converting from TRiDaS to other formats.

5.4. Privacy options

On first launch, TRiCYCLE will ask permission to collect anonymous usage data. This information will help us focus future development efforts, but if you prefer not to submit this data, you can decline. You can change your mind at any time by checking or unchecking the tick box in the options dialog.

By default TRiCYCLE also periodically checks for the availability of updates on the tridas.org website. If you would prefer to check manually you can turn this feature on and either use the 'Check for updates' entry in the Help menu, or visit the TRiDaS website with your normal web browser.

6. Help and more information

The best place to start is through the TRiDaS website (<http://www.tridas.org>) and the Dendro Data Standards forum. The forum is a email list for the discussion of TRiDaS and other dendro data standards issues. It is open for all to join by emailing Peter Brewer (p.brewer@cornell.edu).

TRiCYCLE is an open source product therefore we are very pleased to welcome anyone that would like to assist in its development. This obviously includes programmers, but also people willing to help with documentation and translations too. To find out more information please contact Peter Brewer (p.brewer@cornell.edu).

References

- Aniol, R., 1983. Tree-ring analysis using CATRAS. *Dendrochronologia* 1, 45–53.
- Brewer, P., Murphy, D., Jansma, E., in review. TRICYCLE: a universal conversion tool for digital tree-ring data. *Tree-Ring Research* 67.
- Brewer, P., Sturgeon, K., Madar, L., Manning, S., 2010. A new approach to dendrochronological data management. *Dendrochronologia* 28 (2), 131–134.
URL <http://dx.doi.org/10.1016/j.dendro.2009.03.003>
- Jansma, E., Brewer, P., 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.
URL <http://www.sciem.com/>
- Rinn, F., 2008. TSAP-Win software. Rinntech, Heidelberg.
- Tyers, I., 1999. Dendro For Windows program guide. ARCUS Report 500.

Appendix - File format descriptions

A. 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

A.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 -'

A.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

B. 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

B.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

B.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 ]]"

```

C. Besançon

Format name	Besançon
Other name(s)	SYLPHE
Type	Text file
Extension(s)	txt
Read/write support	Read and write
Reference implementation	
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

C.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.

C.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

C.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	,	,	,	,	,	,	,	,	;	

D. 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

D.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.

D.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:

D.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.

D.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).

D.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.

D.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.

D.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 21th century (calendar year 2001 to 2100).

D.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 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.

D.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.

Bytes	Data type	Field	Description
1–32	C	Series name	Must be upper case and match file name.
33–40	C	Series code.	
41–44	C	File extension	
45–46	I	Series length	Used if a portion of the series is unreliable
47–48	I	Sapwood length	
49–50	I	First valid ring	
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	Quality code	Number of valid characters in series name
58	B		0=not known; 1=very good . . . 5=uncertain
59–60	I		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 D.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 concerning 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.

D.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.

D.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.

E. 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

E.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.

E.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,
```

F. 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

F.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 a 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.

F.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]
13 1010    71  132  74  150  75  156  122  81  46  57
14           [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]
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]  [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

```

G. DendroDB

Format name	DendroDB
Other name(s)	
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

G.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.

G.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 ...
```

H. 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

H.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.

H.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

```

H.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

I. 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

I.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/unmeasured rings should be included as zero.

I.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	

J. 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

J.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/unmeasured 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.

K. 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

K.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.

K.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				

L. ODF Spreadsheet

Format name	ODF Spreadsheet
Other name(s)	ODF, ODS, OpenDocument Spreadsheet, OpenOffice.org Spreadsheet, XML file
Type	ods
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

L.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/unmeasured rings should be included as zero.

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

M. 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

M.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.

M.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

M.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
```

N. 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	
Relative dating support	
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 is 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

N.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.

N.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="Quercus" 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>
```


O. 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

O.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.

O.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

O.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	...

P. Topham

Format name	Topham
Other name(s)	Instrument format
Type	Text file
Extension(s)	txt
Read/write support	Read and write
Reference implementation	
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

P.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.

P.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 ...
```

Q. 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

Q.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).

Q.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/
   tridas-1.2.1.xsd"
4   xmlns="http://www.tridas.org/1.2.1" xmlns:xlink="http://www.w3.org/1999/xlink">
5   <project>
6     <title>Aegean Dendrochronology Project</title>
7     <identifier domain="dendro.cornell.edu">C</identifier>

```

```

8 <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
9 <lastModifiedTimestamp certainty="exact">1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
10 <type>Dating</type>
11 <description>Our key long-range goal is to build long multi-millennial scale tree-ring
12 chronologies in the Aegean and Near East that will extend from the present to the
13 early Holocene to cover, broadly speaking, the last 10,000 years of human and
14 environmental history. Our raison d'être is to provide a dating method for the
15 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>
29 <stateProvinceRegion>NY</stateProvinceRegion>
30 <postalCode>14853</postalCode>
31 <country>USA</country>
32 </address>
33 </laboratory>
34 <category>Archaeology</category>
35 <investigator>Peter I Kuniholm</investigator>
36 <period>1976-present</period>
37 <reference>reference1</reference>
38 <object>
39 <title>White Tower, Thessaloniki</title>
40 <identifier domain="dendro.cornell.edu"
41 >28acb483-f337-412f-a063-59d911c37594</identifier>
42 <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
43 <lastModifiedTimestamp certainty="exact">1997-02-01T14:13:51.0Z</
44 lastModifiedTimestamp>
45 <type normalStd="Corina Dictionary" normalId="4" normal="Building">Building</type>
46 <description>The White Tower of Thessaloniki was originally constructed by the
47 Ottomans
48 to fortify the city's harbour.</description>
49 <coverage>
50 <coverageTemporal>Ottoman</coverageTemporal>
51 <coverageTemporalFoundation>Stylistic</coverageTemporalFoundation>
52 </coverage>
53 <location>
54 <locationGeometry xmlns:gml="http://www.opengis.net/gml">
55 <gml:Point srsName="urn:ogc:def:crs:EPSG:6.6:4326">
56 <gml:pos>40.6263 22.9485</gml:pos>
57 </gml:Point>
58 </locationGeometry>
59 <locationPrecision>20</locationPrecision>
60 <locationComment>Thessaloniki, Greece</locationComment>
61 </location>
62 <object>
63 <title>Fourth floor</title>
64 <type>Floor</type>
65 <element>
66 <title>C-TWT-65</title>
67 <identifier domain="dendro.cornell.edu"
>89dbd409-03a3-42a0-9391-62c6be7009ad</identifier>
<createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</
createdTimestamp>
<lastModifiedTimestamp certainty="exact"
>1997-02-01T14:13:51.0Z</lastModifiedTimestamp>

```



```

68 <type normalStd="Corina Dictionary" normalId="3" normal="Rafter">Rafter</
69 type>
70 <description>15th Rafter from the south</description>
71 <taxon normalStd="Catalogue of Life Annual Checklist 2008" normal="Quercus"
72 normalId="49139">Quercus sp.</taxon>
73 <dimensions>
74 <unit normalTridas="metres" />
75 <height>1</height>
76 <width>1</width>
77 <depth>1</depth>
78 </dimensions>
79 <authenticity>Original</authenticity>
80 <sample>
81 <title>C-TWT-65-A</title>
82 <identifier domain="dendro.cornell.edu"
83 >ff688357-b2d4-4394-a21a-90696cd4558c</identifier>
84 <createdTimestamp certainty="exact"
85 >1997-02-01T14:13:51.0Z</createdTimestamp>
86 <lastModifiedTimestamp certainty="exact"
87 >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
88 <type normal="Corina Dictionary" normalId="1" normalStd="Section"
89 >Section</type>
90 <samplingDate certainty="exact">1981-07-25</samplingDate>
91 <state>Dry</state>
92 <radius>
93 <title>C-TWT-65-A-B</title>
94 <identifier domain="dendro.cornell.edu"
95 >5b7baa8b-cd4e-4b3b-88fa-82939420e544</identifier>
96 <createdTimestamp certainty="exact"
97 >2006-05-04T18:13:51.0Z</createdTimestamp>
98 <lastModifiedTimestamp certainty="exact"
99 >2006-05-04T18:13:51.0Z</lastModifiedTimestamp>
100 <woodCompleteness>
101 <pith presence="absent" />
102 <heartwood presence="incomplete" />
103 <sapwood presence="complete" />
104 <bark presence="present" />
105 </woodCompleteness>
106 <measurementSeries>
107 <title>C-TWT-65-A-B-A</title>
108 <identifier domain="dendro.cornell.edu"
109 >8c50234e-8eda-41bb-b578-01cc881d1eal</identifier>
110 <createdTimestamp certainty="exact"
111 >1997-02-01T14:13:51.0Z</createdTimestamp>
112 <lastModifiedTimestamp certainty="exact"
113 >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
114 <analyst>Laura Steele</analyst>
115 <dendrochronologist>Peter I Kuniholm</dendrochronologist>
116 <measuringMethod normalStd="Corina Dictionary" normalId="1"
117 >Measuring platform</measuringMethod>
118 <interpretation>
119 <firstYear suffix="AD">1254</firstYear>
120 <statFoundation>
121 <statValue>8.3</statValue>
122 <type>t-score</type>
123 <usedSoftware>Corina 2.10</usedSoftware>
124 </statFoundation>
125 <deathYear suffix="AD">1535</deathYear>
126 <provenance>Possibly from the region of Serres</provenance>
127 </interpretation>
128 <values>
129 <variable normalTridas="Ring width" />
130 <unit normalTridas="1/100th millimetres" />
131 <value value="54" />
132 <value value="111" />
<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>
```

R. 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.

R.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
```

S. 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

S.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.

S.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 first 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.

S.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.

S.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 stealing 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
- N4652E01101

- 4652-01101
- 465201101
- 4652 01101

S.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

S.6. Example file - chronology

1	107089	1	Antalya , Elmalı 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	10700016001098	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
29	10700016201173	101122	101191	101146	10	928	10	820	10	935	10	741	10
30	10700016301123	10	781	101111	101054	101275	101052	101068	101049	101016	10	970	10
31	10700016401093	101159	101023	101159	101060	101117	101314	10	843	101057	101040	10	
32	10700016501030	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
34	1070001670	750	12	675	12	614	12	638	12	624	12	600	12
35	1070001680	797	12	940	12	955	12	886	12	878	12	970	12
36	1070001690	928	13	961	131043	13	936	13	939	131003	13	619	13
37	1070001700	717	13	699	14	746	14	900	141022	14	781	14	968
38	1070001710	980	14	817	14	718	14	642	14	554	14	589	14
39	1070001720	930	16	931	16	718	16	721	16	616	16	576	16
40	10700017301047	171141	181080	181128	181144	181112	191066	191252	19	971	191076	19	
41	10700017401284	191242	191001	191145	191219	191162	19	576	20	979	231148	231062	23
42	10700017501119	231255	231267	231352	231397	231487	231116	231092	231150	23	938	23	
43	10700017601118	241240	241258	241023	24	971	241071	241124	241225	241135	241114	24	
44	10700017701072	241171	24	853	24	964	241075	24	820	241154	241059	241270	24
45	10700017801098	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	24
47	1070001800	949	24	990	24	813	24	758	24	821	24	914	24
48	10700018101068	241184	24	852	24	870	241037	241070	241132	241047	24	978	24
49	1070001820	839	241063	241045	24	957	24	958	24	997	24	841	24
50	1070001830	920	241103	241151	241166	24	850	24	962	24	944	24	871
51	1070001840	697	24	973	24	779	24	647	24	689	24	731	24
52	1070001850	619	24	345	24	545	24	688	24	723	241046	24	738
53	1070001860	842	241015	24	888	24	884	24	792	24	594	24	902
54	1070001870	822	24	710	24	838	24	783	24	697	24	768	24
55	10700018801021	25	932	25	799	25	902	251038	251017	25	739	25	750
56	1070001890	798	24	871	24	870	24	625	24	772	24	827	24
57	1070001900	977	241237	241249	241162	241118	241007	241271	241123	241116	241045	24	
58	10700019101167	24	827	24	482	24	952	241370	241260	24	783	241169	24
59	10700019201387	241484	241293	241182	241282	241527	241261	241146	24	920	24	859	24
60	10700019301235	241335	24	799	24	819	241000	24	763	241111	241019	24	916
61	10700019401537	241387	231217	23	929	23	685	23	894	231106	231123	231089	23
62	10700019501384	231172	231151	231130	231244	231187	231118	231144	231268	231245	23		
63	10700019601547	231015	231208	231203	231109	23	602	23	690	23	684	23	901
64	1070001970	963	231095	231368	231069	231084	21	936	191146	191362	191288	191572	19
65	10700019801034	19	870	191186	191047	19	968	191089	191272	191231	191083	189990	0

T. 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

T.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).

T.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

```

U. 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

U.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 forth 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

U.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									

V. WinDENDRO

Format name	WinDENDRO
Other name(s)	
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

V.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 DendroFileOLib 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, DendroFileOLib 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; LAT-EDENSITY; MAXDENSITY; 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 (Obj-KnownDiam). 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/cm³ for densities; radians for angles.

W. Licenses

TRiCYCLE and the underlying libraries developed by the authors is released as free and open source software under the Apache 2.0 license. This allows for the use and modification of the code by both individuals and commercial organisations. TRiCYCLE does, however, rely on a number of other libraries which are released under different licenses.

Table W.1.: Licenses for TRiCYCLE and its dependencies

Library	License
Apache Commons Lang	Apache 2.0
Apache Webservice Common Utilities	Apache 2.0
DendroFileIO	Apache 2.0
ICU for Java	ICU License
Java Architecture for XML Binding (JAXB)	CDDL
Java Excel API (JXL)	GPLv3
Java Simple MVC	MIT
ODF Toolkit	Apache 2.0
Plexus Common Utilities	Apache 2.0
Simple Logging Facade for Java	MIT
TRiCYCLE	Apache 2.0
TridasJLib	Apache 2.0

W.1. Apache 2.0 license

Apache License
Version 2.0, January 2004
<http://www.apache.org/licenses/>

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions for use, reproduction, and distribution as defined by Sections 1 through 9 of this document.

"Licensor" shall mean the copyright owner or entity authorized by the copyright owner that is granting the License.

"Legal Entity" shall mean the union of the acting entity and all other entities that control, are controlled by, or are under common control with that entity. For the purposes of this definition, "control" means (i) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or

otherwise, or (ii) ownership of fifty percent (50%) or more of the outstanding shares, or (iii) beneficial ownership of such entity.

"You" (or "Your") shall mean an individual or Legal Entity exercising permissions granted by this License.

"Source" form shall mean the preferred form for making modifications, including but not limited to software source code, documentation source, and configuration files.

"Object" form shall mean any form resulting from mechanical transformation or translation of a Source form, including but not limited to compiled object code, generated documentation, and conversions to other media types.

"Work" shall mean the work of authorship, whether in Source or Object form, made available under the License, as indicated by a copyright notice that is included in or attached to the work (an example is provided in the Appendix below).

"Derivative Works" shall mean any work, whether in Source or Object form, that is based on (or derived from) the Work and for which the editorial revisions, annotations, elaborations, or other modifications represent, as a whole, an original work of authorship. For the purposes of this License, Derivative Works shall not include works that remain separable from, or merely link (or bind by name) to the interfaces of, the Work and Derivative Works thereof.

"Contribution" shall mean any work of authorship, including the original version of the Work and any modifications or additions to that Work or Derivative Works thereof, that is intentionally submitted to Licensor for inclusion in the Work by the copyright owner or by an individual or Legal Entity authorized to submit on behalf of the copyright owner. For the purposes of this definition, "submitted" means any form of electronic, verbal, or written communication sent to the Licensor or its representatives, including but not limited to communication on electronic mailing lists, source code control systems, and issue tracking systems that are managed by, or on behalf of, the Licensor for the purpose of discussing and improving the Work, but excluding communication that is conspicuously marked or otherwise designated in writing by the copyright owner as "Not a Contribution."

"Contributor" shall mean Licensor and any individual or Legal Entity on behalf of whom a Contribution has been received by Licensor and subsequently incorporated within the Work.

2. Grant of Copyright License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable copyright license to reproduce, prepare Derivative Works of, publicly display, publicly perform, sublicense, and distribute the Work and such Derivative Works in Source or Object form.
3. Grant of Patent License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable (except as stated in this section) patent license to make, have made, use, offer to sell, sell, import, and otherwise transfer the Work, where such license applies only to those patent claims licensable by such Contributor that are necessarily infringed by their Contribution(s) alone or by combination of their Contribution(s) with the Work to which such Contribution(s) was submitted. If You institute patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Work or a Contribution incorporated within the Work constitutes direct or contributory patent infringement, then any patent licenses

granted to You under this License for that Work shall terminate as of the date such litigation is filed.

4. Redistribution. You may reproduce and distribute copies of the Work or Derivative Works thereof in any medium, with or without modifications, and in Source or Object form, provided that You meet the following conditions:
 - (a) You must give any other recipients of the Work or Derivative Works a copy of this License; and
 - (b) You must cause any modified files to carry prominent notices stating that You changed the files; and
 - (c) You must retain, in the Source form of any Derivative Works that You distribute, all copyright, patent, trademark, and attribution notices from the Source form of the Work, excluding those notices that do not pertain to any part of the Derivative Works; and
 - (d) If the Work includes a "NOTICE" text file as part of its distribution, then any Derivative Works that You distribute must include a readable copy of the attribution notices contained within such NOTICE file, excluding those notices that do not pertain to any part of the Derivative Works, in at least one of the following places: within a NOTICE text file distributed as part of the Derivative Works; within the Source form or documentation, if provided along with the Derivative Works; or, within a display generated by the Derivative Works, if and wherever such third-party notices normally appear. The contents of the NOTICE file are for informational purposes only and do not modify the License. You may add Your own attribution notices within Derivative Works that You distribute, alongside or as an addendum to the NOTICE text from the Work, provided that such additional attribution notices cannot be construed as modifying the License.

You may add Your own copyright statement to Your modifications and may provide additional or different license terms and conditions for use, reproduction, or distribution of Your modifications, or for any such Derivative Works as a whole, provided Your use, reproduction, and distribution of the Work otherwise complies with the conditions stated in this License.

5. Submission of Contributions. Unless You explicitly state otherwise, any Contribution intentionally submitted for inclusion in the Work by You to the Licensor shall be under the terms and conditions of this License, without any additional terms or conditions. Notwithstanding the above, nothing herein shall supersede or modify the terms of any separate license agreement you may have executed with Licensor regarding such Contributions.
6. Trademarks. This License does not grant permission to use the trade names, trademarks, service marks, or product names of the Licensor, except as required for reasonable and customary use in describing the origin of the Work and reproducing the content of the NOTICE file.
7. Disclaimer of Warranty. Unless required by applicable law or agreed to in writing, Licensor provides the Work (and each Contributor provides its Contributions) on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied, including, without limitation, any warranties or conditions of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. You are solely responsible for determining the appropriateness of using or redistributing the Work and assume any risks associated with Your exercise of permissions under this License.

8. Limitation of Liability. In no event and under no legal theory, whether in tort (including negligence), contract, or otherwise, unless required by applicable law (such as deliberate and grossly negligent acts) or agreed to in writing, shall any Contributor be liable to You for damages, including any direct, indirect, special, incidental, or consequential damages of any character arising as a result of this License or out of the use or inability to use the Work (including but not limited to damages for loss of goodwill, work stoppage, computer failure or malfunction, or any and all other commercial damages or losses), even if such Contributor has been advised of the possibility of such damages.
9. Accepting Warranty or Additional Liability. While redistributing the Work or Derivative Works thereof, You may choose to offer, and charge a fee for, acceptance of support, warranty, indemnity, or other liability obligations and/or rights consistent with this License. However, in accepting such obligations, You may act only on Your own behalf and on Your sole responsibility, not on behalf of any other Contributor, and only if You agree to indemnify, defend, and hold each Contributor harmless for any liability incurred by, or claims asserted against, such Contributor by reason of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work.

To apply the Apache License to your work, attach the following boilerplate notice, with the fields enclosed by brackets "[]" replaced with your own identifying information. (Don't include the brackets!) The text should be enclosed in the appropriate comment syntax for the file format. We also recommend that a file or class name and description of purpose be included on the same "printed page" as the copyright notice for easier identification within third-party archives.

Copyright [yyyy] [name of copyright owner]

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

<http://www.apache.org/licenses/LICENSE-2.0>

Unless required by applicable law or agreed to in writing, software distributed under the License is distributed on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the License for the specific language governing permissions and limitations under the License.

W.2. MIT License

Copyright (c) <year> <copyright holders>

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in

all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

W.3. ICU License

COPYRIGHT AND PERMISSION NOTICE

Copyright (c) 1995–2010 International Business Machines Corporation and others

All rights reserved.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, provided that the above copyright notice(s) and this permission notice appear in all copies of the Software and that both the above copyright notice(s) and this permission notice appear in supporting documentation.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR HOLDERS INCLUDED IN THIS NOTICE BE LIABLE FOR ANY CLAIM, OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE.

Except as contained in this notice, the name of a copyright holder shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Software without prior written authorization of the copyright holder.

W.4. GNU Lesser General Public License LGPLv3

GNU LESSER GENERAL PUBLIC LICENSE Version 3, 29 June 2007

Copyright (C) 2007 Free Software Foundation, Inc. <<http://fsf.org/>>
Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.

This version of the GNU Lesser General Public License incorporates
the terms and conditions of version 3 of the GNU General Public
License, supplemented by the additional permissions listed below.

0. Additional Definitions.

As used herein, "this License" refers to version 3 of the GNU Lesser
General Public License, and the "GNU GPL" refers to version 3 of the GNU
General Public License.

"The Library" refers to a covered work governed by this License,

other than an Application or a Combined Work as defined below.

An "Application" is any work that makes use of an interface provided by the Library, but which is not otherwise based on the Library. Defining a subclass of a class defined by the Library is deemed a mode of using an interface provided by the Library.

A "Combined Work" is a work produced by combining or linking an Application with the Library. The particular version of the Library with which the Combined Work was made is also called the "Linked Version".

The "Minimal Corresponding Source" for a Combined Work means the Corresponding Source for the Combined Work, excluding any source code for portions of the Combined Work that, considered in isolation, are based on the Application, and not on the Linked Version.

The "Corresponding Application Code" for a Combined Work means the object code and/or source code for the Application, including any data and utility programs needed for reproducing the Combined Work from the Application, but excluding the System Libraries of the Combined Work.

1. Exception to Section 3 of the GNU GPL.

You may convey a covered work under sections 3 and 4 of this License without being bound by section 3 of the GNU GPL.

2. Conveying Modified Versions.

If you modify a copy of the Library, and, in your modifications, a facility refers to a function or data to be supplied by an Application that uses the facility (other than as an argument passed when the facility is invoked), then you may convey a copy of the modified version:

- a) under this License, provided that you make a good faith effort to ensure that, in the event an Application does not supply the function or data, the facility still operates, and performs whatever part of its purpose remains meaningful, or
- b) under the GNU GPL, with none of the additional permissions of this License applicable to that copy.

3. Object Code Incorporating Material from Library Header Files.

The object code form of an Application may incorporate material from a header file that is part of the Library. You may convey such object code under terms of your choice, provided that, if the incorporated material is not limited to numerical parameters, data structure layouts and accessors, or small macros, inline functions and templates (ten or fewer lines in length), you do both of the following:

- a) Give prominent notice with each copy of the object code that the Library is used in it and that the Library and its use are covered by this License.
- b) Accompany the object code with a copy of the GNU GPL and this license document.

4. Combined Works.

You may convey a Combined Work under terms of your choice that, taken together, effectively do not restrict modification of the portions of the Library contained in the Combined Work and reverse engineering for debugging such modifications, if you also do each of the following:

a) Give prominent notice with each copy of the Combined Work that the Library is used in it and that the Library and its use are covered by this License.

b) Accompany the Combined Work with a copy of the GNU GPL and this license document.

c) For a Combined Work that displays copyright notices during execution, include the copyright notice for the Library among these notices, as well as a reference directing the user to the copies of the GNU GPL and this license document.

d) Do one of the following:

0) Convey the Minimal Corresponding Source under the terms of this License, and the Corresponding Application Code in a form suitable for, and under terms that permit, the user to recombine or relink the Application with a modified version of the Linked Version to produce a modified Combined Work, in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.

1) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (a) uses at run time a copy of the Library already present on the user's computer system, and (b) will operate properly with a modified version of the Library that is interface-compatible with the Linked Version.

e) Provide Installation Information, but only if you would otherwise be required to provide such information under section 6 of the GNU GPL, and only to the extent that such information is necessary to install and execute a modified version of the Combined Work produced by recombining or relinking the Application with a modified version of the Linked Version. (If you use option 4d0, the Installation Information must accompany the Minimal Corresponding Source and Corresponding Application Code. If you use option 4d1, you must provide the Installation Information in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.)

5. Combined Libraries.

You may place library facilities that are a work based on the Library side by side in a single library together with other library facilities that are not Applications and are not covered by this License, and convey such a combined library under terms of your choice, if you do both of the following:

a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities, conveyed under the terms of this License.

b) Give prominent notice with the combined library that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

6. Revised Versions of the GNU Lesser General Public License.

The Free Software Foundation may publish revised and/or new versions of the GNU Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the

Library as you received it specifies that a certain numbered version of the GNU Lesser General Public License "or any later version" applies to it, you have the option of following the terms and conditions either of that published version or of any later version published by the Free Software Foundation. If the Library as you received it does not specify a version number of the GNU Lesser General Public License, you may choose any version of the GNU Lesser General Public License ever published by the Free Software Foundation.

If the Library as you received it specifies that a proxy can decide whether future versions of the GNU Lesser General Public License shall apply, that proxy's public statement of acceptance of any version is permanent authorization for you to choose that version for the Library.

W.5. Common Development and Distribution License

COMMON DEVELOPMENT AND DISTRIBUTION LICENSE (CDDL)
Version 1.0

1. Definitions.

- 1.1. "Contributor" means each individual or entity that creates or contributes to the creation of Modifications.
- 1.2. "Contributor Version" means the combination of the Original Software, prior Modifications used by a Contributor (if any), and the Modifications made by that particular Contributor.
- 1.3. "Covered Software" means (a) the Original Software, or (b) Modifications, or (c) the combination of files containing Original Software with files containing Modifications, in each case including portions thereof.
- 1.4. "Executable" means the Covered Software in any form other than Source Code.
- 1.5. "Initial Developer" means the individual or entity that first makes Original Software available under this License.
- 1.6. "Larger Work" means a work which combines Covered Software or portions thereof with code not governed by the terms of this License.
- 1.7. "License" means this document.
- 1.8. "Licensable" means having the right to grant, to the maximum extent possible, whether at the time of the initial grant or subsequently acquired, any and all of the rights conveyed herein.
- 1.9. "Modifications" means the Source Code and Executable form of any of the following:
 - A. Any file that results from an addition to, deletion from or modification of the contents of a file containing Original Software or previous Modifications;

B. Any new file that contains any part of the Original Software or previous Modification; or

C. Any new file that is contributed or otherwise made available under the terms of this License.

1.10. "Original Software" means the Source Code and Executable form of computer software code that is originally released under this License.

1.11. "Patent Claims" means any patent claim(s), now owned or hereafter acquired, including without limitation, method, process, and apparatus claims, in any patent Licensable by grantor.

1.12. "Source Code" means (a) the common form of computer software code in which modifications are made and (b) associated documentation included in or with such code.

1.13. "You" (or "Your") means an individual or a legal entity exercising rights under, and complying with all of the terms of, this License. For legal entities, "You" includes any entity which controls, is controlled by, or is under common control with You. For purposes of this definition, "control" means (a) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or otherwise, or (b) ownership of more than fifty percent (50%) of the outstanding shares or beneficial ownership of such entity.

2. License Grants.

2.1. The Initial Developer Grant.

Conditioned upon Your compliance with Section 3.1 below and subject to third party intellectual property claims, the Initial Developer hereby grants You a world-wide, royalty-free, non-exclusive license:

(a) under intellectual property rights (other than patent or trademark) Licensable by Initial Developer, to use, reproduce, modify, display, perform, sublicense and distribute the Original Software (or portions thereof), with or without Modifications, and/or as part of a Larger Work; and

(b) under Patent Claims infringed by the making, using or selling of Original Software, to make, have made, use, practice, sell, and offer for sale, and/or otherwise dispose of the Original Software (or portions thereof).

(c) The licenses granted in Sections 2.1(a) and (b) are effective on the date Initial Developer first distributes or otherwise makes the Original Software available to a third party under the terms of this License.

(d) Notwithstanding Section 2.1(b) above, no patent license is granted: (1) for code that You delete from the Original Software, or (2) for infringements caused by: (i) the modification of the Original Software, or (ii) the combination of the Original Software with other software or devices.

2.2. Contributor Grant.

Conditioned upon Your compliance with Section 3.1 below and subject to third party intellectual property claims, each Contributor hereby grants You a world-wide, royalty-free, non-exclusive license:

- (a) under intellectual property rights (other than patent or trademark) Licensable by Contributor to use, reproduce, modify, display, perform, sublicense and distribute the Modifications created by such Contributor (or portions thereof), either on an unmodified basis, with other Modifications, as Covered Software and/or as part of a Larger Work; and
- (b) under Patent Claims infringed by the making, using, or selling of Modifications made by that Contributor either alone and/or in combination with its Contributor Version (or portions of such combination), to make, use, sell, offer for sale, have made, and/or otherwise dispose of: (1) Modifications made by that Contributor (or portions thereof); and (2) the combination of Modifications made by that Contributor with its Contributor Version (or portions of such combination).
- (c) The licenses granted in Sections 2.2(a) and 2.2(b) are effective on the date Contributor first distributes or otherwise makes the Modifications available to a third party.
- (d) Notwithstanding Section 2.2(b) above, no patent license is granted: (1) for any code that Contributor has deleted from the Contributor Version; (2) for infringements caused by: (i) third party modifications of Contributor Version, or (ii) the combination of Modifications made by that Contributor with other software (except as part of the Contributor Version) or other devices; or (3) under Patent Claims infringed by Covered Software in the absence of Modifications made by that Contributor.

3. Distribution Obligations.

3.1. Availability of Source Code.

Any Covered Software that You distribute or otherwise make available in Executable form must also be made available in Source Code form and that Source Code form must be distributed only under the terms of this License. You must include a copy of this License with every copy of the Source Code form of the Covered Software You distribute or otherwise make available. You must inform recipients of any such Covered Software in Executable form as to how they can obtain such Covered Software in Source Code form in a reasonable manner on or through a medium customarily used for software exchange.

3.2. Modifications.

The Modifications that You create or to which You contribute are governed by the terms of this License. You represent that You believe Your Modifications are Your original creation(s) and/or You have sufficient rights to grant the rights conveyed by this License.

3.3. Required Notices.

You must include a notice in each of Your Modifications that identifies You as the Contributor of the Modification. You may not remove or alter any copyright, patent or trademark notices contained within the Covered Software, or any

notices of licensing or any descriptive text giving attribution to any Contributor or the Initial Developer.

3.4. Application of Additional Terms.

You may not offer or impose any terms on any Covered Software in Source Code form that alters or restricts the applicable version of this License or the recipients' rights hereunder. You may choose to offer, and to charge a fee for, warranty, support, indemnity or liability obligations to one or more recipients of Covered Software. However, you may do so only on Your own behalf, and not on behalf of the Initial Developer or any Contributor. You must make it absolutely clear that any such warranty, support, indemnity or liability obligation is offered by You alone, and You hereby agree to indemnify the Initial Developer and every Contributor for any liability incurred by the Initial Developer or such Contributor as a result of warranty, support, indemnity or liability terms You offer.

3.5. Distribution of Executable Versions.

You may distribute the Executable form of the Covered Software under the terms of this License or under the terms of a license of Your choice, which may contain terms different from this License, provided that You are in compliance with the terms of this License and that the license for the Executable form does not attempt to limit or alter the recipient's rights in the Source Code form from the rights set forth in this License. If You distribute the Covered Software in Executable form under a different license, You must make it absolutely clear that any terms which differ from this License are offered by You alone, not by the Initial Developer or Contributor. You hereby agree to indemnify the Initial Developer and every Contributor for any liability incurred by the Initial Developer or such Contributor as a result of any such terms You offer.

3.6. Larger Works.

You may create a Larger Work by combining Covered Software with other code not governed by the terms of this License and distribute the Larger Work as a single product. In such a case, You must make sure the requirements of this License are fulfilled for the Covered Software.

4. Versions of the License.

4.1. New Versions.

Sun Microsystems, Inc. is the initial license steward and may publish revised and/or new versions of this License from time to time. Each version will be given a distinguishing version number. Except as provided in Section 4.3, no one other than the license steward has the right to modify this License.

4.2. Effect of New Versions.

You may always continue to use, distribute or otherwise make the Covered Software available under the terms of the version of the License under which You originally received the Covered Software. If the Initial Developer includes a notice in the Original Software prohibiting it from being distributed or otherwise made available under any subsequent version of the License, You must distribute and make the Covered Software available under the terms of the version of the License under which You originally received the Covered Software. Otherwise, You may also choose to use, distribute or otherwise make the Covered Software available under the terms of any subsequent version of the License published by the license steward.

4.3. Modified Versions.

When You are an Initial Developer and You want to create a new license for Your Original Software, You may create and use a modified version of this License if You: (a) rename the license and remove any references to the name of the license steward (except to note that the license differs from this License); and (b) otherwise make it clear that the license contains terms which differ from this License.

5. DISCLAIMER OF WARRANTY.

COVERED SOFTWARE IS PROVIDED UNDER THIS LICENSE ON AN "AS IS" BASIS, WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES THAT THE COVERED SOFTWARE IS FREE OF DEFECTS, MERCHANTABLE, FIT FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE COVERED SOFTWARE IS WITH YOU. SHOULD ANY COVERED SOFTWARE PROVE DEFECTIVE IN ANY RESPECT, YOU (NOT THE INITIAL DEVELOPER OR ANY OTHER CONTRIBUTOR) ASSUME THE COST OF ANY NECESSARY SERVICING, REPAIR OR CORRECTION. THIS DISCLAIMER OF WARRANTY CONSTITUTES AN ESSENTIAL PART OF THIS LICENSE. NO USE OF ANY COVERED SOFTWARE IS AUTHORIZED HEREUNDER EXCEPT UNDER THIS DISCLAIMER.

6. TERMINATION.

6.1. This License and the rights granted hereunder will terminate automatically if You fail to comply with terms herein and fail to cure such breach within 30 days of becoming aware of the breach. Provisions which, by their nature, must remain in effect beyond the termination of this License shall survive.

6.2. If You assert a patent infringement claim (excluding declaratory judgment actions) against Initial Developer or a Contributor (the Initial Developer or Contributor against whom You assert such claim is referred to as "Participant") alleging that the Participant Software (meaning the Contributor Version where the Participant is a Contributor or the Original Software where the Participant is the Initial Developer) directly or indirectly infringes any patent, then any and all rights granted directly or indirectly to You by such Participant, the Initial Developer (if the Initial Developer is not the Participant) and all Contributors under Sections 2.1 and/or 2.2 of this License shall, upon 60 days notice from Participant terminate prospectively and automatically at the expiration of such 60 day notice period, unless if within such 60 day period You withdraw Your claim with respect to the Participant Software against such Participant either unilaterally or pursuant to a written agreement with Participant.

6.3. In the event of termination under Sections 6.1 or 6.2 above, all end user licenses that have been validly granted by You or any distributor hereunder prior to termination (excluding licenses granted to You by any distributor) shall survive termination.

7. LIMITATION OF LIABILITY.

UNDER NO CIRCUMSTANCES AND UNDER NO LEGAL THEORY, WHETHER TORT (INCLUDING NEGLIGENCE), CONTRACT, OR OTHERWISE, SHALL YOU, THE INITIAL DEVELOPER, ANY OTHER CONTRIBUTOR, OR ANY DISTRIBUTOR OF COVERED SOFTWARE, OR ANY SUPPLIER OF ANY OF SUCH PARTIES, BE LIABLE TO ANY PERSON FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY CHARACTER INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOST PROFITS, LOSS OF GOODWILL, WORK STOPPAGE, COMPUTER FAILURE OR MALFUNCTION, OR ANY AND ALL OTHER COMMERCIAL DAMAGES OR LOSSES, EVEN IF SUCH PARTY SHALL HAVE BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION OF LIABILITY SHALL NOT APPLY TO LIABILITY FOR DEATH OR PERSONAL INJURY RESULTING FROM SUCH PARTY'S NEGLIGENCE TO THE EXTENT APPLICABLE LAW PROHIBITS SUCH LIMITATION. SOME JURISDICTIONS DO NOT ALLOW THE

EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THIS EXCLUSION AND LIMITATION MAY NOT APPLY TO YOU.

8. U.S. GOVERNMENT END USERS.

The Covered Software is a "commercial item," as that term is defined in 48 C.F.R. 2.101 (Oct. 1995), consisting of "commercial computer software" (as that term is defined at 48 C.F.R. 252.227-7014(a)(1)) and "commercial computer software documentation" as such terms are used in 48 C.F.R. 12.212 (Sept. 1995). Consistent with 48 C.F.R. 12.212 and 48 C.F.R. 227.7202-1 through 227.7202-4 (June 1995), all U.S. Government End Users acquire Covered Software with only those rights set forth herein. This U.S. Government Rights clause is in lieu of, and supersedes, any other FAR, DFAR, or other clause or provision that addresses Government rights in computer software under this License.

9. MISCELLANEOUS.

This License represents the complete agreement concerning subject matter hereof. If any provision of this License is held to be unenforceable, such provision shall be reformed only to the extent necessary to make it enforceable. This License shall be governed by the law of the jurisdiction specified in a notice contained within the Original Software (except to the extent applicable law, if any, provides otherwise), excluding such jurisdiction's conflict-of-law provisions. Any litigation relating to this License shall be subject to the jurisdiction of the courts located in the jurisdiction and venue specified in a notice contained within the Original Software, with the losing party responsible for costs, including, without limitation, court costs and reasonable attorneys' fees and expenses. The application of the United Nations Convention on Contracts for the International Sale of Goods is expressly excluded. Any law or regulation which provides that the language of a contract shall be construed against the drafter shall not apply to this License. You agree that You alone are responsible for compliance with the United States export administration regulations (and the export control laws and regulation of any other countries) when You use, distribute or otherwise make available any Covered Software.

10. RESPONSIBILITY FOR CLAIMS.

As between Initial Developer and the Contributors, each party is responsible for claims and damages arising, directly or indirectly, out of its utilization of rights under this License and You agree to work with Initial Developer and Contributors to distribute such responsibility on an equitable basis. Nothing herein is intended or shall be deemed to constitute any admission of liability.