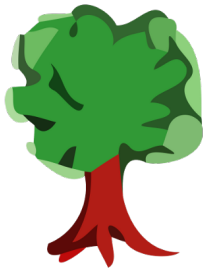
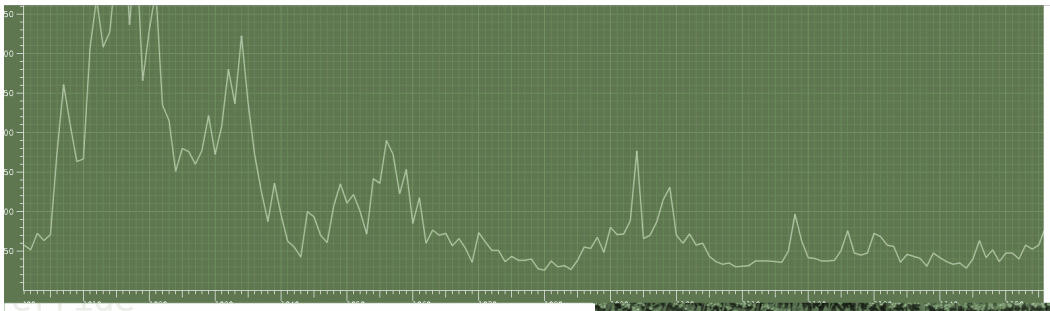
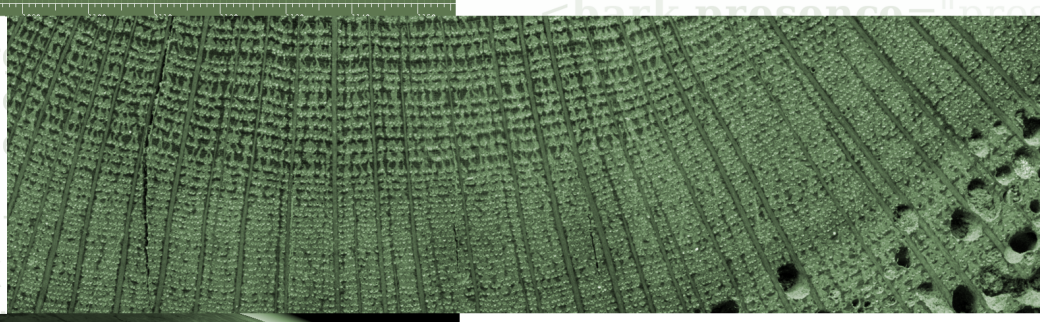
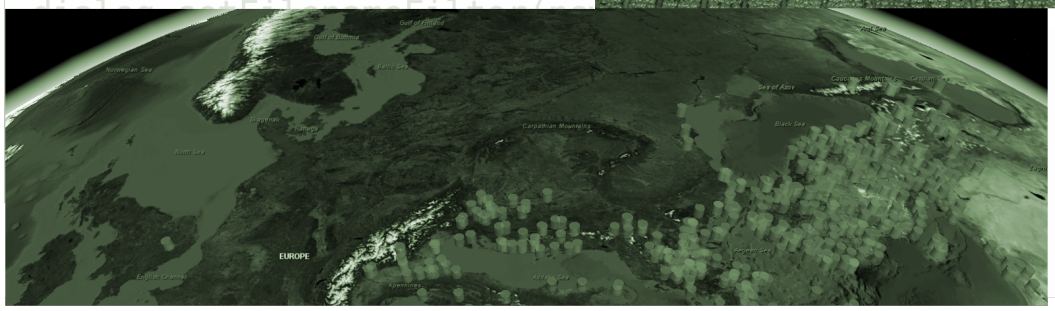


Corina

A guide for users and developers







$$s_{xy} = \Sigma x_i y_i - N(x_i - x_{avg})(y_i$$

$$s_{xx} = \Sigma x_i^2 - N(x_i - x_{avg})^2$$

$$s_{yy} = \Sigma y_i^2 - N(y_i - y_{avg})^2$$

By Peter W. Brewer

For Corina server and desktop
version 2.12

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Compiled: February 10, 2012

CORINA

A guide for users and developers

By Peter W. Brewer

Compiled: February 10, 2012

Contents

Preface

Corina is the tree ring measuring and analysis program developed at the Cornell Tree-Ring Laboratory. It is focused primarily on the measurement of tree ring widths and the organization and curation of the data, metadata and physical samples. It is cross-platform (running on all Java 6 enabled operating systems including Windows, MacOSX and Linux) and open-source. It includes support for standard measuring platforms including Velmex, Lintab and Henson.

Corina has been developed since 2000 as a desktop Java application, following an earlier DOS-based version programmed in C, which itself was derived from a collection of FORTRAN and C utilities. Earlier iterations of Corina (version 0.x and 1.x) were built around a standard file-based data management system. In 2007, work began on a major rewrite of the software whereby this file-based data management was replaced with an object-relational database management system (ORDBMS) and server/client webservice infrastructure. This series of releases (versions 2.x) are what are described in this manual. This initiative was made possible because of the support of the College of Arts & Sciences, Cornell University, via a grant to Sturt Manning to re-envisage the Cornell Tree-Ring Laboratory, which provided support for Peter Brewer to develop Corina at Cornell University.

This manual is divided into two main sections, the first for users, the second for developers. Corina is open source software (see the details of the license on pages 155–160), so you are welcome to inspect and edit the code. The second part of this manual will help you do that.

Over the years Corina has been developed by a number of people: Peter Brewer, Chris Dunham, Aaron Hamid, Dan Girshovich, Ken Harris, Drew Kalina, Rocky Li, Lucas Madar, Daniel Murphy, Robert 'Mecki' Pohl and Kit Sturgeon. We would like to thank the many people that have tested Corina especially: Charlotte Pearson; Carol Griggs; Brita Lorentzen; Jess Herlich; LeAnn Canady; Kate Seufer; and many undergraduate and postgradutes students at Cornell.

We would also like to thank the College of Arts & Sciences and the Department of Classics, Cornell University; the Malcolm H. Wiener Foundation; and the many patrons of the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology for their financial support.

We hope that you find Corina useful and look forward to hearing your feedback.

Part I

User Guide

Chapter 1

Installation

Corina is made up of two packages; the Corina desktop application and the Corina database server. Corina was designed primarily for laboratories with multiple users, each running the Corina desktop application on their own computer connecting to a single central server containing the lab's data. In this situation the Corina server would be run on a separate computer to those running the desktop client, but this need not necessarily be the case. It is perfectly possible to run both the server and the client on the same computer. This is likely to be the situation if you simply want to try out Corina, if you don't have a separate server, or if you do not work in a multi-user laboratory.

1.1 Server installation

For the Corina desktop application to be useful you will require access to a Corina server. If you are running Corina in a lab where the Corina server has already been set up by your systems administrator, you can skip this section.

The Corina server is made up of a number of components, which unlike the desktop client, can't be easily combined together into cross-platform packages. Although all the constituent components are open-source and available for all major platforms, building and maintaining separate packages for each platform is too large a task for a small development team. To conserve resources, we therefore made the decision to utilize Virtual Machine technology to ensure that the Corina server could still be run on all major operating systems. This means that we can package the Corina server for a single operating system (Ubuntu Linux) and then distribute it as a Virtual Appliance that can be run as a program on your normal operating system.

The Corina server is therefore available via two main methods. The first is as a VirtualBox* Virtual Appliance which can be run on any major operating system, the second is as an Ubuntu package for running natively on an Ubuntu Linux server. The source code for the server is also available so it is perfectly possible for more experienced users to set up the Corina server to run natively on other platforms. But to do this you will require a good knowledge of Apache 2, PHP and PostgreSQL. Choose the most applicable method and follow the instructions in the following sections.

1.1.1 Install as Virtual Appliance (recommended method)

To run the Corina server Virtual Appliance, you will first need to download and install VirtualBox from `http://www.virtualbox.org`. Installation packages are available for Windows, MacOSX, OpenSolaris and many Linux distributions.

Once you have VirtualBox installed, you will then need to download the Corina server from the Cornell website `http://dendro.cornell.edu/corina`. This package contains a bare-bones Ubuntu Linux server with every-

*Note that the Corina appliance is provided in the open standard format OVA. You should be able to run the appliance in other Virtual Machine applications (e.g. VMWare, Citrix etc) but the OVA standard is very young and changing fast. We recommend sticking with VirtualBox until the standard stabilizes.

thing required to run the Corina server installed and ready to use. As VirtualBox, the entire Ubuntu operating system and Corina server components are all open source there are no license fees to pay.

1. Open VirtualBox and go to *File* → *Import Appliance*
2. Press the choose button and locate the virtual appliance file that you downloaded from the website[†]
3. Rename the server if you choose, then press the finish/import button
4. Once the server is installed, highlight it in the virtual machine list and press the start button
5. Read and accept the information about how to gain and release control of the keyboard in VirtualBox
6. The server will boot and eventually present you with a command line login screen. Log in with the details:

   Username : corina

   Password : w3l0v3tr33s
7. Start the server configuration by typing:

   ```
   sudo corina-server
   ```

   You will be prompted for the server password again
8. Answer the questions and the configuration will finish by testing your new server (see figure 1.1).
9. Note down the URL of your new Corina webservice as you will need to enter this when you start your Corina desktop client. If you need to know the URL at a later date you can run the tests again by typing:

   ```
   corina-server --test
   ```
10. You can now install and run the Corina Desktop application (see section 1.2)

To save on download size and disk space only the essential packages to make the server run have been installed. This means there is no graphical interface just a command line. Hopefully this should not be a problem as once set up, the only interaction needed with the Virtual Appliance will be through the normal Corina desktop application. If you would prefer to use a graphical interface to the server this can be easily installed. See chapter 11 for further details.

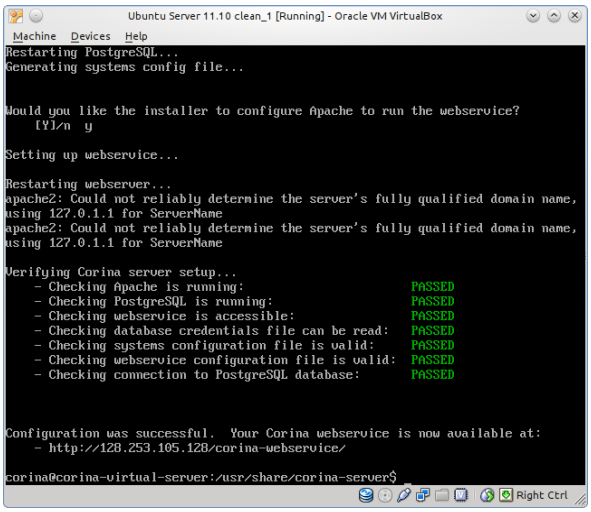


Figure 1.1: Screenshot of VirtualBox running the Corina server. The console contains the results of the tests run at the end of the configuration routine.

1.1.2 Ubuntu native installation

If you are fortunate enough to be running Ubuntu then the native Ubuntu deb package is the best and easiest method for installing the Corina server, otherwise see section 1.1.1 to install the server as a Virtual Appliance.

To install the Corina server in Ubuntu simply download the deb package from the Cornell server `http://dendro.cornell.edu/corina` and install with your favourite package manager. For instance, to install from the command line simply type:

```
sudo dpkg --install corina-server.deb
```

[†]If you are using an older version of VirtualBox it may expect an OVF rather than the OVA file provided. The OVA file is a tar file containing several files required by VirtualBox including an OVF file. If you rename the extension of the OVA file to tar then extract the contents to a folder using a tools like WinRAR you should then be able to continue.

The package will automatically run a configuration
script to assist with creating a database user, building the Corina PostgreSQL database, setting database permissions and setting up the Apache webservice. The configuration ends with a test routine to check all services are set up correctly and if so, will provide you with the URL of the newly configured Corina webservice.

1.1.3 Advanced install on other operating systems

As mentioned previously, the limited resources available for Corina development means that we have been unable to produce native installers for platforms other that Ubuntu. If you are an experience systems administrator though, it should not be too difficult to set up the Corina server manually.

The Corina server is essentially a PostgreSQL database accessed via a PHP webservice running on Apache 2. The following dependencies are therefore required: postgresql-9.1; postgis; postgresql-contrib-9.1; postgresql-9.1-pljava; sun-java6-jre; apache2; php5; php5-pgsql; php5-curl; php5-mhash.

The basic procedure for installation is as follows:

- Install all dependencies
- Create PostgreSQL database from Corina template SQL file
- Set up a database user and provide access to the server in the pg_hba.conf file
- Give this user read and write permissions to the database
- Copy the webservice code into a web accessible folder
- Set up Apache to see this folder by creating an entry in the sites-enabled folder
- Restart PostgreSQL and Apache and check you can access the webservice from a web browser

1.2 Desktop application

Installation packages for the Corina desktop application are available for Windows, MacOSX and Ubuntu Linux. Corina can also be run on other operating systems as long as they support Java 6 or later[‡].

To install Corina, download the installation file for your operating system from `http://dendro.cornell.edu/corina/download.php`. The website should provide you with a link to the installer for your current operating system:

Windows – Run the setup.exe and follow the instructions. If you do not have Java installed the installer will direct you to the Java website where you can get the latest version. Once installed, Corina can be launched via the Start menu.

Mac OS X – As mentioned above, Corina requires Java 6. Although MacOSX ships with Java installed, unfortunately Apple have been very slow to provide Java 6. Although it was released in 2006, it was not until August 2009 that Apple made Java 6 available as part of v10.6 (Snow Leopard). Corina can therefore only be run on Snow Leopard or later. To install Corina, download then open the zip file and drag the Corina.app into your applications folder. To use the 3D mapping or measuring platform hardware in Corina you will also need to install the 'Corina Drivers' package.

Ubuntu Linux – A deb file is available which was designed for use on Ubuntu distributions but should work on any Debian based system. Install using your favorite package management system or from the command line like this: e.g.

```
sudo dpkg --install corina_2.xx-1_all.deb
```

On Ubuntu and similar distributions, the package should add a Corina shortcut to your applications menu. Alternatively you can start Corina from the command line by typing corina.

Other operating systems – Make sure you have Java 6 installed, then download the Corina jar file to your hard disk. You can run Corina from the command line by typing:

[‡]Corina was initially developed against Sun Java 6 JRE, however, now OpenJDK6 is routinely used. See section 13.11, page 68 for more information.

```
java -jar corina.jar
```

Once you have installed your Corina Desktop application and you have access to a Corina server you are now ready to launch Corina for the first time.

1.2.1 First time launch

When you launch Corina for the first time you will be presented with a setup wizard (figure 1.2). Following the wizard to configure the main settings required before you can begin to use Corina. If you want to re-run this wizard at any time you can do so from the entry in the Help menu. You can also manually edit all these settings from the Corina preferences dialog which can be found in *Edit* → *Preferences*.

Figure 1.2: The Corina setup wizard will launch the first time you start Corina.

The pages of the wizard include:

Network connection – this configures how your computer accesses the internet. Most users will be able to use the default 'Use system default proxy settings' option here, but if you know that your computer is behind a corporate proxy server you may choose to manually provide the settings.

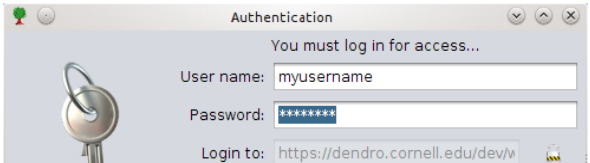
Configuring the Corina server – Corina comes in two parts: the Corina desktop client that you are using; and the Corina server which runs the database that stores your data. If you are working in a lab your systems administrator may have already set up the Corina server and given you the URL to connect to. Alternatively, you may have already installed the Corina server yourself. If so the installation program should have given you the URL. If you don't have access to a Corina server yet, you should close this wizard, then go to the Corina website and download it.

Measuring platform configuration – the next page enables you to configure measuring platform hardware attached to your computer. Some measuring platforms have fixed settings in which case the port settings will be set automatically, but others can be changed in the hardware and must be set explicitly here. Use the 'Test Connection' button to make sure that Corina can successfully communicate with your platform.

Once you have completed the wizard you will be presented with a dialog (figure 1.3) for logging in to your Corina server.

The username and password details requested are your Corina login credentials (not your system or network credentials) provided to you by your systems administrator. If you are using your own Virtual Appliance server, the default admin user details are provided in section 11.4.1, page 53. The dialog gives you the option for saving your username and/or password if you prefer. We recommend using this feature only on personal machines. You may choose to cancel the login if you like and Corina will continue to load, however, you will not have access to the Corina database therefore very few functions will be available to you.

Once you have logged in you will be presented with the Corina home screen. This contains the



main menus for the program as well as three quick-link icons for creating new records, opening existing records and importing existing data files to the database.

1.2.2 Mapping support

Corina includes 3D mapping for visualization of sampling locations. Although this is not necessary for most tasks, to make use of the mapping functions you will require a OpenGL 3D capable graphics card. To check whether your computer already supports 3D mapping, open Corina, go to Admin, then Site map. Corina will warn you if your graphics card is not supported.

All MacOSX computers should automatically support OpenGL. Most Windows and Linux computers made since 2006 should also support OpenGL, however, this does require proper drivers to be installed. In some cases Windows computers may include a compatible graphics card, but may only have the default Windows video drivers installed. If you are having trouble with the mapping in Corina make sure you have installed the most recent drivers for your graphics card. Linux users may be required to install proprietary graphics drivers.

The mapping component of Corina makes use of NASA's open source World Wind Java. NASA's website `http://worldwind.arc.nasa.gov/` contains further information and instructions that you may find helpful if you are having problems getting the mapping to work.

1.3 Uninstalling

We understand that Corina will never suit the requirements of all users, but as an open source product, we would really appreciate feedback as to why it didn't work for you. Without this feedback it is difficult to prioritize future development.

1.3.1 Corina desktop application

For Windows users, Corina desktop can be uninstalled using the standard add/remove programs feature in control panel, or via the item in the Corina start menu. Mac users should simply delete the application from their applications folder. Linux users should use their prefered package management tool e.g. from the command line:

```
sudo dpkg --remove corina
```

1.3.2 Corina server

> ⚠ *Please note that uninstalling the Corina server will delete your Corina database and all the data it contains. Make sure that you export any data you need before doing uninstalling.*

If you are running the Corina server as a virtual appliance simply follow the uninstall instructions for VirtualBox. If you are running Corina server as a native Linux server, you should use your preferred package mangement tool e.g. from the command line:

```
sudo dpkg --remove corina-server
```

Chapter 2

Getting started

Once you have your Corina desktop application installed (see chapter 1) and you also have access to a Corina server (either via your lab network administrator or your own on as a Virtual Appliance) you are ready to start using Corina. Below are some basic instructions for performing common tasks in Corina followed by a number of more in-depth chapters.

2.1 Measuring a new sample

Once your measuring platform has been configured, measuring your first sample is simple. To start a new measurement go to *File* → *New* or click the 'new' icon on the home screen. A dialog will appear where you can scan your sample's barcode, or press the button to enter metadata for your sample later. Barcodes minimize data entry errors and also speed up the process of measuring your samples. See section 8.2 for more information. Once you have scanned your barcode or pressed the button, you will then be presented with an empty Corina data screen (figure 2.1).

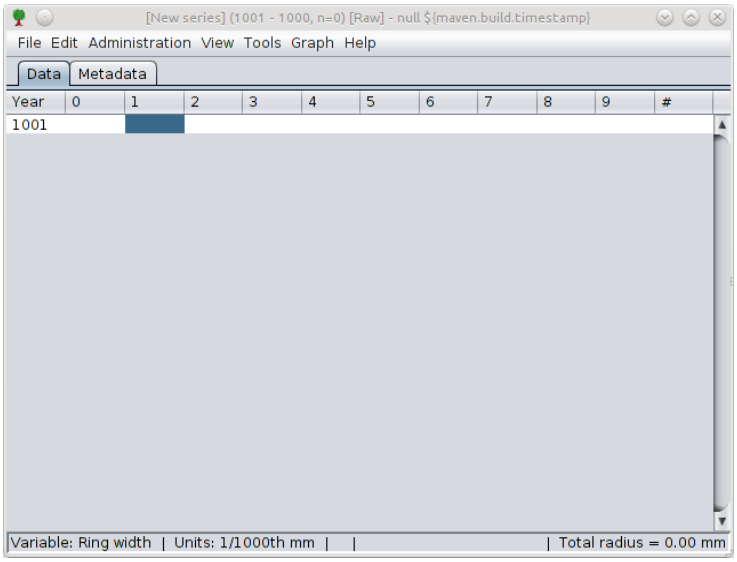


Figure 2.1: An empty data window ready to receive measurements. Note the status bar at the bottom includes buttons for changing the measurement variable, display units and cumulative statistics. The data table stores ring width values in decadal rows following the standard convention which derives from data entry via punch-cards. Undated sequences begin in the relative year 1001 for the same reason.

The next step is to fill out the metadata tab. If you have used a barcode, nearly all of this metadata will be filled in for you, otherwise you will need to fill this out yourself. Details about metadata can be found in chapter 4, page 17.

Before you begin measuring you need to tell Corina what sort of measurements you are doing: whole ring widths; or early/latewood widths (the default is whole ring widths). To specify early/latewood widths you need to go to *Edit* ➔ *Measuring mode...* ➔ *Early and latewood widths*. If you use this menu after you have already measured some rings you will be warned that Corina will delete the data you have already collected. Once in 'early and latewood widths' measuring mode you will be able to choose which data is displayed in the table by clicking the variable box on the status line and choose between: Ring width; Earlywood width; Latewood width; Early/Latewood width.

To begin measuring your sample you can now go to *Edit* ➔ *Start measuring* or you can press F5. While measuring you should be provided with audible feedback for each ring measured with a more pronounced sound made every 10th ring. If there is a problem communicating with your measuring hardware, check your settings in the preferences dialog. If you still have problems contact the Corina developers by going to *Help* ➔ *Report bug on last transaction*, making sure you include your email address and any further information.

Depending on the measuring platform hardware you have, you will see some variation of the measuring panel in figure 2.2. The left display holds the absolute position of the last ring boundary (for device that measure cumulatively), the middle display holds the last recorded measurement width and the right display holds the current position of the measuring plaform (for devices that report live measurements). The right-hand display is useful for devices that don't have a physical display such as the Lintab.

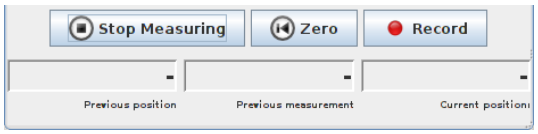


Figure 2.2: Measuring control panel.

Corina supports the measuring of rings both individually and cumulatively. We feel that it is easier and more accurate to measure rings individually, that is to say the device is reset to zero after each measurement. If a device accepts requests to reset measurements (e.g. Quadra Chek boxes) or if it automatically resets itself to zero after recording a measurement (e.g. EVE IO) then this procedure is used by Corina. In this case the user begins measuring by setting the display to zero, then turns the platform to the end of the ring, then either presses the 'measure' button on the hardware device or the 'record' button on the screen.

> 💡 If your device does not have a physical 'measure' button you don't need to use the mouse in Corina to click the 'record' button each time. Use the tab key to ensure the record button is highlighted, then you can use the space bar on your keyboard instead. This means you don't need to lift your eyes from your microscope to ensure you are clicking the button correctly.

Certain devices (e.g. Boekler Microcode boxes) do not listen for requests to reset to zero. In this case to measure each ring individually, you would need to manually reset the reading to zero following each measurement. This would of course be extremely tedious. In this situation Corina measures cumulatively from the beginning of the first ring and calculates the ring width based on the previous ring boundary position. With this method you must be careful not to knock your sample, and you must also take special care when altering radii to navigate around problem structures. If you do knock your sample, the best way to recover is to reset your platform to zero and press the measure button. Next, press the 'stop measuring button', manually fix the values in the data table, then begin measuring again from where you left off.

If you are in 'Early and latewood widths' measuring mode the measurements are made and sent to the data table in pairs. The first measurement should be of the earlywood of the ring, and the next value the latewood measurement. Whether you are currently measuring early or latewood is indicated as a message at the bottom of the measuring panel.

While you measure your sample you can flag features in a ring by right clicking on any cell in the table and selecting one or more of the standard notes (see figure 2.3).

Corina supports all standard TRiDaS remarks including: fire damage; frost damage; crack; false ring(s); compression wood; tension wood; traumatic ducts; single pinned; double pinned; triple pinned and many others. Rings that include remarks are indicated by the relevant icon in the data screen. Depending on your method of work, this can be useful for keeping track of sample pin holes. For instance, if a missing or false ring is discovered after a sample has been pinholed, the offset in pinholes can be easily seen without resurfacing the sample. In the future Corina will also include support for user defined ring remarks.

The data screen also contains a status bar at the bottom. By click on the units section, you can switch between micron and 1/100th mm units. Corina understands the units being supplied by the measuring platform, therefore changes here are purely for display purposes only. If you have a platform that measures in microns, but prefer to see the values in 1/100th mm then you can use this feature. At the bottom ring of the status bar you can choose one of a variety of summary information about your series.

Once you have finished measuring your sample, you should then go to *File* ➔ *Save* to save your series to the database.

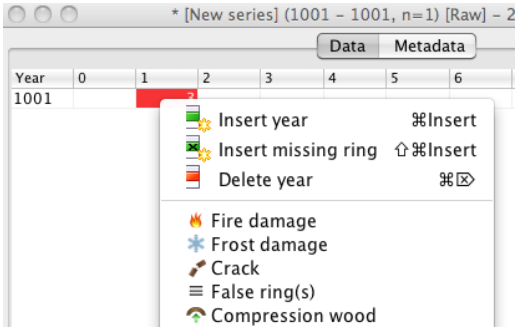


Figure 2.3: Right click context menu showing some of the options for adding remarks to rings.

2.2 Opening existing data

If you have used traditional dendrochronology software, you are probably used to opening existing dendro data files from your computer. Corina works in a different way. All data accessed by Corina is stored within the central Corina database rather than in files. The database provides many benefits over file based storage, most importantly it means there is a high degree of security and integrity in your data.*

To use data that you have stored in existing data files you must first *import* your data into the Corina database. This gives you the opportunity to clean-up your data! For details of how to import your data see chapter 7, page 31.

Once you have data in your database, either by importing existing data files or measuring new samples, you can access your data through the database browser. This is accessed through the *File* ➔ *Open* or *File* ➔ *Open multiple* menus and an example of the dialog is shown in figure 2.4. The same database browser dialog is used in multiple places throughout Corina, e.g. when adding addition series to graphs and when choosing chronologies to crossdate against.

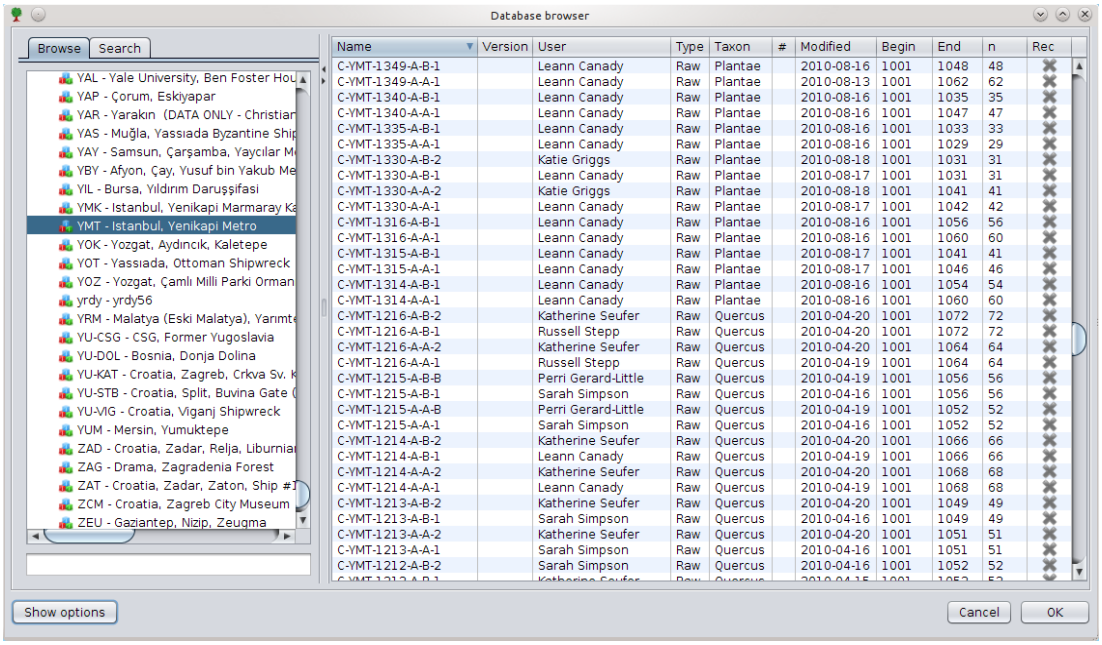


Figure 2.4: Screenshot of the database browser dialog.

*This doesn't mean you don't have to backup your data though! Whoever is in charge of maintaining your Corina database should make sure regular backups are made–preferably offsite.

The database browser is divided into two main parts. On the left is the browse and search tabs, and on the right is the series table. Selecting options in the browse or search tab populates the series table on the right with all the series that match the specified criteria.

> ⚠ *The search tab is currently a 'work-in-progress' so we recommend you use the browse tab until further notice.*

The browse tab shows a heirarchical tree view of the contents of your Corina database based upon the TRiDaS data model. The panel will be pre-populated with all the objects in your database but it is possible to 'drill-down' by right clicking on an object and choosing 'Expand branch'. Expanding an object for instance, will show all the elements associated with that object, and expanding an element will show all the samples associated with the specified element. To better understand the TRiDaS terminology please read chapter 4, page 17.

By double clicking (or right clicking and choosing 'Search for associated series') on an item in the browse panel Corina will search the database for all series that are associated with the specified entity. The results of the search will be shown in the series table on the right of the screen. This table shows basic metadata about each search and is sortable by click on any of the column headers. To open a series, simply select one of these series and click 'OK'. If the database browser is open in 'multiple series' mode, then you can use the arrow buttons to select multiple series to open in one go.

There is also a 'Show options' button on the database browser dialog. This adds additional advanced methods for filtering the series table to help you find the data you are interested in.

2.3 Reconciling data

Corina has been developed not only for experience dendrochronologists, but as a tool for teaching students. It therefore includes a comprehensive 'reconciling' tool for supervisors to check the quality of measurements made by students. The reconcile dialog does a comparison of a measurement series made by a student with a references series of the same radius measured by the supervisor. The same dialog can also prove useful for comparing measurements from two experienced dendrochronologists when handling particularly difficult samples.

Chapter 3

Measuring platforms

Although it is possible to manually enter the ring widths of your samples into Corina, it is normal to automate this process using a measuring platform. Corina supports the most common measuring platforms including Velmex and Lintab. However, please note that standard Lintab platforms use a proprietary communications protocol. Rinntech–the manufacturers of Lintab platforms–claim intellectual property rights over this protocol. During discussions between the Corina development team and Rinntech an agreement was reached whereby the Corina developers agreed not to release details of the protocol. In turn Rinntech has agreed to produce an adapter that can be attached to Lintab platforms so that they communicate with an open ASCII protocol. Users wishing to use Lintab platforms with Corina (or any software not developed by Rinntech) must therefore contact Rinntech and purchase an adapter.

Measuring platforms typically use serial ports to communicate to computers. In recent years computer manufacturers have been phasing out serial ports so you may need to purchase a serial-USB converter. Modern MacOSX, Linux as well as Windows 7 should support most serial-USB adapters out of the box, otherwise you must install the relevant drivers before continuing. Recent Lintab USB platforms use internal serial-USB converters so are treated in exactly the same way by Corina.

To begin, shut down your computer, attach your platform, then reboot and launch Corina. Next, go to the preferences window and open the hardware tab and you should see an interface that looks like figure 3.1.

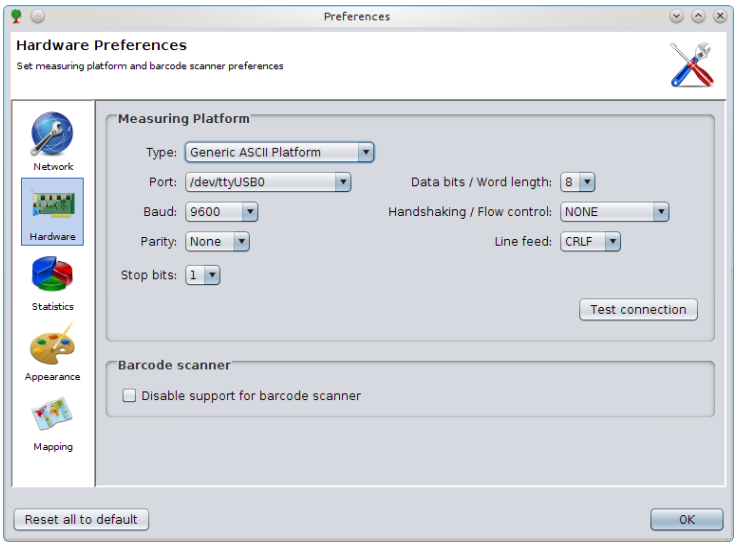


Figure 3.1: The hardware preferences dialog.

In the type pull down menu, select the type of measuring equipment you are using. Note that this refers to the equipment that the computer is attached to, and not necessarily the measuring platform itself. For instance, Velmex platforms are typically connected through a Metronics digital readout device. Included in this list is the EveIO device which is an open-source device designed for the Cornell Tree-Ring Laboratory. Circuit drawings for this device can be obtained from the Cornell lab to enable Hensen measuring platforms to be used with

Corina (and other software). If you measuring platform is not included in the list it should be relatively easy for us to add support so please get in touch and we'll see what we can do. Alternatively you could implement support yourself (either personally or by employing an independent developer). Technical details on how to do this are included in section 13.13, page 69.

Next you must choose the port that your platform is connected to from the pull down menu. In Windows this will be a COM port, in Linux and Mac this will be a /dev/xxx port. Depending on the type of platform you choose, you may also need to set various communication parameters. If these boxes are enabled, please check the documentation that came with your measuring platform to ensure these values are set correctly.

To check whether your platform is working, click the 'Test connection' button (see figure 3.2) and attempt to measure a few rings. Different measuring platforms have different capabilities. For instance, some include a physical switch for firing measurement events, others also include switches for resetting measurements to zero. Some platforms (e.g. Lintab) also continuously report the measurement values to the computer. So depending on the hardware you use, Corina will present the you with slightly different options.

The test dialog includes information about the capabilities of your platform as well as a log window to show the raw information being received by Corina. If you are having trouble interfacing with your platform, you should send the communications log to the developers, along with as much information about your hardware as possible.

Once you are satisfied that you are getting the correct results from the measuring platform, click close on the test window and then close the preferences dialog to return to the Corina home screen.

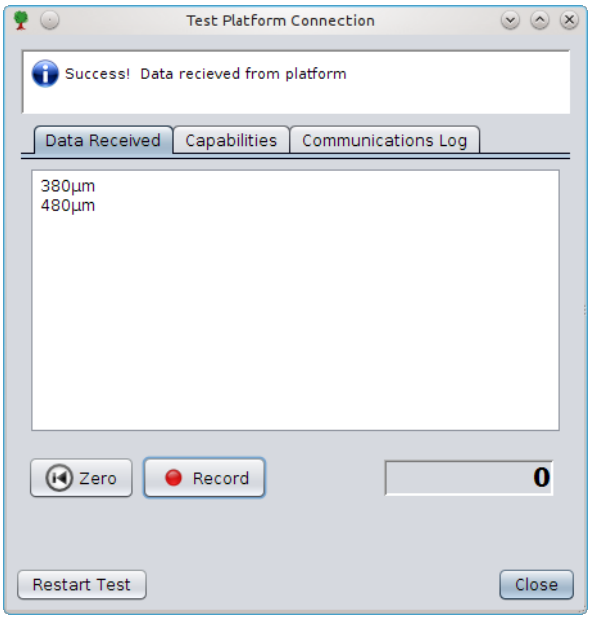


Figure 3.2: Testing the connection to a hardware measuring platform.

Chapter 4

Metadata

Metadata is 'data about data'. In Corina this means all the information associated with your physical samples and measurement series e.g. species, location, who measured it, dimensions, slope, soil type etc.

The metadata in Corina, and in fact the entire Corina data model, is based on the Tree Ring Data Standard (TRiDaS). Before you use Corina you may find it useful to read **?** so that you get a better understanding of the principles of TRiDaS, but a summary is also provided here.

4.1 Tree Ring Data Standard - TRiDaS

TRiDaS is an XML-based data standard for recording dendrochronological data and metadata. More than 80 dendrochronologists, computer scientists and specialists from research disciplines that rely on dendrochronology have so far contributed to its development, including dendroarchaeologists, art and architecture historians, ecologists, geologists and climatologists. The standard is therefore capable of recording the wide variety of metadata required by these different fields. TRiDaS builds upon other established standards, such as GML for the recording of locality information. The extensible nature of XML also means that TRiDaS can evolve to accommodate the changing needs of dendrochronologists over time.

TRiDaS includes a total of eight data entities: project; object; element; sample; radius; measurementSeries; derivedSeries; and value. Detailed descriptions of each of these entities are given below and their relationships are illustrated in figure 4.1.

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. Due to the way research is conducted at the Cornell Tree-Ring Lab, TRiDaS projects are not currently supported within Corina, although future plans include adding project support.

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

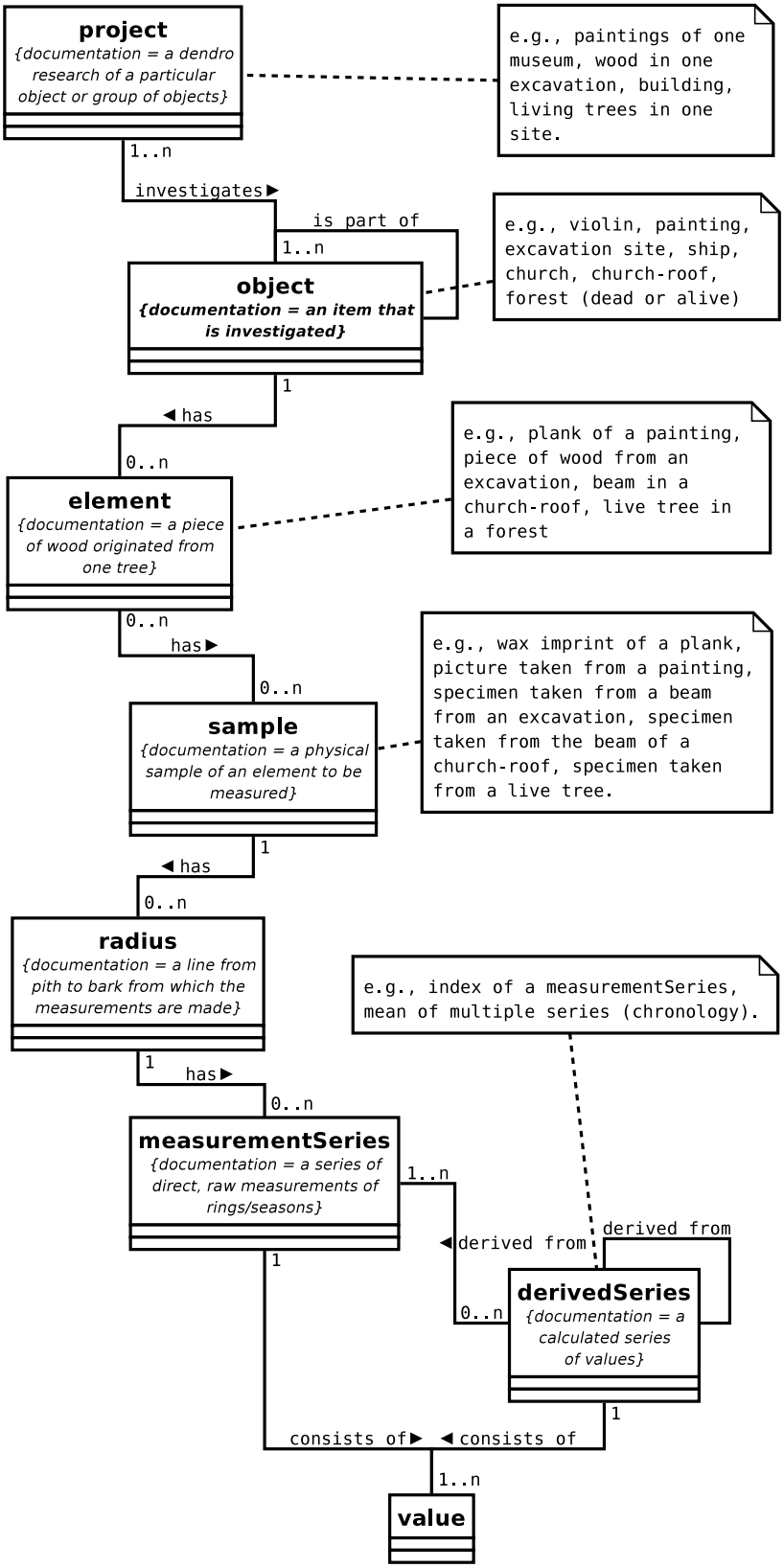


Figure 4.1: TRiDaS data model showing the relationships between data entities. Most of the entities having a simple hierarchical relationship (a project has one or more objects, an element has one or more samples.

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 derivedSeries. 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 **?**. 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. Corina currently only supports total ring width values. Support for other variables is planned for a future version.

Working top to bottom, the TRiDaS entities are nested within each other. For instance a project contains one or more objects, which in turn contains one or more elements, and so on. The benefit of this is that you record data once and once only. In standard file-based dendrochronological software, when creating measurement series you are typically required to type the name of the site, the species of tree etc over and over again. This is not only time consuming, but very error prone.

Keeping data consistent is also difficult. For instance, if it was determined that a tree species was identified incorrectly, in existing file-based software, the user would need to locate all data series from this tree and manally update the metdata. This is not the case in Corina. A tree is represented just once in Corina and samples of this tree, and the subsequent measurement series reference this one entry. If metadata for this tree needs to be changed, the tree record is updated in just this one place. Because the measurement series obtain this information by reference, then all associated series are automatically kept up to date.

4.2 Entering sample metadata

The metadata for a series is viewed and edited on the 'Metadata' tab of the main window such as that shown in figure 4.2. You can see the interface is organized according to the TRiDaS data model with separate screens for object, through to series.

When creating a new series, the metadata screens must be populated in order. This is necessary because of the nesting of entities described above. For instance, an element is associated with an object, so an object must be chosen because and element can be defined. Likewise, an element must be chosen before any samples of this element can be defined.

Much of the time the entities that you need will already be stored within the database. Instead of re-entering data, you simply need to select the existing entry from the database, saving a great deal of time. Depending on the situation buttons will appear at the top of the dialog to let you 'choose' an entry from the database,

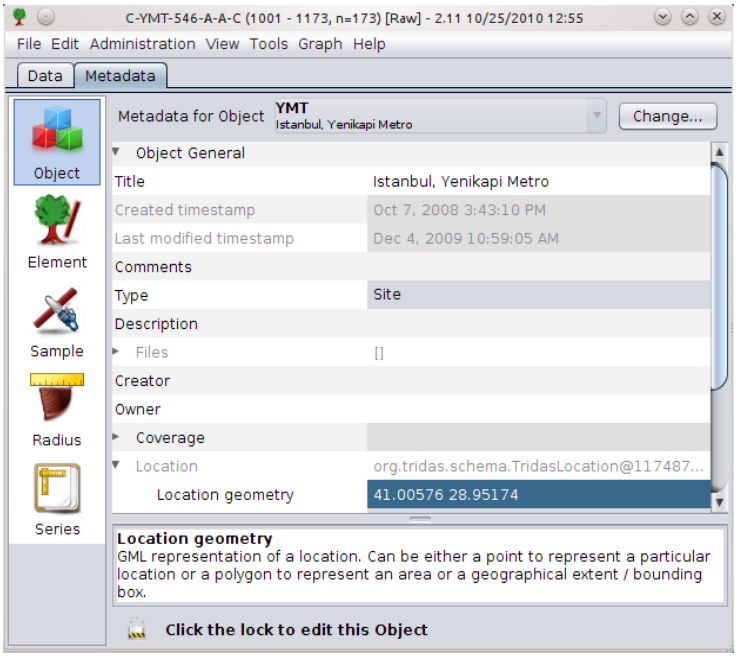


Figure 4.2: Example of the metadata dialog. The screen is showing the details of a TRiDaS object. Note that the location geometry field is highlighted and so a description of what is expected in this field is given below.

'revert' to the previously chosen entry, 'change' the existing entry to a different one from the database, or create a 'new' record.

Please note that the content of these metadata screens is kept read-only by default. To edit the values, you must first click the padlock icon to unlock the fields. When you have finished making changes you need to press the save button to write the changes to the database before moving to another metadata screen.

Very few of the metadata fields in the TRiDaS data model are mandatory, but a few are. In this case, these fields are highlighted with a red background. Note that whether a field is mandatory or not can depend on the other fields that have been filled in. For instance, the dimensions of an element are not required, but if dimensions are given then the units for these measurements must also be provided.

A number of the metadata fields are restricted with regards the values that you can enter. These are known as 'controlled vocabularies' in TRiDaS terms. Controlled vocabulary fields are represented by drop down menus. Similarly fields that expect numerical values (such as element dimensions) will only allow numbers. The final method data entry method is through custom dialogs. The only custom dialog currently implemented is for locations. This accepts coordinates in either decimal degrees or degrees minutes and seconds. Alternatively you can use data from a GPS handset by providing a GPS Exchange (GPX) format file containing the waypoints. The GPX format is the most common interchange format for GPS data. You can pick the relevant waypoint from the drop down menu. You can also preview the defined coordinates on a map using the 'view on map' button.

> 💡 A popular open source GPS communication tool is GPS Babel. It is an easy to use application which can download data from the majority of GPS handsets. See `http://www.gpsbabel.org` for more information.

4.3 Entering bulk metadata

Entering metadata on a sample-by-sample basis works perfectly well, but does not necessarily fit best with the typical workflow of a laboratory. Samples do not typically arrive in a lab in ones and twos, rather in large quantities following a field excursion. In this case it is most efficient to enter all the metadata for the samples

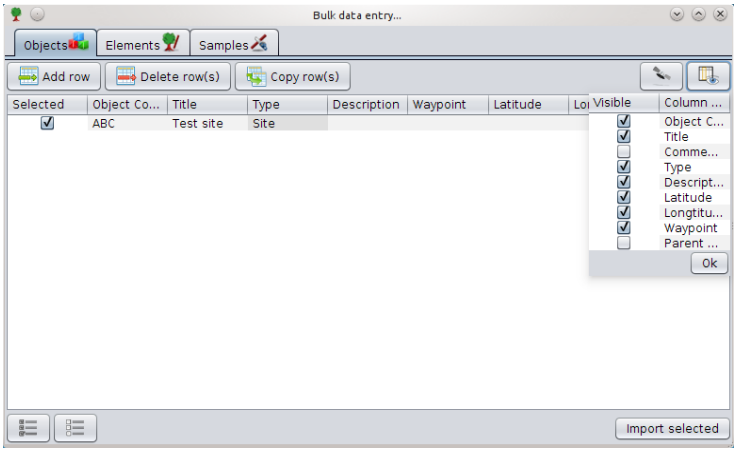


Figure 4.3: The bulk metadata entry screen. The 'show/hide columns' button has been pressed showing how the user can turn on and off particular columns.

as they arrive. This is often best in terms of data accuracy as the metadata can be entered while the field notes are still fresh in the mind.

To enable the efficient entry of lots of metadata Corina includes the bulk data entry interface. This can be access from the file menu and is illustrated in figure 4.3. There are three pages, one each for objects, elements and samples.

The interface is designed like a spreadsheet so as to be as familiar to users as possible. Each row of the table represents a new entry in the Corina database. Which columns are shown to the user is determined by the 'show/hide columns' button on the top right of the screen.

The bulk entry interface also includes support for reading GPS units. By pressing the satellite button on the toolbar, the user can provide a GPS Exchange (GPX) format file containing the waypoint locations recorded in the field. Corina will add a waypoint column to the spreadsheet with a drop down menu which will automatically populate the latitude and longitude fields for the record.

It is common for many of the metadata fields to be same in a single field collection. For instance, when coring trees in a forest, they are often of the same species. Rather than requiring the user to repeatedly type the same data over and over, the 'copy row' button can be used to duplicate a record, and then the user can change the few fields that are different.

When you have entered all the data you want, you can press the 'Import selected' button to write the records to the database.

4.4 Metadata browser

The metadata browser interface provides a convenient way to view all the metadata within your Corina database. It can be accessed through the 'Administration' menu.

The metadata browser contains two parts: a hierarchical representation of all TRiDaS entities in your database on the left; and a metadata viewer for the selected entry on the right. This interface is also the best method for fixing mistakes in your database.

Although Corina's database architecture maintains integrity within your data, it does come at the price of being a little more complicated to fix mislabelled series. For instance, what if you were to measure a series 'B' and assign it to sample ABC-138-A only later to realize you misread the label and it was in fact ABC-188-A. In a traditional file-based system, you would probably just need to rename the file you'd just created. In Corina however, you need to redefine the relationship of the series within the database and reassign it to the create sample. This is best understood when looking at the hierarchical tree in the metadata browser. Hopefully you

will see that you what you need to do is to move the series from its current position in the database to the correct one.

The reorganization of data in this way is achieved by right clicking on items in the hierarchical tree and choosing with 'merge' or 'reassign'.

4.5 Laboratory codes

Corina uses lab codes to refer to the hierarchical nature of the TRiDaS entities in the database. The separate parts of the code a delimited by hyphens and depending on the level of the entity you are referring to, will have a different number of parts. For instance, if you are referring to a tree (an 'element' in TRiDaS terminology) then the lab code will consist of just two parts: the object code and the element code. See figure 4.4 for an illustrated example.

Lab codes are used throughout Corina to describe TRiDaS entities. They can also be used in many places to specify entities that the user would like to choose. For instance, in the database browser, you can type the lab code for an object, element, sample, radius or series to search the system for all the series that match the specified entity. For instance entering 'ABC-5' would search for all series associated with element '5' from object 'ABC'.

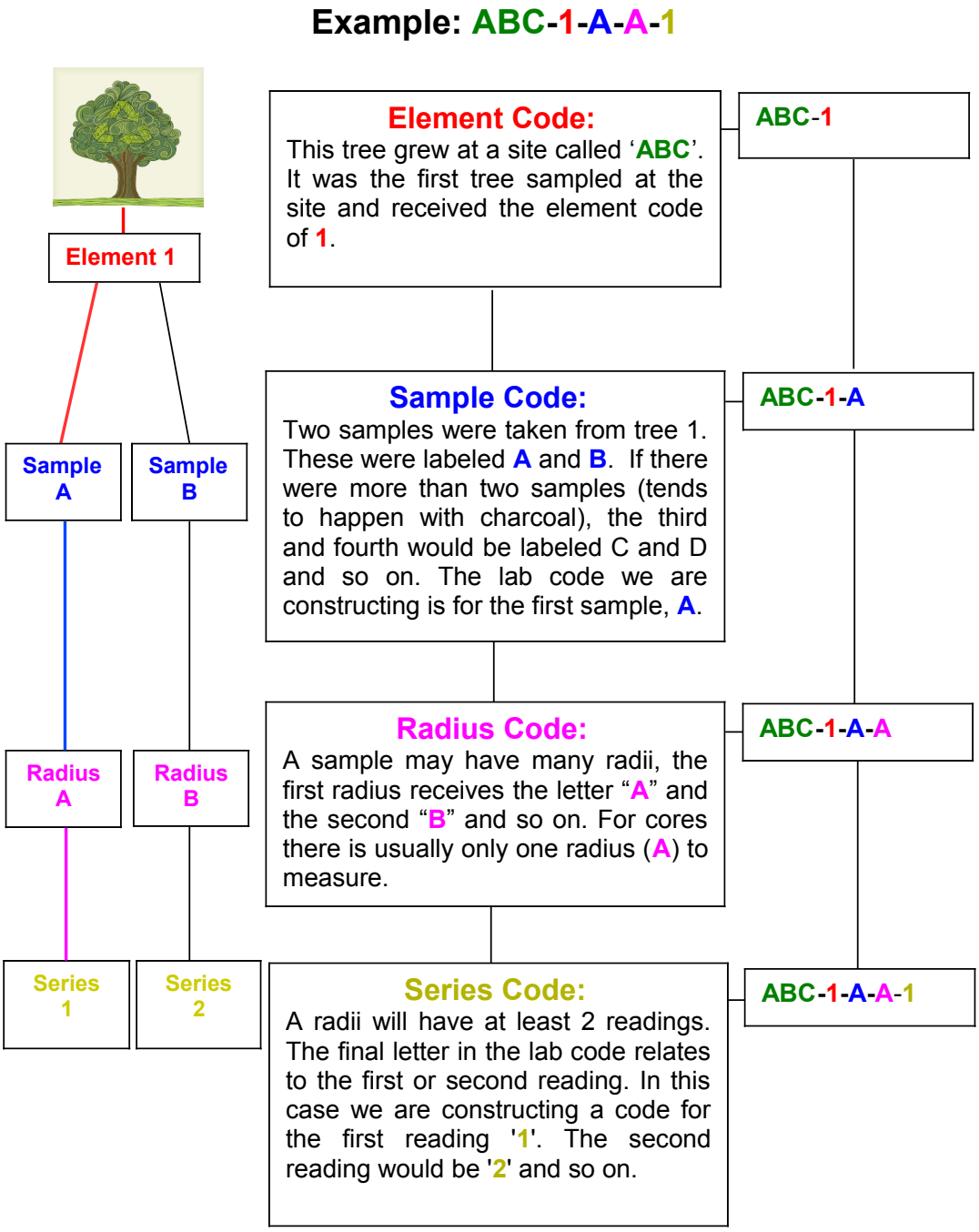


Figure 4.4: Illustration of the how lab codes are built in Corina. Figure courtesy of Charlotte Pearson.

Chapter 5

Mapping

Corina includes an integrated open source 3D mapping system (based on NASA's award winning World Wind Java SDK) similar to the program Google Earth which you're no doubt familiar with. As mentioned in the installation chapter, this mapping system requires an OpenGL 3D capable graphics card. Before you can use the mapping in Corina, you must also have something to map! See the chapter on Metadata (page 17) for information about adding coordinates to your system.

There are two ways to map data from your database. First of all, you can see a map of all the sites (i.e. TRiDaS objects) by going to *Administration* ➔ *Site map*. This will give you a screen like this:

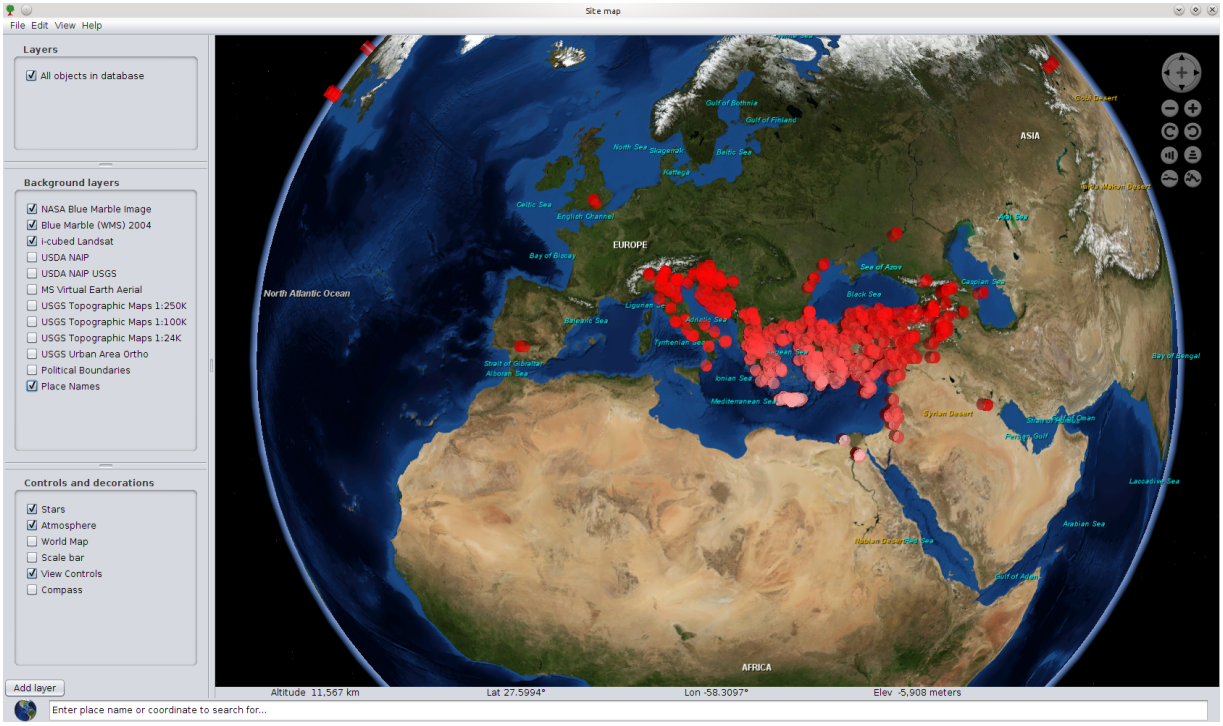


Figure 5.1: Screenshot showing an example of a site map.

You can also see a map of your current series if you have latitude/longitude metadata by clicking on the map tab on the main data screen.

5.1 Navigation

Figure 5.2: On-screen navigation controls.

You can navigate around your maps using the on screen controls (figure **??**), by using your mouse and/or your keyboard. These controls enable you to explore your location information in 3D such as the example of Mount Vesuvius in figure 5.3.

5.1.1 Mouse with scroll wheel

Pan Left mouse button click and drag – all directions
Zoom Use the scroll wheel on the mouse or Left and Right mouse (both buttons) click and drag up and down
Tilt Right mouse button click and drag – up and down or use 'Page Up' and 'Page Down' on the keyboard.
Rotate Right mouse button click and drag – left and right Note: Crossing the top and bottom half of the screen while rotating will change direction.
Stop Spacebar
Reset Heading N
Reset all R

5.1.2 Single button mouse

Pan Left mouse button click and drag - all directions. L left mouse button click once to center view.
Zoom Hold 'Ctrl' on the keyboard and Left mouse button click and drag - up and down
Tilt Hold 'Shift' on the keyboard and Left mouse button click and drag - up and down or use "Page Up" and "Page Down" on the keyboard.
Rotate Hold 'Shift' on the keyboard and Left mouse button click and drag - left and right
Stop Spacebar
Reset Heading N
Reset all R

Another method of navigating around the map is by using the built in gazetteer. You can enter and place name or coordinate information into the box at the bottom of the screen and you will fly to the requested location.

5.2 Interacting with data

Each marker on the map represents either a TRiDaS object or element in your Corina database. By clicking on these pins you can get more information from the database (see figure 5.3).

The example above shows the ring marker is of a site in Napoli called Poggiomarino (code name POG). You can see the option for searching for all series in the database associated with this site, and also the option for viewing all the metadata.

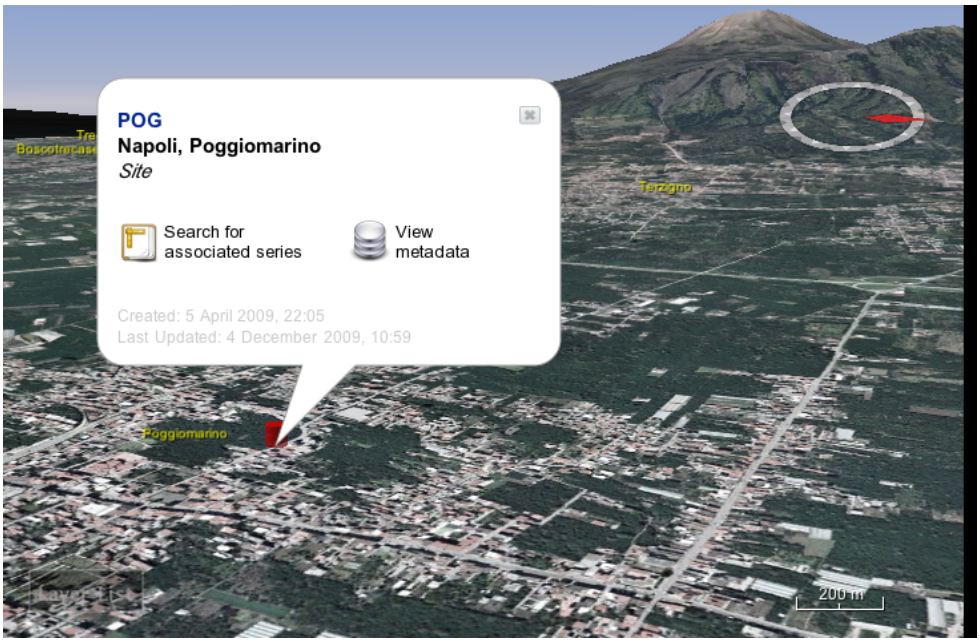


Figure 5.3: Screenshot of a map with information pin expanded

5.3 Map layers

Corina comes ready configured with basic map layers, including high resolution satellite imagery and basic political features. You can turn background layers on and off by going to *View* ➔ *Layers* or using the layer panel at the left of the screen when using 'Site map'.

Map layers are downloaded on-the-fly so there is likely to be a delay when you initially visit to a new region. However, up to 2Gb of map data can be cache locally to your hard disk, so on future visits, maps should load quickly.

5.3.1 Data layers

Data map layers (i.e. site and sample locations) are controlled with the layer list on the left of the screen. When viewing series, you will have the option of adding layers containing points for all the other series at the current site, and showing all the sites in the database.

In the 'Site map' you can use the 'Add layer' button to add data layers of the following types:

All Corina objects – this adds a single layer containing all the objects within the Corina database.

Corina entity from database – this adds a layer containing the location of one record from the Corina database. This is specified by labcode e.g. ABC would add a pin for the site ABC, whereas ABC-1 would add a pin for the element ABC-1.

Elements from an object – this adds a layer containing all the elements for a specified object. The object is specified by labcode.

All ITRDB sites – this downloads the location of all sites currently available in the ITRDB database and adds them as a single layer.

ESRI Shapefile – this enables you to load an ESRI shapefile stored locally on your computer. Corina supports polygon, polyline and point files, although currently it does not enable you to style this data. Data for a layer is presented using a random color.

Google Earth KML/KMZ file – like the ESRI shapefile option this enables you to load spatial data from your computer.

5.3.2 Web Map Service (WMS)

The mapping system in Corina includes support for remote map servers that use the OGC Web Mapping Service (WMS) standard. If you go to *View* ➔ *Layers* ➔ *Add remote layers*, you will get a dialog with a tab for each WMS server configured for your system. By default this includes the NASA Earth Observation and Jet Propulsion Lab servers. By ticking layers in this list you can add data layers to your map.

You can add map data from other WMS servers by clicking the '+' tab and entering the URL of the server you would like to use. This will give an additional tab with all the available map layers. This server will only be available for the duration of your current session so will need to be added each time you start Corina. If you would like a particular WMS server to be made permanently available, your Corina administrator can do this (see 'Managing map services', on page 55 for further details). Additional WMS servers added in this way will be available to all users the next time they connect to your Corina server.

Your system administrator may host a map server specifically for your lab, for instance, containing high resolution plans of an archaeological site that you are working on, or environmental data for your study region. Figure 5.4 shows an example overlay of sea surfaces temperatures loaded dynamically from the NASA EO server.

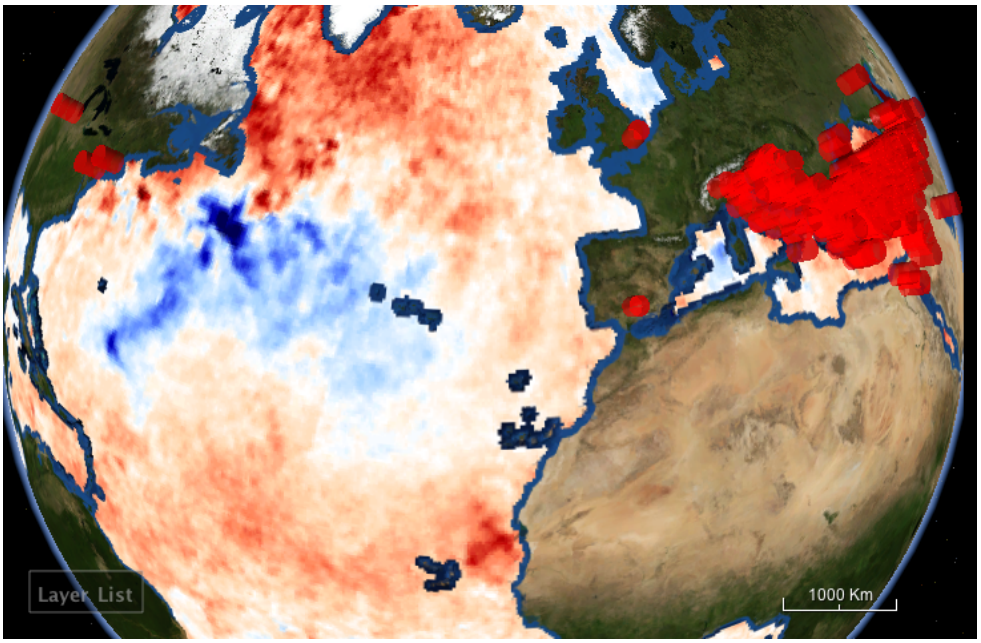


Figure 5.4: Map screenshot with a NASA sea surface temperature overlay dynamically loaded from the NASA WMS server.

5.4 Exporting maps

You can export maps by going to *File* ➔ *Export map as image*. For best results, maximize your map window first. You may also like to turn off various map widgets by going to the View menu. The exported image will include everything you can see on your map screen.

Chapter 6

Graphing

The graphing component is reused in many places throughout the Corina desktop application. The following description although based on the main graphing screen in Corina is largely applicable to all dialogs that include graphs (e.g. crossdating, indexing and reconciliation).

The main method for graphing your tree-ring data is by choosing an option from the Graph menu. Depending on the type of series you have open, the options available to you will be different. For raw measurement series, you will just have the option to 'Graph active series'. This will give you a simple graph of the current series that you have open. If you have a derived series open, then you may also choose 'Graph component series' which will plot all the series that go to create this series, or 'Graph all series' which graphs all the component series as well as the current series.

6.1 Controlling graphs

When newly created graphs are plotted according to the scale on the axes. A feature of Corina graphs though is that they can be manipulated directly on the screen. Both dendrochronology was computerized, dendrochronologists would plot rings manually on to graph paper. These paper graphs were then placed on lightboxes and moved around to enable comparisons. The graph function in Corina emulates this behaviour allowing users to click and drag graphs around to test for visual matches.

Figure 8.1 shows an example graph dialog. The mouse is hovering of the blue measurement series at relative year 1040 illustrating Corina's highlighting and guide line capabilities. A feature not shown in this screenshot is the illustration of sapwood rings. When sapwood rings are present the corresponding years on the chart are denoted via a heavier line.

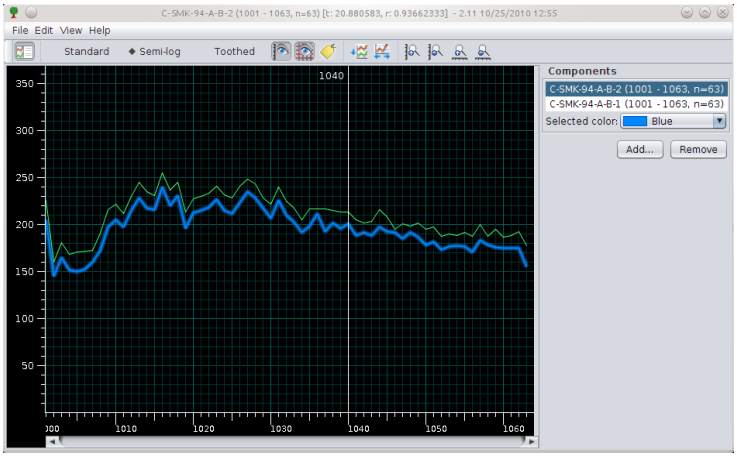


Figure 6.1: An example graph window containing two undated series of the same sample on a semi-log graph. Note the legend is visible with the options for adding or removing series.

The layout of graphs can be changed using both the toolbar buttons and menu options. The type of graph can be changed between a standard line graph, a semi-log graph and a toothed graph using the radio buttons. The remaining buttons are as follows:

 Zoom in on the horizontal axis
 Zoom out on the horizontal axis
 Zoom in on the vertical axis
 Zoom out on the vertical axis
 Toggle show/hide the grid lines
 Toggle show/hide the series labels
 Toggle show/hide the vertical axis
 Spread the series evening up the vertical axis
 Set the baselines of all the series to zero
 Resize graph to fit horizontally
 Toggle show/hide the legend

There are also a number of keyboard shortcuts that you might find useful:

Tab : Cycles through each graph component
Ctrl+W : Increase vertical scale
Ctrl+S : Decrease vertical scale
Ctrl+A : Increase horizontal scale
Ctrl+D : Decrease horizontal scale
Up arrow : Moves selected graph up by 10 units
Down arrow : Moves selected graph down by 10 units
+ : Moves selected graph up by 1 unit
- : Moves selected graph down by 1 unit
HOME : Scroll to first year of series
END : Scroll to last year of series
PAGE UP : Scroll left by one page width
PAGE DOWN : Scroll right by one page width
SPACE : Sets horizontal origin of all graphs to the same value

6.2 Exporting graphs

To export your graphs for use in reports you can go to *File* ➔ *Export plot as PDF file*, or *File* ➔ *Export plot as PNG file*. This presents you with a dialog for setting the colors, labels and size of the exported image. This functionality is due for an overhaul in the future to provide more flexible support for publication quality graphics.

Chapter 7

Importing and exporting

Importing and exporting of dendro data in Corina is provided through the TRiCYCLE libraries. TRiCYCLE is a universal dendro data conversion application for converting back and forth between 22 supported data formats (**?**). The open source libraries that provide the functionality to TRiCYCLE are incorporated directly into Corina providing support for all these formats.

Belfast Apple	ODF Spreadsheet
Belfast Archive	Oxford
Besancon (including SYLPHE variants)	PAST4
CATRAS	Sheffield D-Format (Dendro for Windows)
Comma delimited text files (CSV)	Topham
Corina Legacy	TRiDaS
DendroDB	TRIMS
Heidelberg (TSAP-Win)	Tucson (RWL and CRN)
Microsoft Excel 97/2000/XP	Tucson Compact
Microsoft Excel 2007	VFormat
Nottingham	WinDENDRO

Table 7.1: List of the twenty-two formats supported by Corina. See appendices A–V (pages 89–151) for full descriptions.

7.1 Exporting data

Exporting data is initiated by the *File → Export data menu*. If this is called from the main Corina data window, it will export the current series. If it is called from the Corina home screen, then it will present you with the database browser and allow you to pick one or more series to export. If you use the menu from within the main data editor then it will export

The export dialog contains two tabs. The first allows the user to choose the format that they would like to export to and the folder into which to save the result. Note that the user needs to specify a folder not a filename as many formats are unable to store more than one series in a file. When exporting derived series such as chronologies, the export dialog may therefore need to create multiple files. The second tab contains advanced options for altering the behaviour of the exporter:

What to export – This option enables the user to choose between exporting just the current series, or the current series and all associated series

Grouping – This enables the user to choose to group files into a single export file if possible. For formats that do not support more than one series in a file, this option is ignored.

Naming – This configures how the output files are named. See section 7.1.1 for more details.

Encoding – This specified the character encoding to use in the exported text file. See section 7.1.2 for more information.

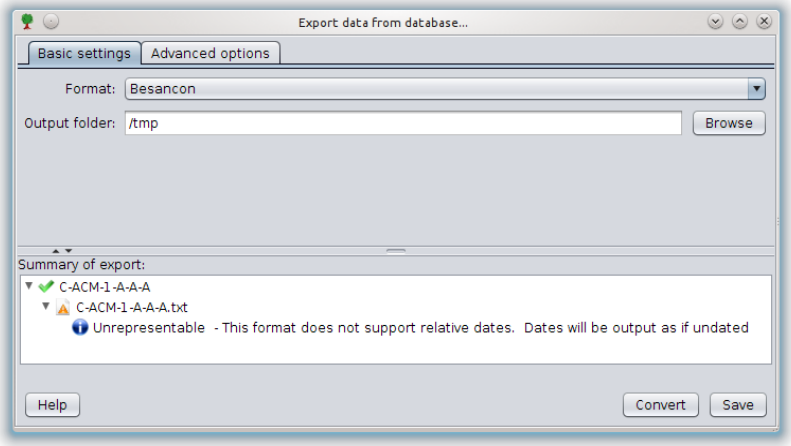


Figure 7.1: Screen showing a series that has been exported to Besançon format. In the summary of the export at the bottom of the screen you can see the warning to the user that this format does not have the ability to represent relative dates properly.

7.1.1 Naming conventions

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 named 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.

Series code – This convention is only applicable to formats that contain just one series. The file is named according to the series code.

Series code (8 characters) – Same as 'Series code', however the file name is truncated to 8 characters if the series code is longer.

Keycode – Similar to 'Series code' but preferentially uses a keycode (supplied by some file formats) if available. If a keycode is not provided, then it falls back to using the series code.

Note that some formats (e.g. CATRAS) require the file name to be the same as a field within the file. In this case the naming convention is overidden, so no matter what convention you specify the filename will be the same. If you manually rename a CATRAS file you will come across errors when loading it in the CATRAS application.

7.1.2 Character sets

Character sets are the mechanism 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 today is Unicode UTF-8. This is capable of representing the vast majority of characters (107,000+) while remaining backwards compatible for the 128 characters that ASCII 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.

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. Corina itself will automatically adapt to files with any type of line feed characters so reading files in Corina will never be a problem. When writing out files, Corina 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 Corina on Windows and choose a MacRoman writing charset, Corina will use Mac style line feeds.

7.2 Importing data

Importing data into Corina is an unavoidably long-winded task. For dendro applications that do not manage the underlying data and metadata, the task of opening up legacy data files is much simpler. In Corina, however, we are more fastidious about our data. Importing legacy data files is not just a matter of reading the ring width values, but also interpreting the metadata so that it is standardized, clean and matches our high data integrity standards. As you can imagine, this comes at the price, although definitely a price worth paying! Before continuing, you need to have a basic understanding of the TRiDaS data model. See chapter 4 (page 17) for more information.

7.2.1 The import dialog

You can launch the import dialog by going to *File* ➔ *Import* and then choosing the format that your file is in. If you are unsure, you can use appendices A–V (pages 89–151) to help you. You may also like to download TRiCYCLE* which includes a file identification tool in it's help menu.

Once you have picked the file you'd like to import, an import dialog screen similar to that shown in figure 7.2 is displayed. The dialog is divided into three main sections: TRiDaS hierarchy (top left); Data viewer (top right); and Warnings panel (bottom).

The TRiDaS hierarchy panel contains a representation of the file being imported according to the TRiDaS data model. This table also contains a status column to indicate whether input is required from the user. The two main status options are 'Stored in database'–to indicate that the entity is already stored in the Corina database–and 'Attention required'–to indicate the entity needs to be cleaned up by the user.

*TRiCYCLE is available from `http://www.tridas.org/tricycle`

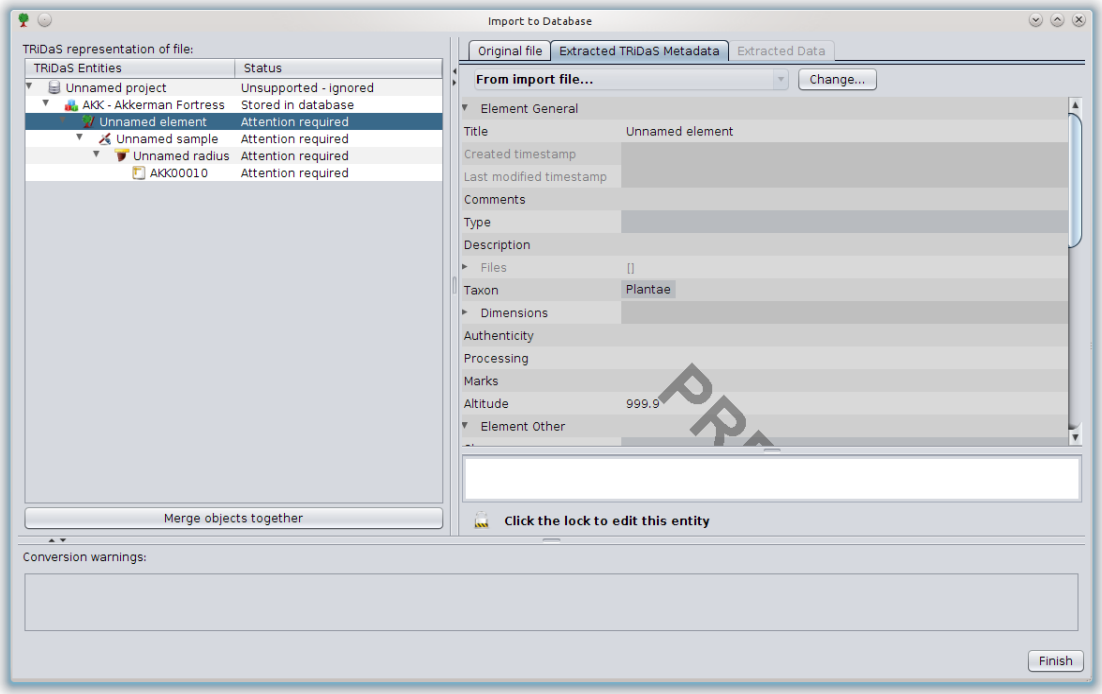


Figure 7.2: Screenshot of the import dialog. The screen is divided into three main sections. The top left contains a TRiDaS representation of the data file that is being imported. The top right panel contains the metadata gleaned from each of these TRiDaS entities. At the bottom of the screen is a table containing any warnings associated with the conversion. In this case there are no warnings.

The data viewer panel on the top right of the dialog contains three tabs. The first gives a standard text editor representation of the file being imported. Note that when errors are detected in the file, Corina will highlight, where possible, the portion of the file that is causing the problem. The second tab contains a metadata editor for the current TRiDaS entity. The third tab contains a viewer for ring width values if the entity selected is a measurment series.

The warnings panel at the bottom of the screen contains a list of any warnings that have occurred during the conversion process. There can be many issues when reading legacy data files, for instance some files do not contain information on the measurement units used. In this case Corina will make an assumption and warn the user. It is important to understand the assumptions and warnings provided by Corina in this panel otherwise erroneous (meta)data may be imported.

7.2.2 Importing when entities are already in the database

If you already have the object, element, sample and radius entities entered in your Corina database for the series you are trying to import the import process largely involves picking the relevant entities from the database.

First of all, click the most senior entity in the TRiDaS hierarchy on the left which has the status 'Attention required'. The dialog will update and the limited metadata that Corina has been able to glean from the file will be shown on the right. As we already have all the information we need about this entity stored in the database, we simply need to replace this 'skinny' entity with the rich one we have in the database. This is down by clicking the 'Change' button in the metadata viewer on the right and then by choosing the correct entity from the pull down menu. Click the choose button and the swap will be complete. Notice now that in the TRiDaS hierarchy that the status for this entity is changed to 'Stored in database'. You can continue working down the hierarchy in a similar way.

7.2.3 Importing when entities are not in the database

If you are importing a file that contains entities that you *don't* already have stored in your database, then you will need to clean them up and save them. Select the most senior entity that needs to be imported in the TRiDaS hierarchy panel. The metadata gleaned by Corina from the legacy file will be previewed in the metadata panel on the right. Next, click the 'lock' icon at the bottom of the metadata panel and the metadata will become editable. You will then need to spend some time filling out and cleaning up the metadata for this entity.

An important part of the import process is the standardization of the metadata. Take for instance the example of the taxon. Most legacy files have some method for indicating what species a file is about, but most do so by allowing the user to type in a free text field. The TRiCYCLE libraries that Corina uses are able to read such fields but the red oak (*Quercus rubra*) may be represented in many ways: oak, red oak, Oak, *Quercus*, *Quercus* sp., *Quercus rubra*, QUER etc, not to mention the scientific synonyms for the species e.g. *Quercus acerifolia*, *Quercus ambigua*, *Quercus angulizana* to name but a few. Many users would know that these represent the same species, but if you were to query your database for Quercus rubra, you would miss records stored under the other names. It is therefore essential to standardize them to a single dictionary of terms. In the case of species names, Corina use the Catalogue of Life (**?**). There are a number of similar enumerated metadata fields in Corina, each indicated by a pull down menu. When importing, these fields will be populated with the non-normalized term read by Corina, but to successfully import the entity into the database, you will need to choose the corresponding 'controlled vocabulary' term from the pull down menu.

Once you have cleaned and normalized your metadata, you need to press the 'Save changes' button to upload the entity into the database. You will be provided with an error message if you have missed any mandatory fields, or if you have not normalized all the data to terms stored in the Corina dictionaries. Once you have successfully saved the entity, the TRiDaS hierarchy on the left will be updated so the status reads 'Stored in database'. You will then need to work your way through the remaining entities to finish importing the file.

7.2.4 Speeding up the process

Manually choosing the relevant entry for each entity is quite a frustrating and time consuming task. When importing a file containing multiple series, the task is compounded by the fact that Corina will often place the series into separate hierarchies. Unfortunately, many legacy file formats do not contain enough information to enable Corina to determine whether they are from the same or different objects. To be on the safe side, Corina therefore places them in separate 'unknown' objects. Rather that manually specifying the correct object repeatedly, you can use the 'merge objects' button to do this for you. You need then only pick the correct object from the database once.

7.3 Exporting graphs

7.4 Exporting maps

Chapter 8

Curation and Administration

8.1 Laboratory workflow

Corina includes a number of functions to assist you with the curation of your physical sample collection. To understand how these are designed to assist users, we must first consider the workflow within a laboratory.

In research laboratories, samples generally come to the lab in large batches following field collection. In this case the typical workflow may be as follows:

1. Collect samples and record field notes as accurately as possible
2. On returning to the lab enter field notes as soon as possible into the 'bulk data entry' interface
3. Print sample barcode labels
4. Prepare physical samples and label with barcodes
5. Assign samples to storage boxes
6. Measure samples, using barcodes to recall metadata from database
7. Crossdate samples / build chronologies
8. When all samples from a box are completed register box as archived and then store

For commercial labs offering dendrochronological dating as a service, samples more likely to arrive in smaller batches. In this case, the bulk data entry interface may not be the most efficient method for entering metadata. In this case the user may simply prefer to use the *File* ➔ *New* method for each sample.

Either way, the concept behind the curation of a collection in Corina revolves around the accurately recording as much metadata about a sample as possible, then labeling the physical sample with a label containing a barcode for Corina and sample code for the user. By entering a sample into the database as soon as it enters the lab, it can be traced throughout the workflow. When a chronology is built, it is easily to quickly and efficient locate all samples that have been used. By assigning samples to boxes, groups of similar samples (e.g. from the same site) can also be easily stored together and located quickly and efficiently.

8.2 Barcodes

Barcodes allow you to keep track of what samples you have and where they are stored. Although it is not essential to use the barcode functions, we strongly suggest you do because they save time and money, but most importantly they greatly reduce the scope for erroneous data entry. For instance, when measuring a sample a user simply scans its barcode and all the relevant metadata is retrieved from the database, rather than relying on them to enter data manually. Barcodes have been routinely used in the retail industry since the 1980s. They can be equally as useful in dendrochronology laboratories.

Corina creates and reads barcodes for samples, measurement series and boxes. Each barcode encodes the unique identification code stored in the Corina database for each of these entities. Due to Corina's use of universally unique identifiers (UUIDs), these codes are guaranteed to be unique opening the opportunity of labs to loan samples, much like libraries do with books. There are many styles (or 'symbologies') of barcodes

in use today, but Corina uses one of the most common (Code 128) which is supported by the vast majority of barcode readers. For a detailed discussion on the specifications of the Corina barcode see section 15.4.

Basic barcode readers are now cheap and widely available, with basic devices retailing for a few tens of dollars. Most are characterized as 'keyboard interface devices' and work like an automated keyboard, typing in a string of characters when a label is scanned.

Within the Corina application, whenever the user is required to specify a box, sample or series, they have the option of typing the human readable lab code or scanning the barcode. By using the barcode, the user can be sure they are not entering typographic errors so we recommend using barcodes whenever possible.

The most important barcode is the label for the physical wood sample. These are easily generated through the *Administration* ➔ *Labels* ➔ *Sample labels* menu entry. Currently the layout of these labels is fixed, but in the future we aim to provide different styles.

8.2.1 Sample labels

Before labels can be generated, metadata entries the sample level must have been made in the database. This is typically done using the 'bulk data entry' interface (see page 20). If samples are already in the database, the user needs to select the object of interest in the label creation dialog to see all the available samples. It is then just a matter of selecting the samples of interest and moving them into the 'selected' column. Once the list is populated (samples from multiple objects can be included), then you can either click 'Preview' to see a PDF of the labels, or 'Print' to print directly.

Figure 8.1: An example of a sample barcode produced by Corina for the Cornell lab. Note the label also includes the human readable code for the sample.

The current label style is designed to fit on standard core mounts and most samples. There are no widely available die-cut labels that fulfill this need, so the labels are intended to be printed on archival grade full page sheet labels (e.g. Avery® layout 6575), and then manually guillotined.

8.2.2 Box labels

The procedure for printing box labels is the same as for samples. Samples must have already been assigned to boxes before the label is printed (see section 8.3 for details). To print (or preview) box labels go to *Administration* ➔ *Labels* ➔ *Box labels*. The label style is designed to be printed on $5'' \times 8\frac{1}{8}''$ labels, two per sheet such as the Avery® 6579 layout. An example is shown in figure 8.2.

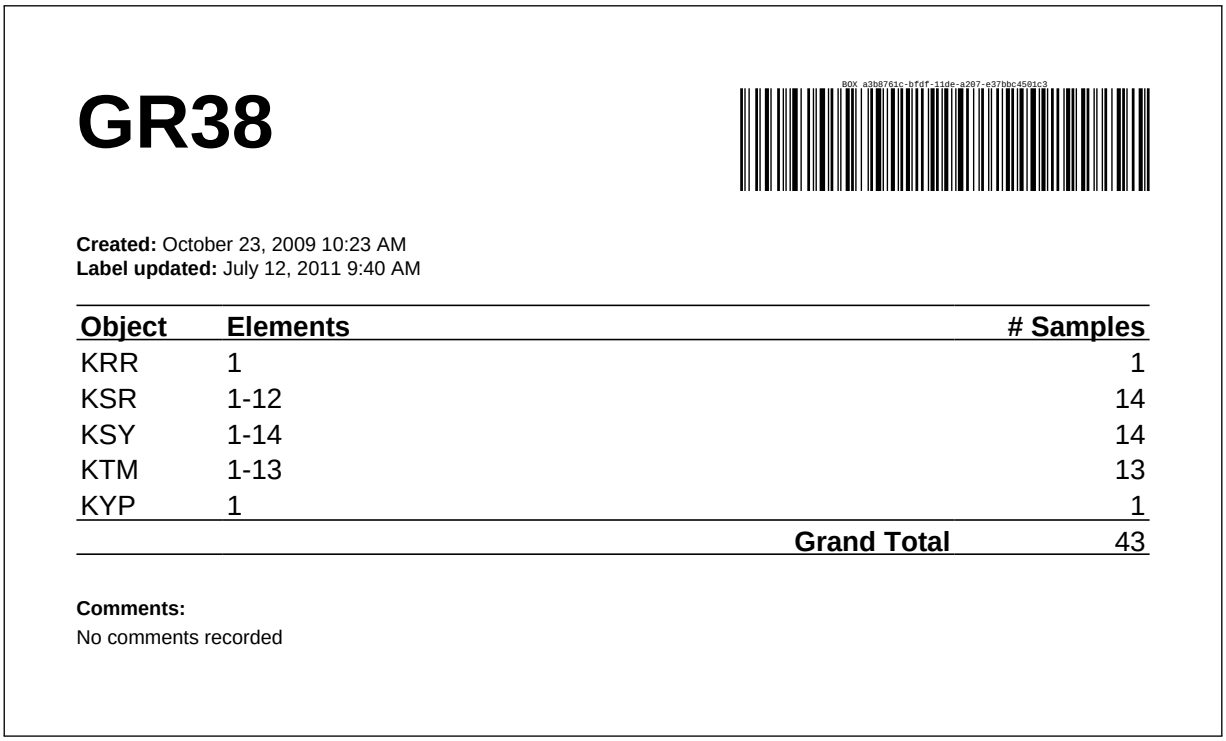
> Until dynamic label styles have been implemented, box labels will print one per page. To make use of the second label on the page, the same sheet should be fed through the printer a second time.

8.2.3 Series barcodes

Series barcodes are printed at the top of a standard series report (see figure 8.3). These are produced through the *File* ➔ *Print*, or *File* ➔ *Print preview*, menus.

8.3 Storage boxes

Corina uses the term 'box' to refer to the collection of samples you archive. Many labs (including Cornell) use cardboard bankers boxes to store samples once they are completed, but the same box concept could refer to draws or shelves in your collection.



GR38

BOX a3b8761c-bfdf-11de-a207-e37bbc4501c3

Created: October 23, 2009 10:23 AM
Label updated: July 12, 2011 9:40 AM

Object	Elements	# Samples
KRR	1	1
KSR	1-12	14
KSY	1-14	14
KTM	1-13	13
KYP	1	1
	Grand Total	43

Comments:
No comments recorded

Figure 8.2: An example of a box label from the Cornell collection. The label provides a human readable name for the box (GR38), a barcode for accessing the box details within Corina, and a summary of the samples contained within the box.

8.3.1 Creating and editing boxes

Records for boxes in the system are created and edited through the *Administration* ➔ *Curation* ➔ *Box details* menu. To editing an existing box, you can scan the barcode label on the box, or select from the list. To create a new box, click the 'Create new box' button and enter its details. There is no restriction on what boxes should be called, but it is probably easiest if you use some sort of numerical sequence to assist with organizing the boxes in your store. At Cornell, we use a two part name for each, the first being the year of collection, the second being a sequential number (e.g. 2009-11).

The contents tab lists all the samples that have been assigned to this box. To add new samples, simply click the 'Add sample to box' button and scan the sample's barcode.

8.3.2 Inventory

An important feature of any collection management system is the ability to perform an inventory on the collection. Even with the most robust system, samples will always go astray so its important to be able to periodically check that the boxes contain what you expect.

The 'Contents' tab of the Box details dialog contains a feature to assist with this. Next to the list of samples that are recorded as present, there is a temporary checklist column. By checking the boxes for each sample actually stored in the box it is easy to see which samples have been mislaid. If the 'Mark unchecked as missing from box' button is then pressed, the date and time the discrepancy was noted is then recorded in the comments field for the box.

C-YMT-1399-A-A-2

SERIES 191dd500-af8b-11df-9b25-1bfba0ced0da

Istanbul, Yenikapi Metro

Created: August 24, 2010 10:23 AM
Last Modified: August 24, 2010 10:23 AM

Measured by: Leann Canady
Supervised by: Charlotte Pearson

Ring widths:

1/100th mm	0	1	2	3	4	5	6	7	8	9
1001		• 132	79	55	160	111	172	198	177	130
1010	• 176	166	160	179	255	236	232	273	188	191
1020	• 182	109	113	92	73	75	69	84	98	121
1030	• 123	146	239	177	177	198	196	230	236	241
1040	• 208	161	161	206	246	253	173	189	164	185
1050	•• 149	112	143	145	108					

• = Single Pinned •• = Double Pinned

Wood Completeness:
- Pith is incomplete.
- A total of 54 rings were measured.
- Heartwood is incomplete
- Sapwood is absent
- Bark is absent.

Interpretation:
- The first ring of this series begins in relative year 1001.
- The pith of this radius was laid down in exactly relative year 1001 and died after relative year 1055.

Element and sample details:
- Taxon: *Quercus*
- Element type: Post
- Sample type: Cross section

Figure 8.3: An example of a report showing barcode and basic metadata about a series.

8.3.3 Checking boxes in and out

Corina includes function for checking boxes in and out of a store, much like when a book is borrowed from a library. The *Administration* ➔ *Curation* ➔ *Check out box from store* and *Administration* ➔ *Curation* ➔ *Return box to store* menus do just this. You can either scan the box barcode or select the box from the drop down menu. These options record when a box is checked out/in and by whom. These details can be seen by users in the box details dialog.

8.3.4 Locating samples

As you might expect, Corina also includes a function for locating your physical samples. This is available in the *Administration* ➔ *Curation* ➔ *Find a sample* menu. There are three methods for locating a sample: via barcode; via lab code; and manually by object/element/sample.

If you have the sample in your hand and you simply want to know which box it should be returned to you can scan the barcode. If you are looking for a sample and you know its lab code then you can enter this instead. Alternatively, you can use the drop down menus to search for one or more samples at once. For instance, you can locate all the samples for a particular object and element.

Chapter 9

Indexing

Trees tend to put on big rings when they're young, and smaller rings when they get older. Some trees put on very large rings, while others put on very small rings. These variations in growth can make it difficult to crossdate samples. Some dendrochronologists therefore prefer to index or normalize their ring width data before combining into chronologies.

Indexing is a manipulation you can perform on your data to make it easier to crossdate.

The procedure for indexing is as follows:

1. You open a series (raw data)
2. You ask Corina to index it
3. Corina shows you some possible curves
4. You pick a curve (based on its graph, statistical scores, and your expectation of how the tree is growing)
5. Corina converts each year's ring width to a ratio of actual growth to expected growth for that year
6. You save the series (indexed data)

Indexing changes the units of a dataset. A raw sample has units of hundredths of a millimeter (0.01 mm) or microns. An indexed sample has units of parts per thousand (0.1%, or ‰).

This doesn't cause a problem with crossdating. The t-score normalizes all samples as part of its test, and the trend only cares if the values are increasing or decreasing. For more information on crossdating and chronology building, see chapter 10. It does, however, cause a problem with 'summing' since summing needs to take the average (what's the average of 1mm and 75%?). Therefore, the samples in a sum must be either all raw, or all indexed.

9.1 Types of index

There are a total of six different indexing methods available in Corina:

9.1.1 Exponential Index

This is the most commonly used index as it matches the way trees typically grow. Quickly when young and then gradually slower. An exponential index is therefore by far the most common index you'll use as 9 times out of 10 this will be the best choice.

This index tries to fit an equation of the following form to your data, searching for the best values of a, b and p.

- $y = a + be - px$

> This is sometimes called a negative exponential index, because the exponent is negative. Corina doesn't require that the exponent is negative, but if it's not, using this index probably isn't such a good idea; it means the tree is generally getting bigger, not smaller.

The least-squares algorithm used comes from **?**; the matrix solving function comes from **?**.

Sometimes the exponential index does a lousy job. If a tree is living in a crowded area and the trees around it get cut down, suddenly it has much better growing conditions, so it might grow faster as it gets older, instead of slower. If you tried to use an exponential curve on a tree like this, it would exaggerate this growth, and useful data would get flattened out.

The result is you're looking at the growing conditions of this one tree, so it's not going to crossdate as well.

Alternatively, imagine you are working on a tree with a fire scar that has a few very large rings. An exponential index wouldn't take much notice of this, because most of the sample is still shaped like an exponential curve, but when you applied it they would be grossly out of proportion. For these types of samples, there are other indexing algorithms available.

9.1.2 Polynomial Index

When you ask Corina to perform a Polynomical Index it tries to fit a polynomial curve to your data using the following equation:

- $y = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_2 x^2 + a_{1x} + a_0$

You decide what degree polynomial, n, to use and Corina automatically finds the best values of a_0, $a_1 \ldots a_n$, to fit your data.

9.1.3 Horizontal Line Index

This only changes the magnitude not shape of the curve and is used when you would link to combine raw and indexed data together. It is a special case of polynomial where the horizontal line is equal to the average value.

- $y = x_{avg}$

This index is not used for crossdataing because dividing each value by the same value doesn't change the shape of the curve, only its magnitude. A horizontal line index is, however, useful because every element in a sum must use the same units, either raw or indexed. Therefore if you want to include a raw sample with an indexed sample then a horizontal line index can be used to convert the raw sample without otherwise altering the shape of the curve.

9.1.4 Floating Index

This is a running average of the 11 surrounding years. The adaptive index is generally used as a 'last resort' when both exponential and a high-degree polynomial have failed. It is simply the average of the eleven surrounding years:

- $ind_i = 1/11(data - i - 5 + data_{i-4} + \ldots + data_{i+4} + data_{i+5})$

This index was originally called floating average, probably in reference to the fact that the index curve "floats" around, not following any explicit $y = f(x)$-type formula. But people tended to call it floating, and then floating-point, which means something very different. You might still hear people calling this index by these other names.

9.1.5 High-Pass Filter Index

The high-pass index is a more general case of the adaptive index. Instead of simply taking the average of 11 values, it takes a weighted average. It's an example of a "high-pass" filter because high-frequency signals can pass through, but low-frequency signals are filtered out.

The default is "1-2-4-2-1", meaning:

- $ind_i = 1/10(data_{i-2} + 2{\cdot}data_{i-1} + 4{\cdot}data_i + 2{\cdot}data_{i+1} + data_{i+2})$

This comes from **?** who used it as a discrete filter before moving to a cubic spline. Note that almost half $(4/10)$ of the computed value is simply its old value. The high-pass index is nearly the same as the input, so the χ^2 values are usually the lowest, therefore do not choose this index solely on a low χ^2 value.

9.1.6 Cubic Spline Index

Cubic splines are a very specific type of high-pass filter. A cubic spline curve is created by combining a collection of cubic (3rd degree polynomial) functions.

There are many methods for constructing cubic splines through a dataset. The algorithm used by Corina has a parameter, s, which controls how tightly the spline fits the data. A lower value fits the data more tightly, a higher value fits the data more loosely. Therefore, s=0 fits the data exactly while s=1 is a simple line. A good starting point for dendro data seems to be around $s = 1x1016$.

Cubic splines were first used for dendro by **?** using an algorithm from **?**.

You can change the s-value used for the subic spline in the preferences. You might use a cubic spline in the same cases you would use a high-pass filter e.g. when the sample doesn't generally follow an exponential or polynomial curve very well, perhaps due to a fire scar.

9.2 Indexing data

To index your data, first you need to open the series you would like to index. Next choose *Tools* ➔ *Index* to display the indexing dialog (figure 9.1).

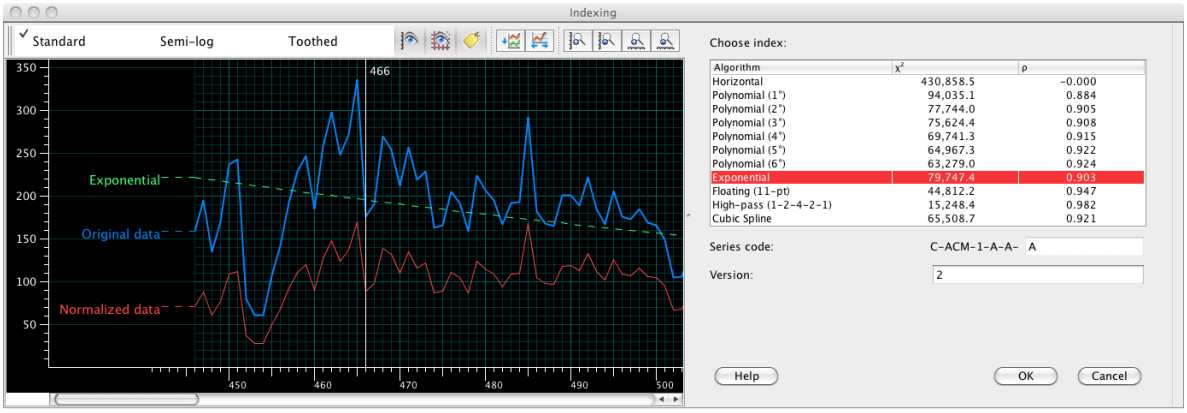


Figure 9.1: Indexing dialog showing the original data in blue, the exponential index of this data in green, and the normalized data in red.

From the indexing dialog you can then choose which type of index to apply to your data. The table on the right shows the available options along with the χ^2 and p values to help you choose the correct index to use. The graph shows your original data, the index line and the result of applying the index to the data and changes dynamically as you pick between different indexing methods. Once you have decided which index you want to use, select it, and click OK ensuring that you have given your data series a new version number.

Chapter 10

Crossdating and chronology building

All algorithms work in pretty much the same way. There's a "fixed" sample, and there's a "moving" sample. Imagine you have printouts of their graphs on translucent paper. The fixed graph is taped to a table, and you can slide the moving sample left and right. This is actually how it was originally done, on graph paper, with one inch per decade. Start with the moving sample to the left of the fixed sample, overlapping it by 10 years. Look at how well the graphs match: this is the first score that's computed. Slide the moving sample to the right one year and so on until you reach the end.

You could do it all simply by moving graphs and eyeballing the crossdates like this but there are hundreds of sites and millennia of chronologies you'll want to crossdate your samples against, so that would take a while. Corina has a few algorithms to find likely crossdates almost instantaneously. They aren't perfect, though, and all crossdates should be inspected visually to ensure they are a good fit.

10.1 Algorithms

Corina includes a total of five different algorithms for crossdating:

10.1.1 T-Score

The *t*-score is the classic crossdate. Unfortunately, every dendro program seems to have a slightly different implementation of *t*-score, so the numbers you get from Corina might not be exactly comparable to the numbers from other programs.

The version Corina uses is based on the algorithms given in **?**, though with some apparent bugs corrected (Ken Harris pers. comm.). In the following equations, $x_0, x_1, x_2, \ldots$ are the data of the fixed sample in the overlap, $y_0, y_1, y_2, \ldots$ are the data of the moving sample in the overlap, and N is the length of the overlap.

The first step is to make each dataset bivariate normal by replacing each value with the mean of the values around it, and then taking its natural logarithm. The preparation for the *t*-score is therefore done as follows and is done to both the fixed and moving series:

- $x_i \leftarrow \frac{x_{i-2}+x_i+x_{i+1}+x_{i+2}}{5}$
- $x_i \leftarrow ln(_{xi})$

The student's T computation is then done as follows:

- $s_{xy} = \Sigma x_i y_i - N(x_i - x_{avg})(y_i - y_{avg})$
- $s_{xx} = \Sigma x_i^2 - N(x_i - x_{avg})^2$
- $s_{yy} = \Sigma y_i^2 - N(y_i - y_{avg})^2$
- $r = \frac{s_{xy}}{\sqrt{(s_{xx} s_{yy})}}$

- $t = r\sqrt{\frac{N-2}{1-r^2}}$

The *t*-score is an explorative statistic. There is no univerally accepted threshold above which a *t*-score is regarded as significant, however, **?** suggest a value of 3.5. For more information see **?**.

10.1.2 Trend

Trend is another popular crossdate statistic. It computes the percentage of years with the same trend (going-up- or going-down-ness). Scores greater than 60%-70% are good. Trend is also referred to as ufigkeitsko-Gleichläeffizient, Gleichläufigkeit and Eckstein's W.

The trend is the simplest crossdate. For each sample, it computes the trend of each 2-year interval (1001-1002, 1002-1003, and so on). The trend of a 2-year interval is simply whether the next ring is larger, smaller, or the same. The trend score is the percentage of intervals in the overlap which are the same. For example, a 75% trend (a very good score, by the way) means that for 75% of the intervals in the overlap, both samples went up in the same years and down in the same years.

If one sample stays the same, and the other increases or decreases, Corina considers that to be halfway between a same-trend and different-trend, and gives it half a point. Trend is a "non-parametric" algorithm, because it only takes into account if a given ring is bigger or smaller than the previous one, not by how much. To the trend, a drop of "100 1" looks exactly the same as a drop of "100 99". Two completely random samples will have a trend of 50%, on average. So you'd expect a trend must be greater than 50% to be significant.

According to **?**, a trend is significant if:

1. $tr > 50\% + \frac{50}{\sqrt{N}}$ – For example a pair of samples with a 50-year overlap needs a $50 + 50\sqrt{50} = 57.1\%$ trend to be significant, but at a 400-year overlap need only a $50 + 50\sqrt{400} = 52.5\%$ trend. In practice, however, this doesn't tend to work terribly well. Using this scheme, there are typically about three times as many "significant" trend scores as *t*-scores, and users want this narrowed down a bit more. So take $\sigma = 3$ and use:
2. $tr > 50\% + \frac{50\sigma}{\sqrt{N}}$ – This gives about the same number of significant trend scores as *t*-scores.

Trends are also used in reconciliation. After they've been reconciled, both readings of a sample should have 100% trend.

10.1.3 Weiserjahre

The Weiserjahre algorithm is used for crossdating summed samples (chronologies) against single samples. All of the algorithms that have been mentioned so far only compare the ring widths. This works fine for raw samples, but when crossdating summed samples, there's a lot more information available, namely, the Weiserjahre data. Wouldn't it make sense to count a [20] 19×1 ring more heavily than a [1] $1 \div 0$ ring? 19 out of 20 samples think it's an increasing year, not just 1.

This is what the Weiserjahre cross does: for each possible overlap, it starts by counting the number of significant intervals of the master for that overlap. A significant interval is one with at least 3 samples, where at least 75% of them have the same trend. Then it computes the percent agreement (like the trend) between the master and the raw sample for only those significant years of the overlap. Of course, for the trend of the master, it doesn't use the trend of the master; it uses the trend of the majority of its elements. They're usually the same, but not necessarily.

Another way to think about the Weiserjahre crossdate is: it's like a trend, but ignoring years where the sum has only 1 or 2 samples, or where there isn't an overwhelming trend in the sum. Also like the trend, the results are given as a percentage.

10.1.4 R-Value

The R-value, or correlation coefficient, is a crossdate which you'll almost never use. It's not terribly useful to dendrochronologists, but statisticians might want to know its value, so Corina makes it available.

The R-value is used in the T-Score, the T-score being defined in terms of the r-value and the overlap, N. If you look at the equations for calculating a T-Score you will see on the penultimate line:

- $r = \frac{s_{xy}}{\sqrt{(s_{xx} s_{yy})}}$

An r-value can range from 0.0 (no correlation) to 1.0 (perfect correlation).

10.2 Crossdating series

10.3 Managing chronologies

Chapter 11

The Corina server

For basic day-to-day running of the Corina server, you simply need to make sure that the server is running. All other interaction and managment (creating users, granting permissions, accessing data) is done through the Corina desktop application. This section, however, outlines a number of aspects of the server that advanced users may find useful.

11.1 Backing up and restoring your database

As with any computer system it is important for you to back regular backups of your data to guard against hardware (as well as human!) errors. The two main methods for doing this are outlined below:

11.1.1 Backup whole Virtual Appliance

The simplest method is to make a copy of your entire Virtual Appliance, but this does have a number of drawbacks. The first is that you need to shut down your server before you can make the backup so this is only possible if server 'downtime' is not a problem for your lab. The second drawback is that it makes a copy of your entire server including the whole operating system, therefore each backup takes a lot more space.

1. Open VirtualBox
2. If you server is running you will need to do a full shutdown. From the server console type `sudo shutdown now` or alternatively you can close the console window and select 'Power off the machine'. This second method is not recommended though as it is like pulling the power plug from the virtual computer.
3. Select your virtual machine in the list on the left and go to *File* ➔ *Export Appliance*.
4. Follow the wizard, specifying a file where you'd like to back the server up to. Keep in mind that this will contain a complete copy of the server (including operating system) so could be 1Gb or more.

11.1.2 Restoring a Virtual Appliance backup

If you have followed the instructions in section 11.1.1 to backup your Virtual Appliance the steps to restoring your server are very similar to how your initially installed it. Simply open VirtualBox, then go to *File* ➔ *Import Appliance* and select the backup file that you made. Follow the wizard and it should restore your server. You can restore onto the same computer that was originally running the virtual machine (remember to give it a new name though if this is the case) or alternatively to any other computer with VirtualBox installed. This method can therefore be used to share entire databases.

11.1.3 Backup PostgreSQL database

The more standard way of backing up your database is to do a dump of the PostgreSQL database itself into a large text file. This is a little more involved, so it is only recommended if you are familiar with command line

and/or Linux. You can create the file with a command like the one below, but you should read up on pg_dump so that you understand the possible options that you can use.

```
pg_dump -f /folder/and/file/to/make.sql name_of_corina_database
```

For example the following line will backup the database called 'corina' into a file called backup.sql in the tmp folder. Keep in mind that the tmp folder is cleaned each time the server is booted.

```
pg_dump -f /tmp/backup.sql corina
```

11.1.4 Restoring a PostgreSQL database

To restore your database from a backup file you can use the standard PostgreSQL command line tool psql to populate an empty database:

```
createdb corina_new
```

```
psql corina_new < /tmp/backup.sql
```

11.2 Upgrading the server

Upgrading the server requires you to type a few commands into the Linux command line. First of all please ensure that you back up your Virtual Appliance and/or database before continuing. We will always endeavour to make sure that nothing happens to your database, even if the upgrade fails for some reason (in which case the system should roll back to your previous version again), but things don't always go to plan.

1. Log in to your Corina server console
2. Type the following commands:

```
cd /tmp
```

```
wget http://url.of.new.server.file
```

```
dpkg --install corina-server-X.X.X.deb
```

The URL of the new file can be obtained from the Corina website.

It would be possible for us to set up an mechanism which server administrators could opt-in to to upgradie Corina servers automatically. We may deploy this in the future, but we'd rather keep the process of upgrading as a conscious decision for the foreseeable future, but especially until we are confident that the upgrade process will not compromise your database.

11.3 Graphical Interface to the Virtual Appliance

For those of you that are unfamiliar with Linux, the basic command line prompt is not likely to be very comfortable. If you are interesting in looking at the server in more detail you may therefore prefer to install a full graphical interface. Unlike Windows, there are a number of different graphical interfaces (or desktops) to choose from in Linux, the most popular being Gnome and KDE. To install one of these you need to type one of the commands listed below. The first line installs Gnome and the second KDE. Windows users that are new to Linux may find KDE more familiar, but Apple users may be more at home with Gnome.

```
sudo apt-get install ubuntu-desktop
```

```
sudo apt-get install kubuntu-desktop
```

11.4 Security

The basic installation of the Corina server includes the standard configuration for Apache, PHP and PostgreSQL. Although these products are considered secure by default, there are a number of measures that can be taken to make them more so. If your server is only accessible within your local intranet (e.g. behind a robust firewall) then you may not feel it necessary to modify the standard setup. Precautions may be deemed more important if you server is accessible from the internet. In this case it would be wise to contact your local network administrator for further information.

11.4.1 Usernames and passwords

There are a number of default usernames and passwords setup on your server. If your server is accessible for the internet we strongly advise you to change these defaults and anyone with knowledge of the Corina server could access and compromise your machine.

System user - these are the credentials you use to log in to the command prompt in your Corina Virtual Appliance. By default the user is 'corina' and the password is 'w3l0v3tr33s'. To change this log in to the command prompt and type `passwd` and follow the instructions. There is no easy way to recover this password if you loose it.

PostgreSQL database user - these are the credentials used by the webservice to read and write to the database and are set by the database administrator during the initial configuration of the Corina server. You are only ever likely to need this again if you want to directly access the database from a third party tool like PGAdminIII. You can reset this password from the Corina Virtual Appliance command prompt by typing `corina-server --reconfigure`

Corina admin user - these are the admin credentials that you use to log in with in your Corina desktop application. Be default the user is 'admin' and the password is 'qu3rcu5'. You should change these the first time you open the Corina desktop application by going to *Admin* ➔ *Change password*.

11.4.2 Authentication and encryption

Corina uses a relatively sophisticated method to ensure that unauthorised users cannot access the Corina database through the webservice. It is loosely based around http digest authentication and uses a challenge and response scheme. This makes use of cryptographic hashes (a relatively short digital fingerprint of some data but which cannot be decompiled to retrieve the original data) and nonces (a pseudo-random string used just once). All hashes used in the Corina webservice use the MD5 algorithm. This decision will be periodically reviewed to ensure that MD5 is the most appropriate and secure algorithm to use. Whilst an MD5 hash of a short phrase can be compromised, the length and randomness of the original data means with current cracking techniques this is essentially impossible. For a complete description of Corina's authentication procedure see section 15.1.

The default Corina server setup, however, uses standard HTTP protocol to communicate between the server and the desktop application. This is the same protocol used for the majority of web pages on the internet and a determined hacker could eavesdrop on this communication. Depending on how important and private you perceive your data you may choose to use Secure Socket Layer (SSL) to encrypt this communication. This is the same technology used by websites such as online banking. To make full use of this upgrade in security you will however also require a SSL certificate from an official licensing authority. These certificates typically cost several hundred dollars per year.

11.5 Directly accessing the database

Although the Corina database is designed to only be accessed by the Corina desktop application via the Corina server's webservice, you may decide that you'd like to directly access the database yourself. For instance, you may like to write complicated SQL queries to probe your database in ways not currently supported by the Corina desktop client.

⚠ *Any changes made to the database may have drastic consequences. We strongly recommend that you never write changes directly to the database as this can cause loss of data and corrupt future upgrades to Corina.*

11.5.1 PGAdminIII

One of the easiest ways to access the PostgreSQL database is through the application PGAdminIII. This is a cross-platform open source application for communicating with PostgreSQL databases. You can install PGAdminIII on your desktop computer and access the remotely running database using your database user credentials.

For security reasons by default the Corina database cannot be accessed from computers outside of the Corina server. The may sound peculiar because the webservice can be accessed from computers anywhere on the web, but the database is actually accessed by the webservice, which is essentially a user running on the same computer as the database. To access the database *directly* from a remote computer you must therefore open access first. This is done by adding an entry to the file '/etc/postgresql/9.1/main/pg_hba.conf'. My personal command line text editor of choice is vim, but it is a little confusing to the uninitiated. If you are unfamiliar with command line text editing you are probably best to use pico:

```
sudo pico /etc/postgresql/9.1/main/pg_hba.conf
```

Scroll down passed all the comments, to the bottom of the file. Add the following line:

```
host all all IPADDRESS/32 md5
```

Make sure you replace IPADDRESS with the IP address of the computer you are trying to connect *from*. This is just one style of pg_hba.conf entry. There are many others which allow you to restrict to specific users, computers, networks etc. See the online PostgreSQL documentation for more details. Save your changes and exit by doing CTRL+X, then restart the Corina server:

```
sudo corina-server --restart
```

You should now be able to access your database through PGAdminIII. To do this open the application and go to *File* ➔ *Add server*. Specify your server's IP address is the host field, and your database username and password.

11.5.2 ODBC

It is also possible to connect to your Corina database via an ODBC connection. This allows limited access to the database from a variety of database applications including programs like Microsoft Access for which further details are given here. To use ODBC you will need to install the PostgreSQL ODBC driver (`http://www.postgresql.org/ftp/odbc/`) on your desktop computer.

Once you've installed the driver you can then open a blank database in Access and go to Files, Get external data then Link tables. In the file dialog box change the file type to ODBC Databases(). Next, select the PostgreSQL Unicode driver, then fill out the server details. You should then be able to open the tables and views from the Corina server database directly from within Access as if they were local tables. Be warned though that Access and ODBC have many limitations compared to PostgreSQL, especially with regards data types. For this reason we *strongly* recommend using this for read only purposes. Using the ODBC connection to write changes to your PostgreSQL database is quite likely to cause serious issues.

11.5.3 PSQL

The final, and most advanced method is to use the psql client on your server. This is a command line client which can be used to interrogate the database. If you're not already familiar with psql it is unlikely that this is a good method for you to use!

11.6 Corina server configuration

11.6.1 Standard server configuration

The Corina server can be configured using the command line tool that is installed on both the Virtual Appliance and native server installs. It is the same tool that is run at the end of the native server install, but can be run at any time to reconfigure or test your system. It must be run with superuser privileges therefore `sudo` is required before the command. For instance to get help on usage type:

```
sudo corina-server --help
```

Possible options to pass the server are:

- '`--help`' – Display a list of the possible options
- '`--version`' – Display the version of the Corina server webservice and database currently installed
- '`--test`' – Run tests on the current configuration
- '`--configure`' – Configure the Corina server from scratch.
- '`--reconfigure`' – Reconfigure the Corina server. This should be done if the database name or user credentials change, or if the IP address of the machine is altered.
- '`--start`' – Start the Corina server
- '`--stop`' – Stop the Corina server
- '`--restart`' – Restart the Corina server

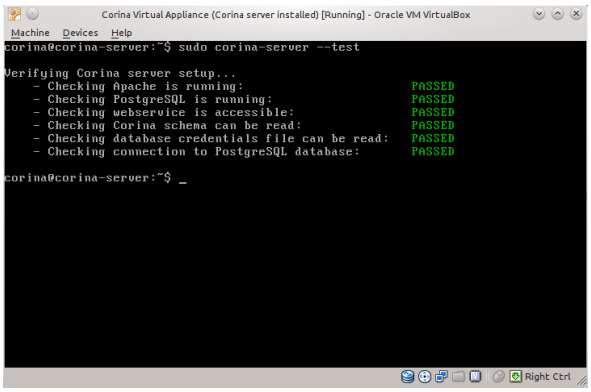


Figure 11.1: Example of the output from the corina-server test.

Figure 11.1 shows an example of asking the server to test the configuration, with all tests passed successfully.

The command line tool stores the majority of settings in the config.php file stored in the base directory of your Corina webservice. In theory you could make changes direct to this file, but we do not recommend this unless you know exactly what you're doing.

11.6.2 Advanced server configuration

In addition to the standard configuration options offered on the command line there are a number of other options that can be set. These are not accessible via the command line because as a rule they should only be altered the Corina developers. They are primarily for use by the developers as an alternative to hard coding values within the server files. For instance, one such value is the TRiDaS version being used by the server. This value will only ever need to be changed alongside other substantial changes to the code.

11.7 Managing map services

There is currently no interface in Corina that lets you specify the WMS mapping services that should automatically be available to your Corina users. Each user can add servers temporarily (see section 5.3) but these will disappear at the end of each session.

Chapter 12

Help and support

12.1 Getting help

At the moment your options for getting help are largely limited to contacting Peter Brewer! Once the user-base of Corina expands we will set up forums and mailing lists to assist.

12.2 Support for future development

Both Corina Desktop and Server are free software available under the General Public License v3 (see appendix X). This means you are free to use Corina in both academic and commercial environments. However, when we talk about 'free software' (as the license explains) we are talking about freedom of use, not free as in price. Corina has inevitably cost a great deal to develop over the years and while you are not asking for a direct contribution, we do need your support for future development.

If there is particular functionality that you would like to see implemented in Corina, under the open-source model this can be done in a number of ways:

Implement the feature yourself! – If you are able to program in Java then we would be delighted to assist you to implement new features. You could do this in isolation* but we hope you will do this collaboratively with us and make the new feature available to the rest of our community. Please contact the developers and we will organize a developers SVN account for you to access and contribute to the source code.

Request a feature from the developers – Contact the developers at Cornell and discuss the feature that you would like implemented. If the feature is relatively easy to implement and/or deemed useful for the Cornell laboratory then we may be able to implement the feature for you.

Pay a third party developer – If you know a third party developer that can make the changes for you then this is also possible. Again, we would ask that you do this in consultation with the existing developers so that any improvements can be contributed back to the community.

Collaborative development – If you have an idea for exciting new functionality we would be pleased to discuss the possibility of collaborative development–for example as part of a grant funded project. The chances of success when applying for infra-structure projects from federal agencies are much greater when proposed as part of a collaborative multi-laboratory project.

*Note that although the GPL license allows you do develop Corina separately, it does include clauses that require you to make the source code of the software you create also freely available under GPL or a compatible license. If you 'fork' the code in this way you will find it increasingly difficult to benefit from improvements made to the official Corina code.

Part II

Developers guide

Chapter 13

Developing Corina Desktop

Corina is open source software and we actively encourage collaboration and assistance from others in the community. There is always lots to do, even for people with little or no programming experience. Please get in touch with the development team as we'd love to hear from you.

13.1 Source code

This section describes how to access the Corina source code, but as you are no doubt aware it is normal (if not essential) to use a integrated development environment for developing any more than the most simplistic applications. If you plan to do any development work, it is probably best to skip this section and move straight on to the 'Development environment' section which includes instructions for accessing the source code directly from your IDE. If, however, you just want to browse the source code please continue reading.

The Corina source code is maintained in a Subversion repository at Cornell. The simplest way to see the source code is via the web viewer on the Cornell website: `http://dendro.cornell.edu/svn/corina/`. You can also examine the Javadoc documentation of the code here `http://dendro.cornell.edu/corina/developers.php`

If you have Subversion installed you can do an anonymous checkout of the code as follows:

```
svn co http://dendro.cornell.edu/svn/corina/
```

An overview of the development can be seen through the Corina Ohloh pages at `http://www.ohloh.net/p/corina/`. Ohloh provides graphics summarizing the code over time, including timelines of commits by user.

13.2 Development environment

The IDE of choice of the main Corina developers is Eclipse (`http://www.eclipse.org`). There are many other IDEs around and there is no reason you can't use them instead. Either way, the following instructions will hopefully be of use.

We have successfully developed Corina on Mac, Windows and Linux computers over the years. The methods for setting up are almost identical.

The first step is to install Eclipse, Sun Java6 JDK, Subversion, Maven and NSIS*. These are all readily available from their respective websites. On Ubuntu they can be install from the command line easily as follows:

```
sudo apt-get install eclipse subversion sun-java6-jdk maven2 nsis
```

*Currently there do not appear to be any readily available binaries for NSIS for MacOSX although you can build this from source. If you do not have NSIS installed you will get an error when packaging Corina, however, all other aspects of the development environment (including building OSX binaries) should work fine.

Once installed, you can then launch Eclipse. To access the Corina source code you will need to install the Subversive plugin to Eclipse. As of Eclipse v3.5 this can be done by going to *Help → Install new software*. Select the main Update site in the 'Work with' box, then locate the 'Subversive SVN Team Provider' plugin under 'Collaboration'. If you are using an earlier version of Eclipse you may need to add a specific Subversive update site. See the Subversive website (`http://www.eclipse.org/subversive/`) for more details. Once installed you will need to restart Eclipse.

Next you will need to install the m2e Maven plugin to Eclipse. This can also be installed by going to *Help → Install new software*, however, you will also need to add the Maven update site as this plugin is not currently available in the main Eclipse repository. You can do this by click the 'Add' button and using the URL `http://m2eclipse.sonatype.org/sites/m2e`. Once again you will need to restart Eclipse before continuing.

Next you need to get the Corina source code. Go to File *New → Project*, then in the dialog select *SVN → Project from SVN*. There are two methods of accessing the Corina repository: anonymously (in which case you will have read only access); or with a username provided by the Corina development team. Anonymous users will need to add a repository in the form: `http://dendro.cornell.edu/svn/corina/` and full users will need to use `svn+ssh://dendro.cornell.edu/home/svn/corina/`.

Once the project has downloaded to your workspace, you may need to set the compliance level. This can be done by going to *Project → Properties → Java compiler* and choosing compliance level of 6.0. Corina uses a handful of Java 6 specific functions, particularly with regards JAXB, so will not run successfully with Java 5.

To launch Corina, you will need to *Run → Run Java application*. Create a new run configuration with the main class set to 'edu.cornell.dendro.corina.gui.Startup'.

13.3 Dependencies

As of June 2011, Maven is used to build Corina rather than the original Ant. One of the main benefits of Maven is that it handles dependencies much more dynamically than Ant. This has become more of an issue as the Corina project as grown, as it is now dependent on over 80 different open source libraries.

In an ideal world, any libraries that your code is dependent on should be available in central Maven repositories and downloaded and installed seamlessly as part of the build process. Maven should also handle transient dependencies (i.e. dependencies of dependencies) automatically. Therefore if a developer knows he needs the functions within a particular library, he simply needs to supply the details of this library without having to worry about the other libraries that this new library is in turn dependent on. Maven also manages versions much more efficiently. If a library is dependent on a particular version of another library this is specified within the Maven build mechanism. This means it is much easier to keep dependencies up-to-date without having to worry about the cascading issues that upgrades often have. In short, Maven is intended to save developers from 'JAR hell'.

In practice, life is not necessarily that simple. Although Maven assists developers in many ways, it also has its own particular quirks and annoyances. The main problem is how to handle the situation when the dependencies you need are not available in central repositories. To solve this you either need to install these jars into your local Maven repository, or make them available in a 3rd party Maven repository. For the ease of developement we have set up a Maven repository as part of the TRiDaS project which can be browsed at `http://maven.tridas.org/`. This repository is already configured within the Corina project so assuming this repository is still alive, then your Corina project should automatically build. If not, then you will need to install the few non-standard jars. These jars will continue to be maintained in the Corina SVN repository and can be installed as follows:

- On your command line navigate to the Libraries folder of your Corina source code
- On Linux and Mac you can then simply run the MavenInstallCommands script
- On Windows you will need to manually run the commands located in this file

For the record, Corina currently depends upon the libraries listed in table 13.1. The table also specifies the licenses that these libraries are made available under.

Library	License
Apache commons lang	Apache 2.0
TridasJLib	Apache 2.0
Batik	Apache 2.0
RXTXcomm	LGPL
JDOM	Apache 2.0
Swing layout	LGPL
Log4J	Apache 2.0
JNA	LGPL
Apache mime 4J	Apache 2.0
Commons codec	Apache 2.0
Http Client	LGPL
Http core	Apache 2.0
Http mime	Apache 2.0
Jsyntaxpane	Apache 2.0
L2fprod-common-shared	Apache 2.0
L2fprod-common-sheet	Apache 2.0
L2fprod-common-buttonbar	Apache 2.0
iText	GAPL
PDFRenderer	LGPL
DendroFileIO	Apache 2.0
Java Simple MVC	MIT
JGoogleAnalyticsTracker	MIT
gluegen	BSD
JOGL	BSD+ nuclear clause
WorldWindJava	NOSA
SLF4J	MIT
JFontChooser	LGPL
MigLayout	BSD
PLJava	BSD
PostgreSQL	PostgreSQL License (BSD/MIT)
Forms	BSD
JXL	LGPL
Netbeans Swing Outline	GPLv2

Table 13.1: Corina's primary and major first order dependencies along with the licenses under which they are used. Note there are a total of 82 libraries upon which Corina draws.

Library	License
Apache commons lang	Apache 2.0
Launch4J	BSD/MIT
NSIS	zlib/libpng
Ant	Apache 2.0
Eclipse	Eclipse Public License - v1.0
ResourceBundle Editor	LGPL
M2Eclipse	Eclipse Public License - v1.0
Subversive	Eclipse Public License - v1.0

Table 13.2: Additional tools/libraries typically used in the development of Corina.

13.4 Code layout

Corina has been actively developed since 2000, so has seen contributions by many different developers. Coding practices have also changed in this time so inevitably there are some inconsistencies with how the source code is organized. For instance, the most recent interfaces have been implemented using the Model-View-Controller (MVC) architecture whereas earlier interfaces contain both domain and user logic in single monolithic classes.

Perhaps the most important inconsistency to understand is due to the transistion to the TRiDaS data model. In earlier versions of Corina used the concept of a 'Sample'[†] to represent each data file. Although large portions of Corina have been refactored to use the TRiDaS data model classes, there are still some places where the Corina Sample remain.

13.5 Multimedia resources

Corina includes infrastructure for multimedia resources such as icons, images and sounds within the Maven resource folder 'src/main/resources'. The most extensive is the Icons folder which contains many icons at various sizes ranging from 16×16 to 512×512 as PNG format files. The icons are accessed via the static Builder class. This has various accessor functions which take the filename and the size required, and return the icon itself or a URI of the icon from within the Jar.

13.5.1 Ring remarks

There are two types of ring remarks in Corina: TRiDaS controlled remarks and Corina controlled remarks. The end user does not know the difference between the two, the only difference between them is how they are handled behind the scenes. TRiDaS remarks are those designated in the TRiDaS schema, whereas Corina remarks are those defined specifically for Corina. They are represented differently in TRiDaS files like this:

```
<tridas:remark normalTridas="double pinned"/>
<tridas:remark normal="Corina" normalStd="insect damage" normalId="165" />
```

To add a new remark type to Corina you will need to first enter it in the database table tlkpreadingnote specifying the vocabulary as '2' (Corina). To display a custom icon for this remark in the software, you will need to add a 16×16 and a 48×48 version to the resources an then add an entry to the CorinaRemarkIconMap in edu/cornell/dendro/corina/remarks/Remarks.java. The 16×16 icon is used in the editor interface, and the 48×48 in PDFs.

13.6 Translations

There is internationalization infrastructure in place to enable Corina to be offered in multiple languages. This is done through the use of Resource Bundles, one for each language. Within the code, whenever a string is required, it is provided using the `I18n.getText()` function which then retrieves the correct string for the current locale. If no string is found, then the default language (English) string is returned. There is an Eclipse plugin to assist with this task called ResourceBundle Editor and it can be downloaded from `http://eclipse-rbe.sourceforge.net`. Once installed it provides a GUI that allows you to simultaneously update all languages at once.

The `I18n.getText()` function can be passed variables for insertion into the translation next e.g. file name, data value, line number etc. These can be passed either as a string array, or as one or more strings. The values are inserted into the translation string at the points marked 0, 1 etc. For instance, the translation string "File 0 exists. Rename to 1?" would accept two strings the first being the original filename and the second being

[†]To avoid confusing the original Corina class named 'Sample' will be referred to as 'Corina Sample' throughout this documentation. Within the code all TRiDaS data model classes are prefixed with 'Tridas' to help avoid confusion. The 'Sample' class is therefore not at all associated with the 'TridasSample' class.

the filename to rename to. For obvious reasons, only non-translateable strings should be passed in this way as they will be inserted indentically in all languages.

The Resource Bundle also includes support for menu mnemonics (to enable navigation of the menus with the keyboard) and accelerator keys (to enable keyboard shortcuts to bypass menus). Mnemonic are set by adding an ampersand before the letter of interest (e.g. &File for File) in the resource bundle. Accelerators are set by adding the keyword 'accel' with the key of interest inside square brackets after the resource bundle entry. Some examples include:

- &Graph active series [accel G]
- Graph &component series [accel shift G]

What key the 'accel' keyword refers to depends on the operating system Corina is being run on. In Windows and Linux it is normally 'ALT' wheras on a Mac it is usually the Apple [U+2318] command key.

There are currently minimal translations for UK English, German, French, Dutch, Polish and Turkish. These are by no means complete, and there are number of interfaces that are not internationalized at all. Further assistance is required from native speakers to complete this task.

13.7 Logging

Logging in Corina is handled by the SLF4J and Log4J packages. Rather than write debug notes directly to System.out, Log4J handles logging in a more intelligent way. First of all, each log message is assigned a log level which are (in order of severity) fatal, error, warn, info, debug and trace. Through a log4j.xml configuration file contained within the resources folder, we can control the level at which messages are displayed. For instance while we develop we would likely show all messages up to and including 'trace', but when we deploy we might only want to show messages up to and including 'warn'.

Log4J also enables us to log to several places (known as appenders), e.g. console, log file or a component within our application. It is also possible to change the level of logging depending on the log type, so minimal messages can be sent to the console but verbose messages to the log file. Corina has the following four appenders configured:

- Standard log file (corina.log) that rolls over up to 2mb of messages
- Submission log file (corina-submission.log) that contains the last 100kb of verbose messages and is used by the bug submission tool to enable users to notify developers of problems.
- Console – standard messages to the console when launched from command line
- Swing GUI – a swing component for displaying basic logs to the users in the application.

To alter the way these appenders are configured you need to edit the log4j.xml file. See the Log4J documentation for further information.

Using the logging framework is very simple. Just define a Logger as a static variable in your class like this:

```
private final static Logger log = LoggerFactory.getLogger(MyClassName.class);
```

where MyClassName is the name of the current class. Then you can log messages simply by calling log.warn('My message'), log.debug('My message') etc.

Before managed logging was introduced to Corina, debugging was often handled through the use of System.out and System.err messages. To ensure that these messages are not lost we use another package called SysOutOverSLF4J. This redirects messages sent to System.out and System.err to the logging system. This is a temporary solution so when working on older classes, please take the time to transition these older calls to the proper logging calls. We can then remove the need for SysOutOverSLF4J.

13.8 Preferences

It is helpful to remember certain user preferences e.g. colors, fonts, usernames, URLs, last folder opened etc so that they don't have to do tasks repeatedly. This is achieved through the use of a preferences file. This file is stored in a users home folder and consulted to see if a preference has been saved, otherwise Corina falls back to a default value.

The preferences are accessed from the static member App.prefs. To set a preference you can do the following:

```
App.prefs.setPref(PrefKey.PREFKEY, "the value to set");
```

where PrefKey.PREFKEY is an enum containing a unique string to identify the preference, and the second value is the string value to set. There are other specific methods for different data types e.g. setBooleanPref(), setIntPref(), setColorPref() etc.

To retrieve a preference, you use a similar syntax:

```
App.prefs.getPref(PrefKey.PREFKEY, "default value");
```

When you get a preference the second parameter contains the default value to return if no preference is found. Like the setPref() method, there are also a host of getPref() methods for different data types.

13.9 Build script

Corina is built using Maven and is controlled through the pom.xml file stored in the base of the Corina source code. Previous versions of Corina used Ant but managing the increasing number of dependencies as Corina has grown become too onerous (see section 13.3 for more details).

Earlier versions of Corina were deployed using Java WebStart technology primarily because this is platform independent and requires just a single click for a user to install. However, this has since been replaced with native installers for the major platforms due to various complications associated with native libraries (see section 13.9.5) required for 3D graphics and serial port hardware. We have also found most users are more comfortable with the standard install procedures that they are used to on their operating systems.

While you develop Maven should automatically build Corina for you in the background. Specific build commands are only required as you approach a release. We use the standard Maven 'life cycle' for building, packaging and deploying Corina. The method for doing this in Eclipse is by right clicking on the pom.xml file and selecting *Run as* ➔ *Maven package* etc. If the option you want is not displayed, you will need to create an entry in the build menu by going to *Run* ➔ *Run configurations*, then create a new Maven Build with the required 'goal'. The main goals are as follows:

clean - This deletes any previously compiled classes and packages in the target folder. It should only be necessary to run this occassionally if Maven has got a bit confused. If this is the case you may also need to force Eclipse to clean too by going to *Project* ➔ *Clean...*

generate-sources - Runs JAXB to generated classes representing the entities within the Corina schema (see section 13.10 for further details). The classes are also generated for TRiDaS entities, but these are deleted in favour of using those provided by the TridasJLib library.

package - This compiles Corina and builds a single executable JAR containing all dependencies (thanks to the maven-shade-plugin) along with native Windows, MacOSX and Linux packages. These are all placed in structured folders within 'target
Binaries' ready for deploying on a website.

install - This installs the compiled jar in your local Maven repository. This is normally used when you are building a library that is being used by another program. It is therefore not necessary for Corina.

deploy - This uploads the compiled jar into the maven.tridas.org repository. Note that you will need to either run this phase from the command line or by setting up a customer run configuration in Eclipse.

I have had some issues with the m2e plugin getting a little stuck. If you find you are getting Maven build errors you may like to try running Maven from the command line. Navigate to the base of your corina folder and type mvn clean, mvn package, mvn install or mvn deploy depending on what you are trying to do.

13.9.1 Windows installer

Maven generates the Windows executable for the Corina application through the 'launch4j' plugin. Windows users, however, expect an installer that will create menu entries and add uninstall options to the control panel. An installer is also required to install the user manual and the native libraries required for the serial-port and 3D graphics features in Corina.

The best open source tool for creating Windows installer scripts is NSIS (see `http://nsis.sourceforge.net`). This is an extremely flexible scripting system that does all we need. If you have NSIS installed the Maven package goal should create both Windows 32 and 64 bit installers automatically. We use the Maven antrun plugin to run the makensis executable twice, once on a script for build the 32bit executable and a second for creating the 64 bit executable. These scripts are stored in Native/BuildResources/WinBuild, and are indentical (they import the major of the script from the same file) with the exception of the location of the native libraries folder. The Maven resource plugin moves them into the target folder and replaces the version numbering for use in filenames etc.

13.9.2 Mac package

The Maven osxappbundle plugin is able to produce both .app and .dmg files. Unfortunately, the libraries for producing .dmg files are proprietary to Apple. When Maven is run on Windows or Linux, it is therefore only able to produce a zipped .app file, and not .dmg. We therefore recommend producing the Mac release on OSX, either natively or under a virtual machine.

Note that the osxappbundle plugin does not support the inclusion of additional files such as native libraries within the .app file. This task is therefore handled separately by the AntRun plugin that inserts the libraries directly to the .app file.

13.9.3 Linux Deb package

A Linux Debian package is produced using the JDeb Maven plugin. If Maven does its job properly, it should all 'just work' as part of the standard maven package phase. In addition to the configuration in the pom.xml, there are three files that are used to configure the final deb file. In src/deb/control/ there is a control file which describes the runtime dependencies, maintainer of the package, description etc. In Native/BuildResources/LinBuild are two files, one a simple bash script that is used to launch Corina on the users computer and the other a .desktop file for configuring how it appears in the users menus. All three of these files are automatically updated with the current version number, so hopefully you shouldn't need to change anything.

13.9.4 Linux RPM package

13.9.5 Native libraries

Although Corina is written in Java, it requires a number of native libraries to make use of OpenGL 3D graphics capabilities and to access the serial port of the computer. This libraries are different for each operating system, and they are also different for 32 and 64 bit machines. The correct libraries must be made available to the OS and are therefore typically installed outside of the jar file as part of the installation process.

On Windows these libraries take the form of Dynamic Link Libraries (DLL) files which are normally placed in the same folder as the executable:

- gluegen-rt.dll
- jogl_awt.dll
- jogl_cg.dll
- jogl.dll
- rxtxSerial.dll

On MacOSX the libraries come as JNILIB files and on Linux as .so files e.g.:

- libgluegen-rt.jnilib and libgluegen-rt.so
- libjogl_awt.jnilib and libjogl_awt.so
- libjogl_cg.jnilib and libjogl_cg.so
- libjogl.jnilib and libjogl.so
- librxtxSerial.jnilib and librxtxSerial.so

On Linux systems this are installed into the /usr/lib folder and on MacOSX they are included within the .app file.

We have experimented with techniques for packaging the libraries within the jar, then extracting the correct libraries based on architecture and dynamically loaded at runtime. This seemed to work relatively well for JOGL/Gluegen, but not rxtx. On certain graphics cards the JOGL/Gluegen libraries also caused a SIGSEGV fault. All native libraries are therefore now handled by the installer for the respective platforms.

13.10 Java Architecture for XML Binding - JAXB

Java Architecture for XML Binding (JAXB) is a technology that automatically maps Java classes to XML schemas and vice versa. It includes the ability to *marshall* data from Java classes to XML files and *unmarshall* data from XML files into Java class representations.

JAXB is used by TridasJLib to create Java class representations of the TRiDaS data model. It is also used directly in Corina to create classes for the Corina web service. Although the Corina webservice is based heavily on TRiDaS (the two were developed in parallel), the Corina schema extends TRiDaS by including classes such as dictionaries and the 'box' concept which are required for a lab data management application.

The Corina JAXB classes are automatically built by Maven using the 'maven-jaxb2-plugin' and placed within the 'src/main/generated' folder. Please note that any manual changes to these classes will automatically be overriden the next time Maven is run. If you feel that changes are necessary to these classes then it is likely that one or more of the following needs modification:

- The Corina schema located in 'src/main/resources/schemas'
- The Corina JAXB bindings located in 'src/main/resources/binding'
- The specification for how JAXB is run located in the 'pom.xml' file

Please note that JAXB supports plugins and extensions for enhancing the classes that it produces. One thing to note in the Maven pom.xml is a nasty workaround when running JAXB. As the Corina schema depends on the GML and TRiDaS schemas, these classes are also built by JAXB. These classes however are already provided by the DendroFileIO library. It should be possible to use a feature called 'episodes' to handle this but this seems buggy and causes issues. For now, we use an antrun task to delete the duplicate classes immediately after they are produced.

13.11 Java version

Although we would like Corina to run on older versions of Java (specifically Java 5), there are a number of features of Java 6 such as JAXB that we really need. This isn't really a problem on Linux and Windows as Java 6 has been around for a long time now, but it is a bit problematic for MacOSX users. For internal reasons Apple was extremely slow bringing Java 6 to MacOSX, only releasing it with 10.6 (Snow Leopard) several years after Windows and Linux. Corina will therefore not run on older Mac machines. This will gradually become less of an issue as machines age and "Snow Leopard or later" becomes less difficult for users to fulfill.

Corina was originally developed against the Sun JDK. Although Sun re-released much of its JDK under the GPL license there are still portions that are only available under proprietary licenses due to various plugins being the copyright of third parties. Although it is still distributed at no cost, it is not 'free' under the terms required by the Free Software Foundation. Corina can still legally be used with the Sun JDK even though it is regarded as proprietary software due to the 'Major components' exception of the GPL license. However, open source purists find this undesirable and so you may prefer to use open equivalents such as OpenJDK, IcedTea or Apache Harmony. For this reason we now develop Corina against OpenJDK6. Preliminary tests show Corina

works fine under OpenJDK7 as well, however, we do not intend to take advantage of Java 7 features in the near future to ensure backwards compatibility for as long as possible. The problem of backwards compatibility for MacOSX seems likely to remain for some time.

13.12 Developing graphical interfaces

Like the rest of the code, a number of different styles and methods have been used for the creation of interfaces in Corina. Many of the earlier interfaces were hand coded, but in recent years WYSIWYG graphical designers have been used to enable the creation of more complex designs. Most interfaces are now Swing-based although AWT widgets are used in places.

Some interfaces were created using the graphical designed in Netbeans IDE. These can be identified by the presence of companion .form files and warning comments in the code indicating which sections are autogenerated. The major drawback with the Netbeans form designer is that it cannot cope with externally made changes. If changes are made to the files outside of Netbeans, then the Netbeans form designer can no longer edit these files so please make sure you are certain this is how you want to proceed. The classes generated by Netbeans are typically used by a subclass via inheritance so that any changes can be external to the form designer generated files.

More recently the Google WindowBuilder Pro tool has been used for interface design. This has the benefit of (usually) being able to parse existing code enabling the modification of existing dialogs. WindowsBuilder does have its quirks though so make sure you keep up-to-date with new releases.

13.13 Supporting measuring platforms

The support for hardware measuring platforms has been designed to be as modular and extensible as possible. Adding support for additional measuring platform types should therefore be quick and painless!

To begin, you need to extend the abstract class edu.cornell.dendro.corina.hardware.AbstractSerialMeasuringDevice. You can of course also extend the class implementation of another platform if you only need to modify a few settings. This is the case for both the QC10 and QC1100 devices which extend the GenericASCIIDevice class. The implementation code is identical for all three, but the derived classes set the port settings to the default values for the two QuadraChek boxes.

There are a number of methods that you will need to override from the base class. If you use Eclipse to generate the class it will create placeholders for all the relevant methods. The toString() method enables you to return the name for the device you are implementing, whereas all the is...() methods enable Corina to understand the capabilities of the device. For instance some devices will accept requests to zero the current measurement and/or request the current measurement value, while others will not (instead they rely on hardware buttons on the device itself). Some devices can have the port settings (such as baud, parity, stopbits etc) altered and the corresponding is...Editable() functions indicate whether this is possible. All user interfaces in Corina are modified in accordance with these methods and show the user only relevant buttons.

The guts of the work in the class are performed in the following methods:

setDefaultPortParams() – this method sets all the default port communications parameters. The abstract class already sets typical values so you only need to override this if they need to change.

doInitialize() – this method is run when the platform is initialized. If your platform needs to do any sort of handshaking then this is where this should be done.

serialEvent() – this method handles any events that are detected from the serial port. All new data received from the platform is decoded here. Values and errors are passed on via the fireSerialSampleEvent() method. Remember that all values should be sent as measurements in microns. If the platform has the ability to work in different units the UnitMultiplier value must be used to ensure the units set by the user are handled correctly.

zeroMeasurement() – if your platform responds to requests to zero the measurement value this is where you should implement this.

requestMeasurement() – if your platform responds to requests to send the current measurement value then you should implement this functionality here.

Once your new class is complete you need to inform Corina that it exists. To do this you need to register the device in edu.cornell.dendro.corina.hardware.SerialDeviceSelector. You should then be able to launch Corina and test your new device in the preferences dialog. The relevant parts of the dialog will be enabled/disabled depending on how you set the corresponding is...Editable() methods in your class. The dialog also includes a seperate test window with a console for debugging the raw data received from the serial port.

13.14 Writing documentation

The documentation in Corina is written in the well established typesetting language LaTeX 2_ε. LaTeX is a great tool for producing high quality documentation with a good structure and style. Unlike standard WYSIWYG (what you see is what you get) word processing applications like Microsoft Word, LaTeX uses simple plain text code to layout a document so that it is often described as WYSIWYM (what you see is what you mean)! The style of a LaTeX document is handled separated enabling the author to concentrate on content. By removing the possibility for authors to tinker with font sizes etc, LaTeX forces you to create clear, well structured documents. For further details see `http://en.wikibooks.org/wiki/LaTeX/`.

The master document is 'Documentation/corina-manual.tex' and imports each chapter file. To build the documentation you will need a editor to update and compile to PDF. On Linux I would suggest Kile, on MacOSX TeXShop and on Windows WinEdt. To add or edit bibliography entries you will also need a BibTeX editor such as JabRef or BibDesk.

Images specific to the documentation should be stored in 'Documentation/Images', but you will also automatically have access to the image and icon resources in the application itself. This can be useful, for instance when illustrating what icon a user needs to click for perform a task. To reference a icon for instance you can use the path 'Icons/48x48/myicon.png'.

LaTeX has fantastic cross-referencing and citation functionality built in. Please follow the lead of the existing documentation!

13.15 Making a new release

Making a new release should be a relatively quick and simply process, but there are still a few things to remember:

- Make sure this documentation is up-to-date!
- Update the logging appenders to an appropriate level so that the user is not swamped by debug messages
- If this release relies upon a certain version of the Corina server, make sure you set this correctly in '/corina-desktop/src/main/java/edu/cornell/dendro/corina/core/App.java'. This is important to ensure that users aren't working against an old version of the server which could have unexpected side-effects.
- Increment the build version number in the pom.xml
- Update the splash screen and background graphics.
- Check the code in Eclipse and eliminate as many warnings as possible.
- Make sure the developers metadata is correct in the pom.xml. Add any new developers that have joined the project since the last release.
- Run Maven package.
- TEST!

- Deploy to maven.tridas.org by running Maven deploy.
- Copy '/target/Binaries' to the `http://dendro.cornell.edu/corina/download/` folder. The new release will automatically be added to the options for download.
- If this new release should be the recommmended release for internal and/or external uses, alter the download.php page to reflect this.

Chapter 14

Developing Corina Server

The Corina server is made up of a PHP webservice run by Apache, connecting to a PostgreSQL database.

The Corina webservice is written entirely in PHP. Like the Desktop Client, the server is developed with Eclipse so most of the setup steps are identical (see chapter 13). You will, however, probably want to install the PHP development plugin so that you get syntax highlighting etc. See the Eclipse PDT website (`http://www.eclipse.org/pdt/`) for further information.

14.1 Webservice

The Corina database is accessed solely through the webservice interface. A webservice is an interface designed to be accessed by programs that send requests and receive responses. Corina uses a style of HTTP+POX (Plain Old XML) to send and receive requests via a HTTP POST. In simple terms the Corina client sends an XML document that describes the request via POST to the Corina server. The server then reads the XML request, performs the request and then compiles the information that has been requested, finally returning the information to the client as another XML document. The syntax of the XML document containing the request and response is determined by the Corina XML schema and makes heavy use of the TRiDaS XML schema for describing dendrochronological entities.

14.1.1 Adding TRiDaS entities to the database

14.1.2 Creating new series

Due to the complications arising from the virtual measurement concept, creating new series in Corina is necessarily more complicated than any other of the TRiDaS entities. The workflow required to create a new series is illustrated in figure 14.3.

14.1.3 Reading and setting permissions

```
   <request type="create"> <permission> <permissionToCreate>true</permissionToCreate>
<permissionToRead>true</permissionToRead> <permissionToUpdate>true</permissionToUpdate>
<permissionToDelete>true</permissionToDelete> <entity type="object"
id="760a19e2-229c-11e1-8756-03b2aff2fe33"/> <securityGroup id="3"/>
</permission> </request>
```

```
   ????????  <request type="read"> <permission> <entity type="object"
id="760a19e2-229c-11e1-8756-03b2aff2fe33"/> <securityGroup id="3"/>
</permission> </request>
```

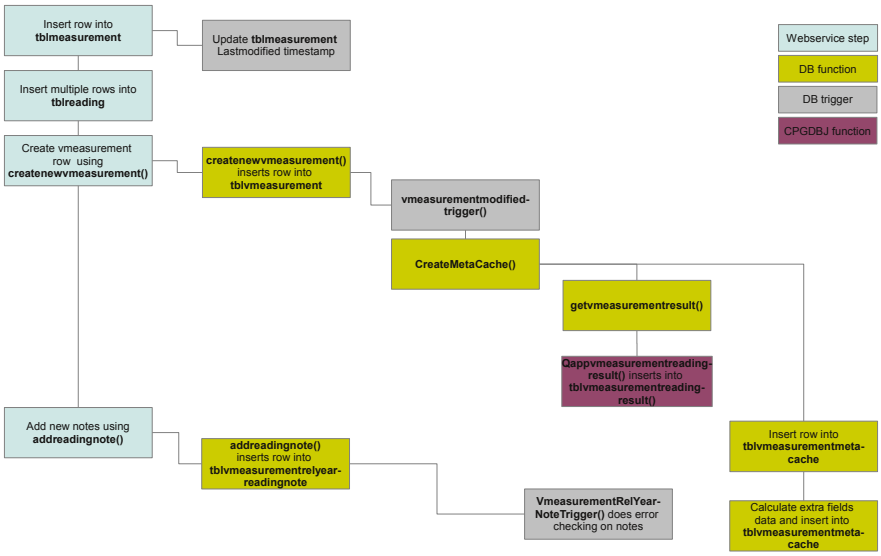


Figure 14.1: Illustration of the steps that happen during the creation of a new measurement series. The stages are presented top to bottom in the approximate order in which they are executed. The majority of the processing is done as a result of the database function createnewvmeasurement() being called by the webservice.

Figure 14.2: Illustration of the steps that happen during the alteration of an existing measurement series. The stages are presented top to bottom in the approximate order in which they are executed.

Figure 14.3: Illustration of the steps that happen during the creation of a new derived series. The stages are presented top to bottom in the approximate order in which they are executed. Depending on the type of derived series being created, a different database function is called to finish the new vmeasurement.

Figure 14.4: Illustration of the steps that happen during the alteration of an existing derived series. The stages are presented top to bottom in the approximate order in which they are executed. Note that presently it is not possible to alter the parameters of a derived series.

```
<request type="update"> <permission> <permissionToCreate>false</permissionToCreate>
<permissionToRead>false</permissionToRead> <permissionToUpdate>false</permissionToUpdate>
<permissionToDelete>false</permissionToDelete> <entity type="object"
id="136a70a6-566b-546b-a3ae-c48cb046e4cd"/> <securityUser id="1"/>
<securityUser id="3"/> </permission> </request>
```

```
<request type="delete"> <permission> <entity type="object"
id="136a70a6-566b-546b-a3ae-c48cb046e4cd"/> <securityUser id="1"/>
</permission> </request>
```

14.2 Server package

The Ubuntu server package is built by Maven at the same time as the desktop package (see section 13.9) during the package goal.

The server packaging is done as a secondary execution of the JDeb plugin. JDeb is configured in the pom.xml by including all the files that need to be copied along with where in the target file system they should be placed. The database files are installed to '/usr/share/corina-server' and the webservices files to '/var/www/corina-webservice'.

The metadata for the deb file is included in the control file located in Native/BuildResources/LinBuild/ServerControl. JDeb makes use of Ubuntu's excellent package management system to handle the dependencies. Adding or editing dependencies is simply a matter of changing the 'depends' attribute control file.

The ServerControl folder also contains scripts called preinst, postinst, prerm and postrm, which are launched before and after installation, and before uninstalling. These files are called with different parameters depending on whether this is part of a fresh install, an upgrade, or an aborted install. There are a number of rules that the resulting deb package should follow (e.g. if a program is configured twice, then the second run should know and understand about previously provided details), the details of which can be found in the Debian Policy Manual*, along with information how and when each of the pre and post scripts is run. Hopefully this side of the server packaging will not need to be touched again, but if you are making changes and are doing anything more than simple tweaks, please consult the Debian policy documentation.

The postinst script is used to trigger the interactive script that helps the user configure the Corina server (described further in section 14.2.1). The steps are as follows:

- Check the user running the script is root as we're doing privileged functions
- Generated scripts from templates
- Configure PostgreSQL database, creating users and/or database if requested otherwise obtaining details if they already exist
- Configure PostgreSQL to allow access to the specified database user
- Configure Apache to access the webservice
- Verify setup by checking Apache and PostgreSQL are running, that the webservice is accessible, the database is accessible and that various configuration files can be read
- Print test report to screen

14.2.1 Corina server script

At the heart of most of the configuration and control of the Corina server is the corina-server script. This is a command line PHP script that is launched after installation and can be re-run by the user to make changes to the configuration. Although such a script would normally be written in Bash or similar, we decided to go with PHP because of the requirement to interact with the Corina PostgreSQL database.

The script isolates the common tasks performed into functions. It uses the getopt() function to read both long (e.g. –blah) and short (e.g. -b) arguments from the command line. These depending on the arguments given, the script then calls the relevant functions.

*Debian Policy Manual – `http://www.debian.org/doc/debian-policy/`

To comply with standard protocols, the script uses the exit() function to return whether the requested task was successful or not. Returning zero means the script was successful, and returning any other integer means the script failed. This is important so that the package management system knows when things have gone wrong, and can then attempt to roll back if possible.

The script includes a number of helper functions and classes that you may find useful when modifying the script:

echoTruncatedString($str, $length – echos a string to the console but truncates it to $length if necessary. If the string is shorter than $length, then it is padded with spaces. This is useful to ensure the following text is displayed aligned, e.g. test results.

requireRoot() – check whether the user running the script has root privileges.

checkServiceIsRunning($service) – checks whether the named service is running on the system. This is performed by checking whether the provided string is present in the response from the shell command 'ps ax'.

setConfigVariable($var, $value) – does a search and replace for a placeholder variable in the config.php file, replacing with $value. Placeholders should be stored in the config.php template as `%%VARIABLENAME%%`.

promptForPwd($isCreating=TRUE) – is an interactive script for getting a password from the user. It checks that the password is strong and asks for it twice to check for typos.

class Colors – can be used to display coloured text on the console. Useful for highlighting errors and test results.

14.3 Handling client version dependencies

In an ideal world, the API for how clients talk to the Corina server would never change. Unfortunately, we don't live in an ideal world! New features in Corina will require changes to the API, as will changes to TRiDaS. In anticipation to such changes, the Corina server includes a mechanism for detecting when a client is too old to handle the API that it is using. In this case the server will refuse to handle the request. A similar complementary mechanism is in place in the client for instances when a client is attempting to talk to an older server that it no longer supports.

At the moment, the Corina desktop client is the only known software that talks to the Corina server, but in the future we may have other 3rd party clients making requests. For example it would be possible to develop a central data repository (much like the ITRDB or perhaps as an extension to the existing ITRDB) that harvests data from multiple labs each running the Corina server. Alternatively, existing 3rd party desktop applications (e.g. TSAP-Win, PAST4 etc) may be extended to enable them to obtain data directly from servers running the Corina server software. Either way, it is important to include the ability to specify the oldest versions of clients that are able to connect, and also to be able to specify different versions for different types of clients.

It is also necessary to include the ability to allow or disallow access to the server by unknown client applications. If a new program is written by other developers and it attempts to access the server it could contain bugs (or even malicious code[†]) that interferes with the server. For a production instance of the server this is obviously undesirable, therefore the systems configuration option 'onlyAllowKnownClients' is set to TRUE.

The minimum versions of each supported client are stored in the database in the table tblsupportedclient. The 'client' field should contain a unique portion of the HTTP_USER_AGENT header provided by the client.

[†]Keep in mind though that a user with the necessary privileges would need to provide this new program with their credentials for it to make changes to data.

14.4 Handling server configuration

The Corina server is configured using two main PHP files: config.php and systemconfig.php. The configuration is split into two primarily because the config.php values are considered to be editable by the server administrator, whereas those in systemconfig.php should normally only be edited by Corina developers.

If you want to make configuration options editable by the administrator of the Corina server, then these should be implemented within the config.php file. There is a config.php.template file which is used to construct the config.php file on the users system. Simply adding hardcoded entries to this file is the simplest way when a default value is appropriate. If you value of your field needs to be generated either by asking the administrator a question (e.g. name of lab), or dynamically at the time of installation (e.g. IP address of the server) then this template file should contain placeholder values which can then be replaced by the corina-server configuration script. For instance the config.php.template file contains a placeholder for the hostname of the server like this: `$hostname = "%%IP%%";`. The value is set by the corina-server script using the function `setConfigVariable($var, $value)`. Keep in mind though, that during an upgrade, the config.php is maintained and not replaced. If you make additions to the config.php.template you will also need to make provision for handling changes to the end users existing config.php.

If you want to add new configuration fields that don't need to be edited by the system administrator, these should be handled in the systemconfig.php file. The systemconfig.php file is automatically generated during installation/upgrade of the server from entries in the database table tblconfig. This means that any changes to the system configuration can be handled as part of the database upgrade simply by adding new rows or editing existing rows in tblconfig. Each entry in this table is made available to the webservice as a global variable once the corina-server script has been run. For instance the row containing key=wsversion and value=1.0.0 is available as the variable $wsversion within the webservice.

14.5 Making a new release

As mentioned in section 14.2, the server package is created at the same time as the desktop binaries as part of the Maven package procedure. There are, however, a number of steps you need to undertake to make sure this goes smoothly.

- Make sure this documentation is up-to-date!
- Increment the `<serverversion>` tag in the pom.xml file
- Make sure that any upgrades that need to be made to the database are included in a new and unique SQL file stored in Databases/db-upgrade-patches. Each file from this folder is run by the installer unless it has previously been run.
- If this version of the server needs a particular version of the client then you'll need to set this value in the tblsupportedclient table by including a relevant SQL statement in your db-update-patches script e.g.:

```
UPDATE tblsupportedclient SET minversion='2.13' WHERE client='Corina WSI';
```

- TEST! If users are running this as an upgrade, then we need to ensure this goes smoothly. Although they are told to backup their database before running we should assume they've ignored the warning and that we are altering precious data. Test both a fresh install and an upgrade from the previous version.

14.6 Administering the Maven repository

The following information is only necessary for the lead-developer and outlines the steps necessary to install and maintain the central Maven repository for Corina. This Maven repository should provide all other developers with the libraries required to develop Corina and which are bundled in the release packages.

14.6.1 Install Apache Archiva

The repository tool that we currently use is Apache Archiva. Installation is relatively simple:

1. Download the zip bundle from the Apache Archiva website
2. Unzip and place on the server in a suitable location (e.g. usr/share/apache-archiva)
3. Run 'sudo bin/archiva start'

If you have an existing backup of the Archiva database then you can place this in the data folder and you should be good to go. If not you will need to do the following steps to configure the repository from scratch:

1. Go to 'http://...:8080/archiva/' in your web browser and set up the admin account
2. In the repositories tab you need to configure both releases and snapshot repositories
3. Set up users with 'Repository Manager' permissions for each user that would like to deploy to the repository. They will need to configure their .m2/settings.xml file to do this
4. Add the following remote repositories:

   Geotk – Identifier: geotk; URL: http://maven.geotoolkit.org/

   Geomajas repository for JPedal – Identifier: maven.geomajas.org; URL: http://maven.geomajas.org/

   maven.iscpif.fr – Identifier: maven.iscpif.fr; URL: http://maven.iscpif.fr/snapshots/

   thirdparty.maven.iscpif.fr – Identifier: thirdparty.maven.iscpif.fr; URL: http://maven.iscpif.fr/thirdparty/
5. Add proxy connectors for the above repositories

The remote repositories contain libraries maintained by others that are not (at the time of writing) in the central Maven repositories. We include them here to ensure they are cached in our repository and so are available to our developers even if these external repositories go down.

Chapter 15

Systems architecture

The centralised nature of the Cornell Tree-Ring Lab data required a server-client architecture of some type. In the original Corina v1 this was achieved simply by having users save their data in a network folder stored on a central server. Whilst this method was adequate, it has many data storage issues that can be largely solved by moving the data storage infrastructure to a relational database management system.

Although it would be possible (and arguably simpler) to refactor Corina to talk directly to one central database server it was decided to go a step further and implement a Web Services orientated server-client architecture for Corina v2.

A web services approach decouples the desktop client from the server so that the server can work on its

15.1 Authentication design

The authentication mechanism is loosely based around http digest authentication and uses a challenge and response scheme. This makes use of cryptographic hashes (a relatively short digital fingerprint of some data but which cannot be decompiled to retrieve the original data) and nonces (a pseudo-random string used just once). All hashes used in the Corina webservice use the MD5 algorithm. Whilst an MD5 hash of a short phrase can be compromised, the length and randomness of the original data means that using current cracking techniques would require a very substantial amount of processing power e.g. supercomputer or large botnet. Flaws in the MD5 hash are also mitigated by the time-sensitive nature of the Corina nonce, meaning that any attack would need to be successful within a 2 minute window. New weaknesses in security are, however, revealed on a fairly regular basis so the authentication architecture will be periodically reviewed to ensure that it still meets our needs.

The first time a client attempts to retrieve data from the webservice (or when the client's credentials are incorrect or have expired) the following events occur:

- Server returns an message requesting authentication. This message includes a nonce (a hash of the current date and time to the nearest minute) which we will call 'server nonce'.
- The client creates a second nonce (client nonce) which is a random hash of it's choosing, and a response which is a hash of "username:hashofpassword:servernonce:clientnonc". It sends this response, along with the username and client nonce back to the server but does not send the original server nonce.
- The server computes the same "username:hashofpassword:servernonce:clientnonce" hash using the information it has stored in the database. As the server nonce is constant for a minute the two response should match. If not the server recomputes the server nonce for one minute ago and tries again. This ensures that the server nonce sent to the client is valid for between 1 and 2 minutes.
- Once the server authenticates the user a session cookie is sent to the client. On subsequent requests the server recognises the session id and doesn't request authentication again.

As the user's password is hashed at all points, even if the communication is hijacked the attacker will not be able to derive the users password. The user's password is also stored in hash form within the database. This also means that system administrators do not have access to the passwords either.

The use of the server nonce within the response means that it will only be valid for a maximum of two minutes. This minimizes the possibility of a replay attack.

15.2 Database permissions design

The database has a user and group based security scheme at three TRiDaS levels: object, element and series. A user can be a member of one or more groups, and groups can be members of zero or more other groups. The current implementation allows for one nested level of groups within groups however this could be extended if required. Security is set on a group-by-group basis rather than on a single user to ensure ease of management.

There are five types of permissions granted: create, read, update, delete and no permission. Each permission is independent of each other with the exception of 'no permission' which overrides all other permissions.

A group can be assigned one or more of the permissions types to any of the sites, trees or measurements in the database. Intermediate objects such as subsites, specimens and radii inherit permissions from their parent object. For instance if a group has permission to read a site then it will have permission to read all subsites from that site.

It is envisaged that most of the time, permissions will be set on a site-by-site basis. It will not be necessary to explicitly assign permissions to trees and measurements as all permissions will be inherited. So assuming that no permissions are set on a tree for a particular group, the permissions for the tree will be derived from the site from which the tree was found. If, however, permissions are assigned to the tree, then these will override those of the site. In this way it will be possible to allow a group to read the data from one particular tree from a site in which there otherwise do not have permission to access.

Privileges are cumulative. This means that if a user is a member of multiple groups then they will gain all the privileges assigned to those groups. If one of the groups that the user is a member of has 'no privileges' set on an object it will however override all other privileges. Therefore if a user is a member of groups A and B, and group A has read privilege and group B has 'no privilege' then the user will not be able to access the record.

A special 'admin group' has been created into which only the most trusted users are placed. Members of the admin group automatically gain full privileges on all data within the database. They also have permission to perform a number of administrative tasks that standard users are insulated from.

15.3 Universally Unique Identifiers

All entities in the Corina database have a primary key based on the Universally Unique Identifier (UUID) concept. This is a randomly created 128-bit number which due to the astronomically large number of possibilities (3×1038) means that it is guaranteed to be unique across all installations of Corina. This code is typically represented by 32 hexadecimal digits and 4 hyphens like this: 550e8400-e29b-41d4-a716-446655440000.

15.4 Barcode specifications

Barcodes in Corina are based on the UUID primary keys of database entities. Because they are used for different entities in Corina (boxes, samples and series) it was also necessary to incorporate a method for determining what type of entity a barcode represents. This is done by appending a single character and a colon to the beginning of the UUID: 'B:' for box; 'S:' for sample; 'Z:' for series.

The barcodes in Corina use the Code 128 scheme. This symbology was chosen as it allows the encoding of alphanumeric characters in a high-density label and can be read by all popular barcode scanners. While it would have been possible to create a barcode of plain UUIDs, the 36 (or even 32) characters would result in a barcode wider than many scanners could read. Most scanners on the market have a maximum scan width of at least 80mm, so this was used as the baseline to work to.

To make the barcodes less than 80mm, the UUID (with prepended entity type character code) are Base64 encoded. For example the series with UUID 3a8f4336-d17d-11df-abde-c75e325aebae would be encoded from Z:3a8f4336-d17d-11df-abde-c75e325aebae to become: Wjo6j0M20X0R36vex14yWuuu

Chapter 16

Corina Database

The database behind Corina is run on the popular open source relational database management system, PostgreSQL (Postgres).

16.1 Database structure

16.2 Spatial extension

Corina uses the PostGIS extension to Postgres to store and query spatial data within the database. Rather than storing coordinate axis in separate fields, a single specialist 'geometry' field type is used.

16.3 CPGDB functions

The Corina Postgresql Database (CPGDB) functions are a set of functions for searching, processing, and manipulating the data in the postgresql database. All functions are in thecpgdbschema, to allow for easy development alongside the database without modifying the database or its structure.

Thus, to execute a cpgdb function, you must preface the function name with cpgdb, e.g.:

```
SELECT * FROM cpgdb.GetVMeasurementResult('xxxx');
```

GetVMeasurementResultID – This function populates the tblVMeasurementResult and tblVMeasurementReadingResult tables, returning a single varchar which contains the tblVMeasurementResult ID. You probably want to use GetVMeasurementResult instead.

GetVMeasurementResult – This function returns a table row from tblVMeasurementResult which has been populated with information from the provided VMeasurement ID.

GetVMeasurementReadingResult – This function is provided as a convenience method. It requires a VMeasurementResultID obtained from one of the above two functions. Data is returned sorted by year, ascending.

FindVMChildren – This function reverse traverses the database and gives a list of derived VMeasurements. This is most useful when given the ID of a direct VMeasurement, to find any sums, redates, or others based upon it.

FindVMParents – This function traverses the database and gives a list of parents VMeasurements. This is most useful when given the ID of a Sum, Redate, or Index, to find which VMeasurements it was based on.

FindChildrenOf – This function returns a list of all VMeasurements derived from something. Given 'tree' and '16', for instance, it will find all VMeasurements derived from Tree ID 16. e.g.:

```
select * from cpgdb.findchildrenof('specimen', 1);
```

⚠ *Does not traverse through object relationships. Will only return children of a single particular object. See FindChildrenOfObjectAncestor()*

FindChildrenOfObjectAncestor – This function returns a list of all VMeasurements derived from a particular object and its descendants. The output is the same format as FindChildrenOf.

FindObjectTopLevelAncestor – Returns the toplevel ancestor object of a given object. Will return the given object if it has no toplevel ancestor.

FindObjectAncestors – Returns the ancestor objects of a given object, guaranteed from bottom to top. Can return an empty set.

FindObjectDescendants – Returns the descendant objects of a given object using a depth-first traversal. Can return an empty set.

FindObjectDescendantsByCode – Convenience wrapper around FindObjectDescendants which takes an object code rather than ID.

FindObjectsAndDescendantsWhere – Returns the objects and that match a given WHERE clause and their descendants. Does not return duplicates.

FindElementObjectAncestors – Returns the ancestry tree of objects, given an element id. Really just a helper function for FindObjectAncestors().

GetGroupMembership – This function returns a unique list of all the groups the specified user is a member of.

GetGroupMembershipArray – This function returns an integer array of all the securityGroupIDs the specified user is a member of.

GetUserPermissions – Returns an array of the permissions the specified user has for a particular object ID. The function backtracks *tree* → *site* → *default* and *site* → *default* if no explicit permissions are found. If 'No permission' is returned it is the only member of the array. If a user is a member of group 1 (admin), they automatically get all permissions.

MergeObjects – This function merges two objects together. The first object is taken as the basis with all its fields maintained unchanged. Any fields that are different in the second object are noted in the comments field for checking later. If a field is null in the first object but present in the second, then this value is used. The function cascades through the entity hierarchy merge subordinate entities where required using the other merge functions.

MergeElements – As for MergeObjects but for elements.

MergeSamples – As for MergeObjects but for samples.

MergeRadii – As for MergeObjects but for radii.

16.4 Complex database functions

Beyond the standard database functions discussed in section 16.3, the Corina database uses PLJava perform more complex tasks. PLJava means that we can leaverage the full power of Java to perform calculations and analyses on the database.

Part III

Appendices

Appendix 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

```
EXAMPLE SITE
A1805
106
188
165
184
112
103
111
239
226
132
143
146
140
100
176
139
124
115
78
80
156
75
110
80
130
83
157
99
115
102
110
108
87
135
107
96
70
128
119
86
101
106
129
88
101
151
106
97
110
97
91
93
100
124
99
134
125
105
96
107
142
100
COMMENT –     PB 15–NOV–99
```

Appendix 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

```
EXAMPLE SITE
1
176
342
338
334
409
362
308
360
264
325
318
51
48
47
60
49
48
"[[ARCHIVE]]"
1277
9177
.01
1.035795
0.212144
BOB 25/03/95
EXAMPLE SITE #01
Pith F Sap 32
""
"[[ END OF TEXT ]]"
```

Appendix 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

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

Appendix D

CATRAS

Format name	CATRAS
Other name(s)	None known
Type	Binary
Extension(s)	cat
Read/write support	Read only
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 (**?**) 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.

CATRAS is a closed format with no documentation. 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 on the condition that the format remained closed source. Subsequently others have independently released application and code that can read ring-width data from CATRAS files to a greater or lesser extent.

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, CATRAS stores them as byte pairs. 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 of 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
0	0	0
1	1	0
...	...	...
255	255	0
256	0	1
257	1	1
258	2	1
...	...	...

A byte pair can therefore store 256x256=65536 values (more than enough for most number fields). Matters are complicated though by the need to store negative numbers. In CATRAS pairs with an MSB¡=128 are positive, while pairs with an MSB ranging from 255 to 128 (counting backwards) represent negative values:

Value	LSB	MSB
-1	255	255
-2	254	255
-3	253	255
-4	252	255
...	...	...

D.2.3 Categories

Categories are typically recorded as single bytes as most categories have just a few possible values. They can therefore be conceptualised 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.2.4 Dates

Dates are stored as three single bytes, one for day, one for month, one for year. With only 256 values available for 'year', all dates are stored with 2 digit years e.g. 25/12/84. When reading CATRAS files all years ¿70 are therefore treated as 20th century, whereas years ¡70 are treated as 21st century. This is an arbitrary decision for use in this library as CATRAS does not care either way.

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. Our current understanding of the header bytes is as follows but I'm not convinced that these are all correct. Deciphering these requires painstaking work because we must try to ascertain how each byte is being used (e.g. as a byte pair, single byte or as a string):

- 1-32 - Series name
- 33-40 - Series code
- 41-44 - File extension
- 45-46 - Series length
- 47-48 - Sapwood length
- 49-50 - Start year
- 51-52 - End year
- 53 - 1=pith 2=waldkante 3=pith to waldkante
- 54 - 1 = ew only last ring
- 55-56 - Start year
- 59-60 species also needs a catras.wnm file
- 61-63 - Creation date
- 64-66 - Amended date
- 67 - Sapwood
- 68 - 1=valid stats
- 69-75 - dated?
- 84 - 0=raw 1=treecurve 2=chronology
- 85-86 - User id
- 89-92 - Average width
- 93-95 - Standard deviation
- 96-100 - Autocorrelation
- 101-104 - Sensitivity

D.4 Data

The remaining bytes in the file contain the actual data values stored as integer byte pairs. It appears that older version of CATRAS included one or more padding values of -1. These values should be ignored. The end of the data values are indicated by a stop value of 999.

Following the ring-width data values there are 42 bytes of unknown meaning. These are then followed by byte pairs representing the counts/sample depth for each ring if the series is a chronology.

D.5 Unknown bytes

There are a number of bytes in both the header and data sections that are are unaccounted for and are therefore likely to contain data that we are ignoring. For this reason although we could attempt to create CATRAS files from what we know we can't be sure they would be valid:

- Header
  - 57-58
  - 69-82
  - 105-128
- Data
  - 0-42 following end of data marker

Appendix 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 values in millimetres. 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

```
Year,MySample1,MySample2
500,0.33,
501,0.26,0.26
502,0.2,0.2
503,0.14,0.14
504,0.08,0.08
505,0.02,0.02
506,0.2,0.2
507,0.14,0.14
508,0.08,0.08
509,0.2,
510,0.33,
511,0.08,
512,0.33,
513,0.22,
```

Appendix 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

```
Trebenna, Byzantine Fortress, NW tower 1AB

;ID 907010;NAME Trebenna, Byzantine Fortress, NW tower 1AB;DATING R;UNMEAS_PRE 1;
    UNMEAS_POST 1
;FILENAME G:\DATA\TRB\TRB1AB.SUM


;TYPE S;SPECIES Juniperus sp.;FORMAT R;PITH +
;TERMINAL vv;CONTINUOUS N;QUALITY +
;RECONCILED Y
;DATA
 1001          125   219   207   139    62   107    29    91    65
                 [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]
 1010    71   132    74   150    75   156   122    81    46    57
           [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]
 1020   147    78    89   126    73   121    67    71    64   129
           [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]
 1030   149   155   122   126    53   136    90    65   100    67
           [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [1]   [2]
 1040    67   101   132   102    40    67    42    36    62    29
           [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]
 1050    30    44    46    40    34    61    55    29    44    63
           [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]
 1060    62    38    22    26    26    28    37    21    21    27
           [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]
 1070    17    18    50    21    33    12    17    16    27    20
           [2]   [2]   [2]   [2]   [2]   [2]   [2]   [2]   [1]   [1]
 1080    18    11     9     8  9990
       [1]   [1]   [1]   [1]   [1]

;ELEMENTS
G:\DATA\TRB\TRB1A.REC
G:\DATA\TRB\TRB1B.REC
;weiserjahre
 1001   1/0      0/1      0/1      0/1      1/0      0/1      1/0      0/1      1/0
 1010   1/0      0/1      1/0      0/1      1/0      0/1      0/1      0/1      1/0
     1/0
 1020   0/1      1/0      1/0      0/1      1/0      0/1      1/0      0/1      1/0
     1/0
 1030   1/0      0/1      1/0      0/1      1/0      0/1      0/1      1/0      0/1
     1/1
 1040   2/0      2/0      0/2      0/2      2/0      0/2      0/2      2/0      0/2
     2/0
 1050   2/0      1/1      0/2      0/2      2/0      0/2      0/2      2/0      2/0
     1/1
 1060   0/2      0/2      2/0      1/1      2/0      2/0      0/2      1/1      2/0
     0/2
 1070   1/1      2/0      0/2      2/0      0/2      2/0      1/1      1/0      0/1
     0/1
 1080   0/1      0/1      0/1
~ Unknown User
```

Appendix 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

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

Appendix 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 (**?**) 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

```
HEADER:
DateEnd=-66
KeyNo=27
Project=Growth studies
Length=103
Location=Example site
Species=PISY
SapWoodRings=14
WaldKante=WKF
State=Colorado
PersId=FR
KeyCode=271017
Country=USA
DateOfSampling=19950506
TreeNo=5
CoreNo=1
Exposition=North-West
CreationDate=19970526
SoilType=Sand
DATA: Tree
   125   130    99   120   115   145   151   130   135   151
   200   190   151   170   170   174   170   200   210   130
   180   197   210   160   180   155   180   199   140   150
   146   140   145   150   155   110   115   113   120   130
   110   120   150   120   120   110   115   160   160   145
   135   145   125   115   145   149   120   150   160    99
   110    75    70    82    96    90   120   151   155   130
   132   133   149   110   130   120   128   118   125   115
    95    90   110    98    80    85    97    88    70   100
    90    70    80    90    85    78    95    84    70    90
    80    75    70     0     0     0     0     0     0     0
```

H.3 Example file - chronology

```
HEADER:
KeyCode=ABCK0530
DataFormat=HalfChrono
SeriesType=Mean curve
Length=60
DateBegin=987
DateEnd=1046
Dated=Dated
Location=Example site
Species=QUSP
GlobalMathCommentCount=0
ImageCount=0
CommentCount=0
BibliographyCount=0
DATA: Double
   125     1   125     2   264     2   206     2   115     2
   111     2   188     2   308     2   197     2   419     2
   238     2   227     2   279     2   293     2   271     2
   309     2   170     2   204     2   163     2   175     2
   164     2   211     2   134     2   141     2   107     2
    72     2    74     2    91     2   110     2    47     2
    87     2    87     2    35     2    47     2    80     2
    66     2    38     2    82     2    78     2    65     2
    63     2    76     2    67     2    91     2    73     3
    39     3    41     3    78     3    57     3    54     3
    41     3    39     3    52     3    53     3    43     3
    48     3    32     3    32     3    48     3    59     3
```

Appendix 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 suppported 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 values in millimetres. 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	

Appendix 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 values in millimetres. 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.

Appendix 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

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

Appendix L

ODF Spreadsheet

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

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 values in millimetres. 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.

Appendix 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

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

  1  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  2  2  2  2  2  2
  2  2  2  2  1
```

Appendix 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 (**?**) 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 than 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 volor 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 appled 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

```
<?xml version="1.0"?>
<PAST_4_PROJECT_FILE>
    <PROJECT Name="title0" Version="400" Locked="FALSE" Password=""
        CreationDate="04/05/2006 2:13:51 PM" EditDate="09/01/2010 13:02" ActiveGroup="0"
        Reference="-1" Sample="-1" PersID="investigator0" Groups="2" Records="3">
<![CDATA[description0
]]></PROJECT>
    <SETTINGS/>
    <GROUP Name="title1" Visible="TRUE" Fixed="FALSE" Locked="FALSE" Changed="FALSE"
        Expanded="TRUE" UseColor="TRUE" HasMeanValue="FALSE" IsChrono="FALSE"
        Checked="FALSE" Selected="FALSE" Color="0" MVKeycode="" Owner="-1">
        <![CDATA[]]></GROUP>
    <GROUP Name="Unnamed Group" Visible="TRUE" Fixed="FALSE" Locked="FALSE" Changed="
        FALSE"
        Expanded="TRUE" UseColor="TRUE" HasMeanValue="FALSE" IsChrono="FALSE" Checked="
            FALSE"
        Selected="FALSE" Color="0" MVKeycode="" Owner="-1"><![CDATA[]]></GROUP>
    <RECORD Keycode="title6" Length="4" Owner="0" Chrono="FALSE" Locked="FALSE" Filter="
        FALSE"
        FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE" FilterWeight=""
            Offset="0"
        Color="0" Checked="FALSE" VShift="0" IsMeanValue="0" Pith="FALSE" SapWood="0"
        Location="locationComment1" Species="Quercus" Waldkante="" FirstValidRing="0"
        LastValidRing="0" UseValidRingsOnly="FALSE">
        <HEADER><![CDATA[Unit=1/100th millimetres
]]></HEADER>
        <DATA><![CDATA[123     1       1       0       123
123     1       1       0       123
123     1       1       0       123
125     1       1       0       125
]]></DATA>
    </RECORD>
    <RECORD Keycode="title6" Length="4" Owner="0" Chrono="FALSE" Locked="FALSE" Filter="
        FALSE"
        FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE" FilterWeight=""
            Offset="0"
        Color="0" Checked="FALSE" VShift="0" IsMeanValue="0" Pith="FALSE" SapWood="0"
        Location="locationComment1" Species="QUSP" Waldkante="" FirstValidRing="0"
        LastValidRing="0" UseValidRingsOnly="FALSE">
        <HEADER><![CDATA[Unit=1/100th millimetres
]]></HEADER>
        <DATA><![CDATA[123     1       1       0       123
123     1       1       0       123
123     1       1       0       123
125     1       1       0       125
]]></DATA>
    </RECORD>
    <RECORD Keycode="Unnamed series" Length="2" Owner="1" Chrono="FALSE" Locked="FALSE"
        Filter="FALSE" FilterIndex="-1" FilterS1="100" FilterS2="100" FilterB1="FALSE"
        FilterWeight="" Offset="0" Color="0" Checked="FALSE" VShift="0" IsMeanValue="0"
        Pith="FALSE" SapWood="0" Location="" Species="" Waldkante="" FirstValidRing="0"
        LastValidRing="0" UseValidRingsOnly="FALSE">
        <HEADER><![CDATA[Unit=Wierd units
]]></HEADER>
        <DATA><![CDATA[96      1       1       0       96      fire_damage; fire_damage;
34      1       1       0       34      fire_damage; fire_damage;
]]></DATA>
    </RECORD>
</PAST_4_PROJECT_FILE>
```

Appendix 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 (**?**) 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

```
Ship wreck 4 timber mean
170
A
10784
W
4
R
made PB 22/6/2004
?
?
?
?
0
0
N
N
A
Example
M
QUSP
?
D
391
454
309
314
270
273
229
319
267
276
128
163
221
269
214
201
218
199
198
209
156
177
...
```

Appendix 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

```
3.42
3.38
3.34
4.09
3.62
3.08
3.60
2.64
3.25
3.18
3.42
3.38
...
```

Appendix 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 **?**. 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 **?**.

Q.2 Example file

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

```
            <address>
                <addressLine1>B48 Goldwin Smith Hall</addressLine1>
                <addressLine2>Cornell University</addressLine2>
                <cityOrTown>Ithaca</cityOrTown>
                <stateProvinceRegion>NY</stateProvinceRegion>
                <postalCode>14853</postalCode>
                <country>USA</country>
            </address>
        </laboratory>
        <category>Archaeology</category>
        <investigator>Peter I Kuniholm</investigator>
        <period>1976-present</period>
        <reference>reference1</reference>
        <object>
            <title>White Tower, Thessaloniki</title>
            <identifier domain="dendro.cornell.edu"
                >28acb483-f337-412f-a063-59d911c37594</identifier>
            <createdTimestamp certainty="exact">1997-02-01T14:13:51.0Z</createdTimestamp>
            <lastModifiedTimestamp certainty="exact">1997-02-01T14:13:51.0Z</
                lastModifiedTimestamp>
            <type normalStd="Corina Dictionary" normalId="4" normal="Building">Building</
                type>
            <description>The White Tower of Thessaloniki was originally constructed by
                the Ottomans
                to fortify the city's harbour.</description>
            <coverage>
                <coverageTemporal>Ottoman</coverageTemporal>
                <coverageTemporalFoundation>Stylistic</coverageTemporalFoundation>
            </coverage>
            <location>
                <locationGeometry xmlns:gml="http://www.opengis.net/gml">
                    <gml:Point srsName="urn:ogc:def:crs:EPSG:6.6:4326">
                        <gml:pos>40.6263 22.9485</gml:pos>
                    </gml:Point>
                </locationGeometry>
                <locationPrecision>20</locationPrecision>
                <locationComment>Thessaloniki, Greece</locationComment>
            </location>
            <object>
                <title>Fourth floor</title>
                <type>Floor</type>
                <element>
                    <title>C-TWT-65</title>
                    <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>
                    <type normalStd="Corina Dictionary" normalId="3" normal="Rafter">
                        Rafter</type>
                    <description>15th Rafter from the south</description>
                    <taxon normalStd="Catalogue of Life Annual Checklist 2008" normal="
                        Quercus"
                        normalId="49139">Quercus sp.</taxon>
                    <dimensions>
                        <unit normalTridas="metres"/>
                        <height>1</height>
                        <width>1</width>
                        <depth>1</depth>
                    </dimensions>
                    <authenticity>Original</authenticity>
                    <sample>
                        <title>C-TWT-65-A</title>
                        <identifier domain="dendro.cornell.edu"
                            >ff688357-b2d4-4394-a21a-90696cd4558c</identifier>
                        <createdTimestamp certainty="exact"
                            >1997-02-01T14:13:51.0Z</createdTimestamp>
                        <lastModifiedTimestamp certainty="exact"
                            >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
                        <type normal="Corina Dictionary" normalId="1" normalStd="Section"
```

```
                            >Section</type>
                        <samplingDate certainty="exact">1981-07-25</samplingDate>
                        <state>Dry</state>
                        <radius>
                            <title>C-TWT-65-A-B</title>
                            <identifier domain="dendro.cornell.edu"
                                >5b7baa8b-cd4e-4b3b-88fa-82939420e544</identifier>
                            <createdTimestamp certainty="exact"
                                >2006-05-04T18:13:51.0Z</createdTimestamp>
                            <lastModifiedTimestamp certainty="exact"
                                >2006-05-04T18:13:51.0Z</lastModifiedTimestamp>
                            <woodCompleteness>
                                <pith presence="absent"/>
                                <heartwood presence="incomplete"/>
                                <sapwood presence="complete"/>
                                <bark presence="present"/>
                            </woodCompleteness>
                            <measurementSeries>
                                <title>C-TWT-65-A-B-A</title>
                                <identifier domain="dendro.cornell.edu"
                                    >8c50234e-8eda-41bb-b578-01cc881d1ea1</identifier>
                                <createdTimestamp certainty="exact"
                                    >1997-02-01T14:13:51.0Z</createdTimestamp>
                                <lastModifiedTimestamp certainty="exact"
                                    >1997-02-01T14:13:51.0Z</lastModifiedTimestamp>
                                <analyst>Laura Steele</analyst>
                                <dendrochronologist>Peter I Kuniholm</dendrochronologist>
                                <measuringMethod normalStd="Corina Dictionary" normalId="
                                    1"
                                    >Measuring platform</measuringMethod>
                                <interpretation>
                                    <firstYear suffix="AD">1254</firstYear>
                                    <statFoundation>
                                        <statValue>8.3</statValue>
                                        <type>t-score</type>
                                        <usedSoftware>Corina 2.10</usedSoftware>
                                    </statFoundation>
                                    <deathYear suffix="AD">1535</deathYear>
                                    <provenance>Possibly from the region of Serres</
                                        provenance>
                                </interpretation>
                                <values>
                                    <variable normalTridas="Ring width"/>
                                    <unit normalTridas="1/100th millimetres"/>
                                    <value value="54"/>
                                    <value value="111"/>
                                    <value value="71"/>
                                    <value value="40"/>
                                    <value value="56"/>
                                </values>
                            </measurementSeries>
                        </radius>
                    </sample>
                </element>
            </object>
        </object>
    </project>
</tridas>
```

Appendix 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

```
pb
05/10/94
 1816
 169
 96
 165
 85
 139
 87
 112
 ...
 999
```

Appendix 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 file and last data line for a series may have less than 10 data values so that the majority of lines begin at the start of a decade.

The final data value should be followed by a 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 steeling the last character of the series ID to give them five characters for the year. For example: ABCDEFG-9999. This

conversely limits the series ID to 7 characters. To add to the confusion, other users have been known to add an arbitrary number (e.g. 5000) to all year numbers to overcome this problem.

- The fact that 999 is used as the stop marker for series in 1/100th mm means that Tucson files cannot store a ring value of 9.99mm. In the unlikely event that a sample should have this large a ring, it should be rounded up or down to 998 or 1000.
- Some programs appears to add padding values after the stop marker to fill the rest of the 10 data values in the row.
- Some data files seem to use 9990 as a stop marker
- Some files appears to use a full-stop character to indicate empty data values after the stop marker.
- Data values in RWL files are space delimited, however some programs use tabs instead.
- When reading Tucson files, COFECHA and ARSTAN ignore all lines that do not match the standard data line format. As such, some users have used this to enable them to include multiple comment lines in their files.
- The ITRDB documentation says they should be recorded as DDMM or DDDMM, but this along with sign (N,S,E,W,+ or -) would require 11 characters, when the Tucson specification only allows for 10. Perhaps this was due to an assumption that all places would be in the northern hemisphere? This has resulted in a large amount of variation in the way that coordinates are recorded making it extremely difficult to parse them without error. Here are some examples (including some that use 11 chars not 10):
  - 4652N01101E
  - +4652-01101
  - N4652E01101
  - 4652-01101
  - 465201101
  - 4652 01101

S.5 Example file - raw series

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

S.6 Example file - chronology

```
107089 1 Antalya, Elmali Isletmesi                                CDLI
107089 2 Turkey       Cedar             1800M  3640 02955          1370 1988
107089 3 Peter I. Kuniholm
1070001370 567  11115  1 798  11105  11407  1 398  1 436  1 543  1 490  1 225  1
1070001380 127  1  39  1  29  1  69  1 178  1 445  1 227  1 510  11020  11120  1
10700013901390  11310  1 979  11585  11111  1 444  1 214  1 520  1 275  1 224  1
1070001400 153  1 371  1 567  1 711  1 835  1 687  1 322  1 291  1 291  1 218  1
1070001410 168  1 378  1 557  1 410  1 315  1 202  1 531  1 765  1 797  1 840  1
1070001420 440  1 774  1 946  1 838  1 397  1 380  1 206  1 510  1 695  1 521  1
1070001430 461  1 978  1 967  1 857  1 978  1 733  1 522  1 333  1 577  1 477  1
1070001440 730  1 752  1 932  1 955  1 898  1 629  11170  1 738  1 920  1 363  1
```

```
1070001450 863  1 896  1 965  1 390  1 172  1 126  1  69  1 209  1 313  1 883  1
10700014601255  11220  11364  11035  11364  11282  11364  11611  11369  11273  1
10700014701797  12035  11821  11927  11819  11807  11464  21421  21009  21089  2
10700014801042  21040  21404  2 955  21291  2 982  21186  21042  2 728  2 781  2
1070001490 800  21040  2 503  2 869  21387  21365  21574  21591  22178  21594  3
10700015001629  31282  31126  31409  31433  31406  31239  31479  3 990  31063  3
10700015101026  31035  31175  31217  31500  31358  31171  31140  31005  31340  3
10700015201225  31164  31283  31496  31439  31603  31335  3 982  3 973  31147  3
10700015301086  31146  41403  41454  41209  41451  41292  4 964  41003  41289  4
1070001540 895  4 951  4 745  4 835  4 800  41182  4 952  41097  4 973  4 973  4
10700015501158  41370  41245  41392  41215  41047  51133  5 847  5 961  51295  5
10700015601287  51082  5 899  51012  51195  51409  51107  5 962  5 970  51031  5
1070001570 990  51028  51206  51092  51414  51209  51090  51265  51261  51019  5
1070001580 791  5 995  5 956  5 933  61144  61022  61001  61007  61097  61290  6
10700015901263  6 902  71002  71151  71032  8 968  8 592  8 940  8 936  81131  8
10700016001098  81128  81334  81255  91136  91097 101273 101075 10 952 10 897 10
1070001610 915 10 991 10 735 10 708 10 627 10 848 101010 10 872 10 959 101138 10
10700016201173 101122 101191 101146 10 928 10 820 10 935 10 741 10 812 101126 10
10700016301123 10 781 101111 101054 101275 101052 101068 101049 101016 10 970 10
10700016401093 101159 101023 101159 101060 101117 101314 10 843 101057 101040 10
10700016501030 101268 10 971 101059 101078 101170 101159 101388 101194 101260 10
1070001660 917 101222 101052 101165 101325 101608 101161 121181 12 931 12 992 12
1070001670 750 12 675 12 614 12 638 12 624 12 600 12 506 12 681 12 887 12 708 12
1070001680 797 12 940 12 955 12 886 12 878 12 970 12 916 12 861 12 861 121021 13
1070001690 928 13 961 131043 13 936 13 939 131003 13 619 13 846 13 838 13 822 13
1070001700 717 13 699 14 746 14 900 141022 14 781 14 968 141028 141051 141341 14
1070001710 980 14 817 14 718 14 642 14 554 14 589 14 637 14 677 16 710 16 877 16
1070001720 930 16 931 16 718 16 721 16 616 16 576 16 519 16 790 161046 161067 16
10700017301047 171141 181080 181128 181144 181112 191066 191252 19 971 191076 19
10700017401284 191242 191001 191145 191219 191162 19 576 20 979 231148 231062 23
10700017501119 231255 231267 231352 231397 231487 231116 231092 231150 23 938 23
10700017601118 241240 241258 241023 24 971 241071 241124 241225 241135 241114 24
10700017701072 241171 24 853 24 964 241075 24 820 241154 241059 241270 241022 24
10700017801098 24 903 241038 241147 241141 241162 24 782 241221 241424 241208 24
1070001790 974 241265 241256 241281 241166 241580 24 889 24 955 241158 241101 24
1070001800 949 24 990 24 813 24 758 24 821 24 914 24 889 24 999 24 991 241163 24
10700018101068 241184 24 852 24 870 241037 241070 241132 241047 24 978 24 852 24
1070001820 839 241063 241045 24 957 24 958 24 997 24 841 241209 241053 241013 24
1070001830 920 241103 241151 241166 24 850 24 962 24 944 24 871 24 989 24 906 24
1070001840 697 24 973 24 779 24 647 24 689 24 731 24 981 24 709 24 949 24 580 24
1070001850 619 24 345 24 545 24 688 24 723 241046 24 738 24 785 24 742 24 815 24
1070001860 842 241015 24 888 24 884 24 792 24 594 24 902 24 885 24 841 24 770 24
1070001870 822 24 710 24 838 24 783 24 697 24 768 24 515 24 670 24 855 24 793 24
10700018801021 25 932 25 799 25 902 251038 251017 25 739 25 750 25 963 251149 25
1070001890 798 24 871 24 870 24 625 24 772 24 827 241046 241182 24 701 24 704 24
1070001900 977 241237 241249 241162 241118 241007 241271 241123 241116 241045 24
10700019101167 24 827 24 482 24 952 241370 241260 24 783 241169 241096 241108 24
10700019201387 241484 241293 241182 241282 241527 241261 241146 24 920 24 859 24
10700019301235 241335 24 799 24 819 241000 24 763 241111 241019 24 916 241252 24
10700019401537 241387 231217 23 929 23 685 23 894 231106 231123 231089 23 896 23
10700019501384 231172 231151 231130 231244 231187 231118 231144 231268 231245 23
10700019601547 231015 231208 231203 231109 23 602 23 690 23 684 23 901 23 968 23
1070001970 963 231095 231368 231069 231084 21 936 191146 191362 191288 191572 19
10700019801034 19 870 191186 191047 19 968 191089 191272 191231 191083 189990  0
```

Appendix 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

```
     176=N     1277=I  ABCD01                                                  -2(26F3.0)~
1423383344093623083602643253181341512192682902222782581731982942021701761721 21
 87130114108170135131126 87100 86104103127112 94 96120168149119124 79 67 88 90
 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
 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
 52 50 77 50 63 75 77 64 66 57 80 57 78 65 68 75 65 98 85 82119 89 85 87 83108
129123160117129121 88 69 97 77 96106 71 89 50 65133 89 88 50 60 95 95 91102158
 83 55 98 70 45 46 40 36 64 58 52 58 56 94 51 48 47 60 49 48
```

Appendix 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 mutliple 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/_
```

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

Appendix 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 DendroFileIOLib have decided to comply by not implementing a WinDENDRO format writer. However, in the interests of the dendro community and to ensure users can gain access to their data, DendroFileIOLib does include support for reading WinDENDRO format files.

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

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

Line 1 should contain 8 tab-delimited fields

- Field 1 = WINDENDRO
- Field 2 = WinDENDRO file format version number, either 3 or 4
- Field 3 = Orientation of the data: R = in rows; C = in columns. All WinDENDRO files are in rows
- Field 4 = The column number where the data values begin. For version 3 files this is 13 and version 4 files this is 36
- Field 5 = The direction the data is recording in: P = pith to bark; B = bark to pith
- Field 6 = Whether the data is recorded incrementally (I) or cumulatively (C). WinDENDRO files are always incremental.
- Field 7 = Whether the bark width has been measured (Y or N). If yes, then there will be one more data value than there are rings

- Field 8 = RING

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

- TreeName - The name of the tree being measured
- Path identification - ID of the path along which the series is measured
- Site identification - Name of the site from which the tree was taken
- YearLastRing - Year of the last ring in the series
- Sapwood - Distance (in mm) from the start of the sample to the start of the sapwood.
- Tree height - Height of tree in metres
- Tree age - Age of the tree. If unknown this should be 0, then it is assumed to be equal to the number of rings
- SectionHeight - Height up the tree in metres at which the sample was taken
- User variable - User defined variable - must be numerical
- RingCount - Number of rings the series contains
- DataType - Keyword indicating the type of data measured. This can be: RINGWIDTH; EARLYWIDTH; LATEWIDTH; EARLYWIDTH%; LATEWIDTH%; DENSITY; EARLYDENSITY; LATEDENSITY; 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 additional to these fields, version 4 files also include the following:

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

- VoidArea - Total area occupied by the void areas
- PathLength - Length of radius measured

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

Appendix W

XML Error Codes

Table W.1: The Corina webservice provides error feedback by means of an error code and description.

Section	Code	Description
General	001	Error connecting to database
	002	Generic SQL error
Authentication	101	Authentication failed
	102	Login required
	103	Permission denied
	104	Unsupported request
	105	Invalid server nonce
	106	User unknown
	107	Unsupported client
	108	Unsupported client version
Miscellaneous	666	Unknown Error
	667	Program bug
Internal	701	Internal SQL error
	702	Feature not yet implemented
	703	Invalid XML being returned by webservice
	704	Configuration error
User	901	Invalid user parameter(s)
	902	Missing user parameter(s)
	903	No records match
	904	Parameters too short
	905	Invalid XML request
	906	Record already exists
	907	Foreign key violation
	908	Unique constraint violation
	909	Check constraint violation
	910	Invalid data type
	911	Series with this version number already exists

Appendix X

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Appendix Y

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