

THE INTERNATIONAL TREE-RING DATA BANK: ENHANCEMENTS AND APPLICATIONS TO GLOBAL CHANGE PROBLEMS

1. Introduction

The International Tree-Ring Data Bank (ITRDB) had several goals during the recently funded proposal for the 1994-1995 fiscal year:

- increase the worldwide coverage of tree-ring data spatially and temporally;
- expand the types of tree-ring data archived to include data from image analyses, radiocarbon calibration, and chemical composition;
- develop a system for and begin archiving the derived reconstructions of climate developed from these tree-ring chronologies;
- establish criteria and guidelines for implementing a more rigid assessment of quality control standards in tree-ring data;
- enhance and improve the software distributed by the ITRDB to give researchers greater ability to develop tree-ring data;
- solicit comments and suggestions from the international community on how the ITRDB could be improved.

Because this proposal was a data initiative, the primary goal was to increase the holdings of the ITRDB and the World Data Center - A for Paleoclimatology (WDC-A). By increasing the global network of tree-ring chronologies, scientists will better understand (1) global and regional processes of climate dynamics, (2) patterns and processes of hydrologic dynamics, (3) the relationship between oceanic and atmospheric processes, and (4) the impact of human-caused factors to the atmosphere.

Although other goals were secondary, they were necessitated because tree-ring data are not developed in a "vacuum." To increase the holdings of the ITRDB, the ITRDB must address the complex nature of tree-ring data development, which requires strict quality control standards, specialized software, and the critically-important input of scientists from all over the world.

Future and continuous contributions of tree-ring data to the ITRDB will be necessary to update old chronologies and expand the geographic coverage, thus ensuring global change questions will be addressed and eventually answered. Therefore, the ITRDB has taken a leadership role in the dendrochronological community to help resolve some of the problems that hinder development of tree-ring data. These problems include: (1) poor communications between laboratories; (2) a variety of tree-ring data formats generated by numerous software packages

around the world; (3) a lack of objective criteria for establishing and maintaining the high standards of tree-ring data expected by the WDC-A; and (4) the lack of standardized software for the development of tree-ring data.

2. New contributions to the holdings of the ITRDB

An increasing rate of data contributions to central repositories, such as the ITRDB, is an indication that project goals are being met. The primary goal of the ITRDB is to ensure the continued assimilation of tree-ring data from around the world, thereby ensuring data will be available for future research. During this one-year project, a large amount of tree-ring data was contributed from numerous dendrochronologists, representing many geographic regions across a multitude of subdisciplines (e.g., dendroecology and dendrogeomorphology). New data sets were added from such countries as France, Russia, Japan, Lithuania, and Slovenia. Large data sets were contributed for many areas in the United States, Canada, and Spain.

Chronologies were developed and contributed for many new species as well (e.g., black ash, *Fraxinus nigra* Marsh.). During this project, the ITRDB was fortunate to receive, for the first time ever, tree-ring data based on additional parameters other than ring width or density data (see discussion on Canadian contributions). A major addition to the holdings of the WDC-A for Paleoclimatology were the entire data sets developed for the FORAST (Forest Responses to Anthropogenic Stress) project. Contributions made since the end of the last fiscal year funded project (1992-1993) included these large data sets:

1. Valuable data sets were contributed by Dr. Donald A. Graybill and Gary Funkhouser of the Laboratory of Tree-Ring Research (LTRR), consisting of the long bristlecone pine (*Pinus longaeva* D.K. Bailey) chronologies and measurement files. Seven sites were contributed, all located in California, including the 8,000 year long Methuselah Walk chronology from the Schulman Grove.
2. A second large contribution was made by Dr. Thomas W. Swetnam of the LTRR. These data sets consisted of 66 ponderosa pine (*Pinus ponderosa* Laws.) chronologies for sites in New Mexico, Colorado, and Oregon specifically developed to analyze the effects of insect outbreaks on tree growth.
3. A third large contribution was made by Donald A. Graybill and Gary Funkhouser. These data sets consisted of 61 measurement files and their respective chronologies for sites in Colorado, New Mexico, and Arizona, developed specifically to analyze effects of air pollution on tree growth in a project funded by the Environmental Protection Agency.

Other tree-ring data sets contributed during this interim included: (4) data sets for two sites in New Zealand, donated by Dr. Jonathan Palmer of Lincoln University; (5) an oak chronology in Virginia donated by David M. Lawrence of the University of Virginia; (6) four data sets for a subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) site in southeastern Arizona, donated by Henri D. Grissino-Mayer of the Laboratory of Tree-Ring Research at the University of Arizona; (7)

measurement data for 13 sites in Poland contributed by Dr. Edward Feliksik of the Department of Forest Ecology at the Agricultural Academy; and (8) chronology and measurement data for 14 sites in Washington state, contributed by Dr. David L. Peterson of the College of Forest Resources at the University of Washington. These contributions represent a sizable increase in the number of data sets held by the ITRDB, and we are extremely grateful to these scientists who took the time to contribute their data, thus ensuring their availability for future research.

Since the end of the last funded project, approximately 1099 data sets were contributed, representing 412 chronology files and 687 measurement files (more data sets have been contributed but have not yet been assimilated by the Data Manager of the ITRDB). These 412 chronologies represent a 14% increase in the number of chronologies now held by the ITRDB. This amount is a significant increase above the number of chronologies (ca. 200) contributed during the last project funded by the NOAA Paleoclimatology Program during fiscal year 1992-1993. Therefore, it is reasonable to project the number of contributed tree-ring data sets will exceed 400 by next year. However, the success of the ITRDB should not be judged solely by the number of data sets eventually contributed, because the ITRDB relies exclusively on the ©voluntary© contributions of data by scientists. Success should also be judged on the ability of the ITRDB to resolve difficulties that limit these voluntary contributions.

We will specifically discuss contributions made during the past fiscal year funded project (between May 1994 and May 1995) by geographic region (Table 1). Contributors to the ITRDB were developed by researchers in many different countries (Table 2): the United States, Canada, Spain, Lithuania, Russia, England, Switzerland, Australia, Slovenia, and The Czech Republic. Species represented by the most recent contributions are listed in Table 3.

2.1 United States

2.1.1 Alaska

Dr. Klaus Felix Kaiser of the Swiss Federal Institute of Forestry Research in Birmensdorf, Switzerland, contributed 23 ring-width data sets from various locations in Alaska. All data sets are Sitka spruce (*Picea sitchensis* (Bong.) Carr.), with inside dates as early as A.D. 1616. This is an extremely valuable addition to the ITRDB because it increases the spatial distribution of tree-ring holdings over a very large geographic area for Alaska. In the future, these data may also play a significant role in archeological investigations similar to those begun in the 1930s-1940s by J.L. Giddings.

2.1.2 Arkansas

Dr. David W. Stahle, Dr. Malcolm K. Cleaveland, and Dr. John G. Hehr of the Department of Geography at the University of Arkansas made substantial contributions for many areas of the southern United States. In Arkansas, baldcypress (*Taxodium distichum* (L.) Rich.) data sets (chronologies and measurement files) were donated for five sites. These data sets are among the

longest yet contributed to the ITRDB, extending as far back as AD 998. Baldcypress was shown by these contributors to be a sensitive indicator of spring rainfall for the southeastern U.S.

2.1.3 Arizona

Henri D. Grissino-Mayer and his colleagues at the Laboratory of Tree-Ring Research (The University of Arizona) contributed data sets for two additional sites in southeastern Arizona. The southwestern white pine (*Pinus strobiformis* Engelm.) chronology (AZ550) is the first for this species donated to the ITRDB, and represents one of the longest chronologies yet developed for southern Arizona (AD 1249). Four additional sites were contributed by Dr. Keith R. Briffa of the Climatic Research Unit, University of East Anglia, United Kingdom, and Dr. Fritz H. Schweingruber of the Swiss Federal Institute of Forestry Research in Birmensdorf, Switzerland. These four sites were part of a large network of sites collected for the western United States to reconstruct summer temperature from tree-ring density data. All sites contributed by Briffa and Schweingruber to the ITRDB discussed in this report were part of that network, and all sites consisted of two chronologies, one based on total ring width measurements, and the second based on maximum latewood density measurements.

2.1.4 California

The contributions to the ITRDB for California mark one of the largest, most spatially diverse contributions during the last fiscal year. Dr. David L. Peterson of the College of Forest Resources, University of Washington, donated tree-ring data for 19 sites in the San Bernardino Mountains of southern California. These sites are important because they represent data for bigcone Douglas-fir (*Pseudotsuga macrocarpa* (Vasey) Mayr), a species known to be sensitive to air pollution. Brendan Buckley, currently at the University of Tasmania, Australia, contributed a very long foxtail pine (*Pinus balfouriana* Grev. & Balf.) chronology (CA555) extending back to AD 1177. Keith Briffa and Fritz Schweingruber donated data for five more sites for the western U.S. network, the earliest extending to AD 1513 (CA560), for lodgepole pine (*Pinus contorta* Dougl. ex Loud.), mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), and California red fir (*Abies magnifica* A. Murr.).

2.1.5 Colorado

Keith Briffa and Fritz Schweingruber donated data for three sites in Colorado developed for the western U.S. network to reconstruct summer temperature, the earliest chronology extending to AD 1530 (CO553). These data sets were developed from Engelmann spruce (*Picea engelmannii* Parry).

2.1.6 Georgia

Few tree-ring data have been developed for the coastal state of Georgia, although previous studies showed that pine species have potential for reconstructing past rainfall. David W. Stahle,

Malcolm K. Cleaveland, and John G. Hehr developed the longest, most climatically sensitive tree-ring data yet for this state from baldcypress, and donated three very long chronologies to the ITRDB extending back to AD 929. Relict wood for this species has recently been dredged from low-lying swampy areas in Georgia by the Nature Conservancy, and the possibility exists for extending the tree-ring record back to the BC period for the southeastern U.S.

2.1.7 Idaho

Keith Briffa and Fritz Schweingruber donated Engelmann spruce data for two sites in Idaho for the western U.S. network to reconstruct summer temperature, the earliest chronology extending to AD 1530 (ID008). These contributions are important because Idaho remains under-represented in the spatial distribution of sites for the western U.S.

2.1.8 Illinois

A long (AD 1468) baldcypress chronology and its measurement file were donated by David Stahle and his colleagues at the University of Arkansas. Few tree-ring data exist for this state, and this contribution helps extend the spatial for the eastern U.S.

2.1.9 Louisiana

David W. Stahle, Malcolm K. Cleaveland, and John G. Hehr contributed the first tree-ring data sets developed for this coastal state (LA001). These data were also developed from baldcypress, and extend back to AD 997.

2.1.10 Maine

Two research groups made numerous contributions to expand the spatial coverage for Maine. Annie Hager, W.H. Livingstone, and Alan S. White of the Department of Forest Biology, The University of Maine, donated tree-ring data for six sites, most extending back to the mid- to late 1800s. However, length is not the outstanding feature of these data sets. Rather, these data sets were developed from black ash, a uncommon species that grows in boggy areas of the northern U.S. and southern Canada. Previously, most tree-ring data for Maine consisted of red spruce (*Picea rubens* Sarg.). Andrew Bartholomay and Robert Eckert contributed tree-ring data for three sites from Acadia National Park as part of a study investigating the effects of air pollution on tree growth. These data were developed from eastern white pine (*Pinus strobus* L.), another species for which data were lacking.

2.1.11 Missouri

David W. Stahle and his colleagues contributed four data sets for one site developed from baldcypress. This chronology extends back to AD 1185, and is an important contribution to fill in the spatial network for the central U.S.

2.1.12 Mississippi

David W. Stahle and his colleagues also donated the first tree-ring data ever developed for the state of Mississippi (MS001). These data consisted of baldcypress and is an important contribution for the southeastern U.S.

2.1.13 Montana

Keith Briffa and Fritz Schweingruber contributed eight tree-ring data sets (including maximum latewood density measurements) for four additional sites in Montana where spatial coverage was sparse. These data were developed from Engelmann spruce, the longest chronology extending to AD 1496.

2.1.14 North Carolina

Two research groups donated valuable tree-ring data for North Carolina. Dr. A.C. Barefoot and Dr. W.L. Hafley of the Department of Forestry at North Carolina State University contributed tree-ring measurement data for four sites. Three data sets represent three different species, loblolly pine (*Pinus taeda* L.), shortleaf pine, (*P. echinata* Mill.), and longleaf pine (*P. palustris* Mill.) from a single tree farm. These data are exceptionally long for these species. David W. Stahle and his colleagues at the University of Arkansas contributed baldcypress tree-ring data for two sites (eight data sets). The Black River chronology (NC008) is currently the longest tree-ring chronology ever developed in the southeastern U.S., and represents one of the longest continuous chronologies now held by the ITRDB outside of the bristlecone pine data sets. We consider this one of the major contributions yet made.

2.1.15 New Mexico

The spatial coverage of tree-ring sites in New Mexico is one of the more exceptional, because tree-ring data have a long history in this state due to the abundance of archeological sites. Keith Briffa and Fritz Schweingruber contributed six tree-ring data sets for three additional sites, based on measurement data from Engelmann spruce and Douglas-fir. All three are high elevation sites that may prove useful in ongoing research to reconstruct precipitation (and temperature) for New Mexico over a wide spatial area.

2.1.16 Oregon

Keith Briffa and Fritz Schweingruber contributed eight tree-ring data sets for four sites, based on measurement data from California red fir, mountain hemlock, and Douglas-fir. These data sets will expand the spatial coverage of tree-ring sites for Oregon, where most chronologies cluster along the western side of the state.

2.1.17 Tennessee

David W. Stahle and his colleagues at the University of Arkansas contributed baldcypress tree-ring data for one site (four data sets) in Tennessee. This site, Reelfoot Lake, was instrumental for analyzing the possible effects of the New Madrid earthquake that struck the central Mississippi River Valley in 1811-1812. In addition, long chronologies are very rare for Tennessee, and this baldcypress chronology is a major contribution.

2.1.18 Utah

Despite its lack of forested areas, Utah has numerous tree-ring sites that cover most of the state. Data for an additional three sites (six data sets) were contributed by Keith Briffa and Fritz Schweingruber. These data were based on Engelmann spruce measurement data, and extend back to AD 1511.

2.1.19 Virginia

Once again, David Stahle and his colleagues contributed additional sites based on baldcypress from the coastal areas of Virginia to increase the spatial network of tree-ring sites in the southeastern U.S. One site, Blackwater River VA021) extends back to AD 932, making this the longest tree-ring data set ever developed for Virginia. Elaine K. Sutherland of the USDA Forest Service in Delaware, Ohio, and Henri D. Grissino-Mayer and Connie A. Woodhouse of the Laboratory of Tree-Ring Research at the University of Arizona contributed four data sets from one site in Virginia based on Table Mountain pine (*Pinus pungens* Lamb.). This is the first contribution to the ITRDB for this species, considered one of the lesser known pine species in North America.

2.1.20 Washington

Washington has one of the largest network of tree-ring sites (currently 84) of any state. Keith Briffa and Fritz Schweingruber continued their coverage of the western U.S. by sampling and contributing eight chronology data sets from four sites. These data sets were based on measurements from Pacific silver fir (*Abies amabilis* Dougl. ex Forbes), western larch (*Larix occidentalis* Nutt.), and Douglas-fir. Klaus Felix Kaiser of the WSL in Birmensdorf, Switzerland, contributed measurement data sets for four additional sites in Washington, the earliest extending to AD 1630.

2.1.21 Wyoming

Wyoming is another western U.S. state where tree-ring data are noticeably lacking. However, Keith Briffa and Fritz Schweingruber contributed ten data sets for five sites, bringing to a total of 25 chronologies for Wyoming. More importantly, these Engelmann spruce chronologies are the longest currently developed for this species. The Sylvan Pass site (WY023) extends back to AD 1388, exceptional for this species.

2.2 Canada

The contributions made of tree-ring data from Canada were very extensive, donated by several research groups. Harold C. Fritts and Charles W. Stockton of the Laboratory of Tree-Ring Research, The University of Arizona, donated measurement and chronology data for six sites collected in the Lake Athabaska area in 1970. These data sets were developed from white spruce (*Picea glauca* (Moench.) Voss), the earliest chronology extending to AD 1698. Jaroslav Dobry and K. Klinka of the Czechoslovak Academy of Sciences, The Czech Republic, contributed 16 data sets developed from Pacific silver fir and western redcedar (*Thuja plicata* Donn ex D. Don) growing in British Columbia. These tree-ring data were shown by these researchers to be excellent proxies of past rainfall, despite the location of these forests in a very mesic environment.

An impressive contribution from Canada was made by Sylvain Archambault and Yves Bergeron of the Centre d'etudes nordiques, Universite Laval. This chronology was developed from northern white-cedar (*Thuja occidentalis* L.) and extends back to AD 1186, currently the longest chronology from Canada held by the ITRDB (data sets extend prior to AD 1000, developed by Brian Luckman and Margaret Colenutt of the University of Western Ontario, but these have not been contributed). This data set was shown to be responsive to rainfall by these researchers, enabling a near 1000 year reconstruction of rainfall for Canada.

Keith Briffa and Fritz Schweingruber extended their network of North American sites into Canada as well, and contributed eight data sets from four sites. These were developed from mountain hemlock and Engelmann spruce, the earliest dating to AD 1629. Dr. Klaus F. Kaiser also contributed data from Canada consisting of tree-ring measurement data from three white spruce sites.

One of the more interesting contributions was made by Ian Campbell, T. Gower, and Thierry Varem-Sanders of Forestry Canada, Northern Forestry Centre, in Edmonton, Alberta. A total of 24 data sets were contributed. Remarkably, these data sets represent data from only two jack pine (*Pinus banksiana* Lamb.) sites. What makes these data sets even more unique is that twelve different ring parameters were measured per ring, which included: (1) total ring width, (2) earlywood width, (3) latewood width, (4) basal area increment, (5) basal area mass, (6) earlywood mean basic density, (7) latewood mean basic density, (8) minimum earlywood basic density, (9) maximum latewood basic density, (10) total ring mean density, (11) relative earlywood width, and (12) relative latewood width. These were the first contributions of tree-ring data developed using image analysis techniques. Future contributions to the ITRDB will see an increase in data developed using such technology, as image analyses are being conducted in many tree-ring laboratories around the world.

2.3 France

By far, the largest contribution of tree-ring data to the ITRDB during the last fiscal year by a single scientist was made by Dr. Guy Didier Bert of the Ecophysiology Unit, National Agronomic Research Institute, in Nancy, France. These data were collected to investigate growth decline in silver fir (*Abies alba* Mill.) in the Jura Mountains along the border between France and Switzerland. The area covered by this study was ca. 11,500 square kilometers. Data were collected from a total of 208 sites, 144 in France and another 64 in Switzerland. A total of 1,248 increment cores were obtained for this study, representing over 115,170 individual ring measurements. Ring measurements for all 1,248 cores were contributed by Didier Bert (FRAN10.RWL), making this an extremely valuable addition to the holdings of the ITRDB.

2.4 Japan

Surprisingly, given the number of Japanese dendrochronologists currently practicing tree-ring research, and given the number of recent tree-ring symposia held by the Japanese, Japan is wholly absent from the holdings for the ITRDB. We hope to remedy this situation in the future. The lack of contributions emphasizes the logistical problems inherent in differences in language, scientific approach, and analytical techniques used. In general, Japan has been isolated dendrochronologically. However, the first Japanese tree-ring data set was developed and contributed by Klaus F. Kaiser of the WSL in Birmensdorf, Switzerland, based on measurement data for Japanese red pine (*Pinus densiflora* Sieb. & Zucc.).

2.5 Lithuania

The ITRDB is proud to have received its first contribution from the country of Lithuania (LITH001.RWL), donated by Rutile Piksryte of the Dendroclimatochronology Laboratory at Vytautas Magnus University in Kaunas. This data set was developed from Scots pine (*Pinus sylvestris* L.), and impressively extends back to AD 1777. A large number of tree-ring data sets have been developed by Lithuanian researchers, and we hope additional data will be forthcoming from this region.

2.6 Russia

Russian researchers have been practicing dendrochronology since the early parts of this century, and have perhaps developed more tree-ring data sets than any other country outside of the United States. Unfortunately, these data have not made their way into the holdings of the ITRDB, because most data have not been digitized onto magnetic media for transfer. Most reside solely on paper output. There is clearly a need for outreach from the West to facilitate more contributions from this largely forested country.

This past year, the ITRDB was fortunate to obtain four data sets (two chronology files and their measurements) from Dr. Stepan Shiyatov of Laboratory of Dendrochronology, Institute of Plant and Animal Ecology, Ural Division of Russian Academy of Sciences, in Ekaterinburg, Russia. These tree-ring data were developed from Dahurian larch (*Larix gmelinii* var. *japonica*

(Regel) Pilg.), and extend back to AD 1690. These sites were located in Kamchatka on the far eastern border of Russia, thereby increasing the spatial network of sites for Siberia.

2.7 Slovenia

The eastern European countries are vastly under-represented in the European network of tree-ring sites. However, we hope to remedy this situation in the near future as more laboratories begin conducting tree-ring research in areas here such research has been lacking. Last year, Dr. Katarina Cufar and Dr. Tomislav Levanic of the Department of Wood Science and Technology at the University of Ljubljana in Ljubljana, Slovenia, contributed tree-ring data (six data sets total) from three sites in Slovenia. The longest of these extends back to AD 1751, and were developed from silver fir. Tree-ring data for the southern and southeastern regions of Europe are sparse when compared to the western, central, and northern portions, so the contributions by Dr. Cufar and Dr. Levanic are extremely important for filling in gaps in the European network of sites.

2.8 Spain

The contributions from Spain were considerable during the past year, and were donated solely from one research group. Mar Genova, C. Angel Fernandez, Almudena Perez-Antelo, and Emilio Manrique of the Departamento Sistemas Forestales, Ciudad Universitaria, in Madrid, Spain, contributed a very large data set consisting of 53 files. These data represent 14 sites located mostly in the central portions of Spain, and were developed from Austrian pine (*Pinus nigra* Arnold) and Scots pine. The length of several of these chronologies is impressive, extending back to AD 1485 (SPAI011) and AD 1527 (SPAI012). These chronologies were developed to analyze the climate/tree growth relationship for these species in areas where this relationship has received little attention. Most research in Spain has focused in the border areas and in the Pyrenees Mountains in the north, so these contributions are especially important for increasing the spatial network of sites in the Iberian Peninsula. In addition, the length of these chronologies could make them useful for obtaining years of construction for noted structures in Spain, as observed by one of the Spanish researchers. Little archeological research of this nature has been conducted in Spain, unlike other European countries.

2.9 The FORAST data set

The ITRDB was fortunate to receive the entire holdings of the FORAST (Forest Responses to Anthropogenic Stress) data set from Dr. Sandy McLaughlin and Dr. Tom Boden of the Oak Ridge National Laboratory in Oak Ridge, Tennessee. This immense project was designed to determine whether changes in long-term growth of eastern forest tree species occurred within the last 50 years, and to determine possible factors contributing to these declines in tree growth. A multidisciplinary group representing 15 eastern laboratories collected over 14,000 increment cores from over 7,000 trees from 17 states. In addition to the tree-ring data, information on tree and stand characteristics were obtained, as well as information on all climate and pollution indices,

including SO₂, NO_x, and ozone concentrations. All tree-ring, stand, site, climate, and pollution data are available from the NGDC in Boulder, Colorado, as part of the ITRDB, and the entire FORAST data sets is housed in its separate subdirectory on the NGDC server.

The tree-ring data contributed represent measurement files only. A total of 466 data sets were contributed, representing a wide geographic area in the eastern U.S. A total of 33 different tree species were sampled, including white oak (*Quercus alba* L.), red maple (*Acer rubrum* L.), pitch pine (*Pinus rigida* Mill.), tulip poplar (*Liriodendron tulipifera* L.), shagbark hickory (*Carya ovata* (Mill.) K. Koch), sweetgum (*Liquidambar styraciflua* L.), and basswood (*Tilia americana* L.). Most series extend to the early 1900s, although several extend to the 1800s and even earlier. Little or no prior research had been conducted on the majority of the species sampled in this project. Therefore, the FORAST project was extremely valuable for investigating the dendrochronological potential of species not ordinarily analyzed. The ITRDB is extremely grateful to the Oak Ridge National Laboratory, and the 15 other laboratories who helped sample and develop these data.

2.10 Climate reconstructions

As stated in the proposal, a primary goal of the ITRDB is the archiving of the actual climate reconstructions developed from the tree-ring data themselves. Archiving these reconstructions is extremely important, because not all paleoclimatic research groups have the capability to produce high-quality climate reconstructions from tree-ring data. Tree-ring data are considered accurate proxies of past climate, but do not themselves yield quantitative measures of past climate. Researchers must first investigate the climate/tree growth relationship, then use analytical techniques to develop quantifiable measures of past climate that eventually yield the final reconstructions. The archiving of these final reconstructions will become a top priority for the ITRDB in the future, as this archiving would more directly address the issue of global climate change. During the past fiscal year, the ITRDB was fortunate to receive data for climate reconstructions from two sources.

First, Dr. Harold C. Fritts of the Laboratory of Tree-Ring Research at the University of Arizona contributed an entire software package called DIFMAP to the holdings of the ITRDB, housed in its own subdirectory on the NGDC server in Boulder, Colorado. Extensive documentation exists elsewhere for this software package, and won't be presented in detail here. However, DIFMAP uses climate reconstructions of temperature, precipitation, and sea level pressure developed from 65 tree-ring chronologies from western North America. The software can create "difference maps" to test whether climate during certain years was significant from climate during the remaining years. For example, major fire years occurred in the Southwest during 1716, 1748, 1773, 1819, and 1851. DIFMAP can determine whether climate during these years was anomalous compared to the remaining years in the climate reconstruction grid. The reconstructions consist of annual and seasonal (i.e., spring or summer) values, and are themselves kept in individual files (e.g., all annual temperature reconstructions are in file TANRE.DAT). DIFMAP and its numerous climate reconstructions for the western U.S. represents a substantial contribution to the holdings of the ITRDB, and we are thankful to Dr. Fritts for this donation.

Second, Drs. David W. Stahle and Malcolm K. Cleaveland of the Tree-Ring Laboratory at the University of Arkansas contributed numerous dendroclimatic reconstructions for the central and southeastern United States. These reconstructions included six for Iowa: reconstructed Iowa state average June PDSI, July PDSI, June PHDI, July PHDI, total precipitation (previous August to current July), and total precipitation reconstructed for Farmersburg. These reconstructions were based on white oak, and extend back to 1640 (file IOWA.REC). These researchers also contributed a reconstruction of July PHDI for Missouri extending back to 1596 (file MISSOURI.REC). The longest reconstruction yet developed for the southeastern U.S. was based on tree-ring data from baldcypress, and represented a normalized average of three reconstructions each for three separate states: North Carolina, South Carolina, and Georgia (the three separate reconstructions were also contributed). The reconstruction of March to June total precipitation for the Southeast extends back to AD 933 (file SEUSA.PRE). These researchers contributed a reconstruction of the Southern Oscillation Index (SOI) that extends back to AD 1699, based on tree-ring data developed in the Sierra Madre Occidental of Mexico and the southern Great Plains of the U.S. (file SOI.REC). Finally, Drs. Cleaveland and Stahle contributed a reconstruction of runoff (calendar year in cubic km/year) for the White River in Arkansas. This reconstruction extends back to AD 1700 (file WHITERIV.REC). In all, the researchers from Arkansas contributed 14 reconstructions, which represents a major addition to the holdings of the ITRDB.

3. Development of quality control standards

3.1 Introduction

Another primary goal of this project was to establish guidelines for evaluating the quality of tree-ring data contributed to the ITRDB. Prior to this project, few specific guidelines existed, and the ITRDB and WDC-A had to rely on the good-faith judgment and expertise of individual contributors who were supposed to assure that all data had been crossdated accurately with new technology available in the software distributed by the ITRDB. Given that over 100 researchers contributed data to the ITRDB over the last 21 years, and that these data represented over 1,250 sites from around the world based on over 100 different species, it was inevitable that some data would be contributed that could be considered substandard. However, the ITRDB, and the dendrochronological community in general, had no baseline information for determining what criteria should be used to separate acceptable tree-ring data sets from substandard ones.

3.2 Objectives

Specific objectives of this project were: (1) to evaluate the quality of crossdating in all tree-ring measurement data sets held by the ITRDB to date, and (2) to develop criteria that establish whether a tree-ring data set is high-quality and acceptable for the ITRDB. These criteria were established to be used for all species, across all geographic regions, for tree-ring data derived in various contexts (i.e., archeological material, or treeline species). Eventually, separate criteria will have to be established for: (1) specific geographic areas, because application of criteria established

for trees growing in North America may be inappropriate for trees growing in South America; (2) types of tree species, because criteria for conifers will be vastly different from criteria established for hardwoods; and (3) context of samples, because criteria established for forest border trees will be different from criteria established for wood obtained from archeological sites, such as bogs in England or The Netherlands.

3.3 Methods used

All tree-ring measurement data sets were downloaded from the NGDC onto the server here at the Laboratory of Tree-Ring Research. Prior to beginning the quality control assessment, all measurement files had to be reformatted to ensure the data were in an internationally acceptable format. Over 900 raw measurement files were inspected and reformatted, if necessary. During this process, many new data sets were uncovered, because some European files actually consisted of numerous data sets in one file, whereas the convention is one data set per file. This process began in September, 1994, and was completed by December 31, 1994, and ensured that all measurement files were in an acceptable format that was readable by the majority of software used by dendrochronologists around the world. This process also ensured that all site, tree, location, and PI information held by the ITRDB for each chronology was correct. If not, corrections or updates were made to the individual files. If header information was missing, an ITRDB representative contacted the PI to obtain and/or update the header information for each file.

During the quality control assessment, the ITRDB wished to maintain permanent records of the results of the assessment and of the crossdating quality of each contributed data set. Each data set would have its own associated text (ASCII) file that future researchers could access and learn about the measurement data and its respective chronology. To accomplish this, the quality control and crossdating program COFECHA, developed by Richard L. Holmes, had to be modified specifically for the ITRDB quality control assessment project to output all the statistical information to a separate file. Another program, called QA, was written by Henri D. Grissino-Mayer to then take the file created by COFECHA, and allow a technician to add additional information concerning the crossdating quality of the data sets. Program QA creates the final text file to be associated with each data set.

Once all data were reformatted, and the programs created or modified, the quality control assessment began. The ITRDB decided this assessment should be conducted by two researchers, a technician and supervisor, to ensure no errors were made and to help correct potential problems. In October, 1994, the ITRDB hired a student assistant, Mariette Seklecki, from the Dendrochronology class at the University of Arizona. Her task was to: (1) run COFECHA for each of the 900 data sets and print all output; (2) evaluate the output for each COFECHA run, and note possible crossdating problems; and (3) create the final text file containing all information for the quality control assessment for each data set. The supervisor for this project was Henri D. Grissino-Mayer. His task was to take each output from COFECHA, then confirm or modify the evaluations

made by the student technician. An example of a text file containing the quality control assessment for one of the data sets held by the ITRDB is provided in Table 4.

We focused this assessment on 50-year ring segments that COFECHA determined dated better at a position other than the original dated position based on simple correlation coefficients. However, this criterion alone did not signify a misdated segment, because higher correlations may arise simply by chance. In addition, the correlation coefficient for the alternative position may be only slightly higher than the coefficient for the original position. Therefore, additional criteria were required. Analyses of data sets that contained few problematic 50-year segments revealed that spurious correlations were seldom twice that for correlations determined for the original dated position (for example, 0.54 versus 0.51). Data sets with many problematic, and possibly misdated, segments revealed correlations much greater than those obtained for the original dated position (for example, 0.73 versus 0.04). Therefore, a 50-year segment was considered possibly misdated if the correlation coefficient for the alternative dated position was at least twice that determined for the original dated position.

This criterion only determined that a 50-year segment was possibly misdated. We considered an entire series to be misdated if the majority of all 50-year segments tested dated better at positions other than the original dated positions based on the correlation coefficients. Occasionally, however, the majority of segments that dated better at alternative positions did so at many different, illogical positions (for example, adjustments of -10, -5, +3, +10, and -4 years for consecutive, 50-year segments). Therefore, for a series to be considered obviously misdated, these alternative positions must be systematically dated at alternative positions that appeared reasonable (for example, adjustments of -2, -2, -2, -1, -1, -1 years). If the alternative positions were not systematic, then that core was considered anomalous when compared to the remaining cores. Segments with low correlations, but which were not considered obviously misdated, were noted in the text file.

3.3 Results

This quality control assessment tested the crossdating accuracy of 239,600 50-year segments in 26,173 series from 887 raw measurement files. Of these 887, the crossdating of a few individual series in only 31 data sets (3.5%) showed a likelihood of error. Nine of these 31 data sets were developed by a researcher before quality control software was readily available. We have contacted a representative of this particular research group, and are presently resolving these dating problems. We point out that the errant series in these data sets were easily diagnosed by COFECHA, and corrections can be accomplished by simply adjusting the dating of the errant series by one or two years. We emphasize these particular data sets are still valuable, but should be used with caution until corrections are made to the errant cores.

In addition to data sets that contained obviously misdated series, some problematic data sets contained many series in which crossdating could not be confidently confirmed despite no obvious misdated series being apparent. This condition occurred because too many segments in

most series had low overall correlations with the master chronology for that data set. For example, data set ITAL024.RWL did not contain any obviously misdated individual series, but 24 of the 50 segments tested for crossdating were flagged by COFECHA due to low correlations with the master chronology. This amount represents 43% of all possible segments tested in this data set. This information is reported in the text file associated with these data sets.

After testing all 887 data sets and permanently archiving the results from these tests in text files, we plotted the frequency distribution of the percentages of misdated segments. Most data sets (793 of the 887 tested, or 89.4%) contained 0-2% misdated segments. However, the 31 data sets with problematic segments could easily be distinguished from the remaining data sets as having 10% of all segments tested flagged by COFECHA (Figure 1). Therefore, this level (10%) can be used to preliminarily assess whether a measurement data set contributed to the ITRDB meets criteria for acceptable crossdating.

4. New data types in the ITRDB

One goal of this project was to expand the types of data archived by the ITRDB. We have started archiving tree-ring measurements developed for purposes other than climate reconstruction and not associated with any derived tree-ring climatic chronology. Possible candidate tree-ring data included:

- tree-ring measurement data collected from wood and charcoal in archeological contexts;
- annual data providing details on dates of wildfires;
- reconstructions of streamflow derived from tree-ring data;
- ring-width variations at different locations in the stem profile;
- tree-ring data derived for analyzing tectonic or volcanic history;
- tree-ring data developed for the chemical composition of wood;
- data that provide information on radiocarbon calibration;
- the actual climate reconstructions themselves developed from the derived chronologies.

During the past year, the ITRDB received contributions of tree-ring data developed from archeological material from several locations (e.g., The Netherlands, Germany, and Great Britain). Several tree-ring data sets were also contributed used to analyze stand dynamics via stem analysis profiles at different levels in the tree. The ITRDB also began archiving the climate reconstructions developed from the tree-ring data. However, the ITRDB has not received tree-ring data developed for fire history, flood history, tectonic activity, volcanic studies, chemical composition, or radiocarbon calibration. These data do exist, but the influx of such data to the ITRDB may take longer because no standard formats have been developed for the archiving and exchange of such data, which hinders their contribution. In this situation, the policy of the ITRDB is to accept contributions of such data in the format used by the original developer of the data.

5. Developing an international format for data exchange

As mentioned in the proposal, a major obstacle in the dendrochronological community was the lack of standard, internationally-accepted formats in which to archive tree-ring data. Each of the many laboratories around the world practicing dendrochronology has essentially developed their own data format, including: Decadal (Tucson), Trims, ITRDB, Hemmenhofen, Goettingen, Catras, Heidelberg, Belfast, Sheffield, UEA, HOLZN, etc.). This variety in formats hinders the easy exchange of tree-ring data between laboratories, their use in global change applications, and their eventual contribution to the ITRDB. Therefore, an objective of the ITRDB was to begin the development of standard formats for the archiving of tree-ring data, and begin developing means to transform other formats to these standard formats.

5.1 The ITRDB ad hoc committee on data formats

We began by soliciting comments from the dendrochronological community earlier this year via the ITRDB Dendrochronology Forum on the Internet. This led to a discussion lasting well into the summer from numerous concerned scientists around the world. It was clear that discussion alone would not resolve these problems, and that this issue should be addressed by an organized, international committee representing the worldwide dendrochronological community. Researchers unanimously decided this issue should be handled by the Tree-Ring Society (TRS) and its newly-elected president, Dr. David C. LeBlanc of the Department of Biology at Ball State University, together with the ITRDB. Dr. LeBlanc suggested an ad hoc committee be formed to tackle the problem of data formats in dendrochronology. Martin Munro, of the Laboratory of Tree-Ring Research in Tucson, then set up a separate Internet discussion list on the server at the LTRR, which currently has approximately 30 members subscribed.

Dr. LeBlanc and Henri D. Grissino-Mayer outlined the following guidelines for the formation of such a committee, subsequently posted on the Internet forum:

1. Members of the committee should be volunteers from the dendrochronological community, not just members of the ITRDB and/or TRS;
2. The committee should represent the international community to the greatest extent possible, to insure both a diversity of input and resolution that is suitable to all.
3. The committee should include representatives from the diverse subfields of dendrochronology, and should include software developers and users alike.
4. The committee should include a committee member of the ITRDB because decisions regarding standardizing of tree-ring data will have significant repercussions on the data bank.
5. Committee members must know as much as possible about the data formats currently used, which will mean contacting various laboratories around the world.

6. Committee members will have to be active members, able to dedicate some time to the resolution of this debate.

Eventually, the committee will make recommendations on how to accommodate the new types of data being generated, especially in fields that use image analysis and densitometry. Recommendations must consider the nature of laboratories worldwide, and should be compatible with laboratories at all levels of expertise and development. The ITRDB/TRS also recommended that the committee also report results from their efforts in a journal, perhaps the Tree-Ring Bulletin, and present their results in an open forum at the next international tree-ring conference to be held in Mendoza, Argentina.

Numerous researchers advised that the standard Decadal (Tucson) format be retained because all dendrochronological software currently in use is able to read and create this type of data format. However, new data are being developed using image analysis techniques for which no standard format has been developed, which eventually led to the following questions being posted regarding all tree-ring data:

1. What kind of tree-ring data do we want to archive?

By far, the overwhelming response was the archiving of raw measurement data in addition to the chronologies themselves, because a chronology can always be defined in terms of the raw data. This has always been the main priority of the ITRDB, and we will maintain our focus on the contribution of both raw measurement and chronology data.

2. How many variables need to be recorded for each ring?

Most responders said there was no limit to the amount of information recorded per ring. These variables, however, should be contained in separate files, as is currently conducted by the ITRDB. However, some discussants mentioned that numerous variables for one radius can be archived in one file, and the data format committee will be investigating this possibility.

3. How compatible should the new formats be with the currently used ones?

Most everyone agreed that new formats and software should be backwards compatible with the older formats. However, some respondents mentioned that completely new formats should be developed due to the large amount of data generated and the additional information needed for these data. This is especially true for the data generated in image analyses.

4. Should the data be maintained in a relational database?

Some discussants mentioned that archiving the tree-ring data should take advantage of the power offered by relational databases due to their ability to create multiple "look-up" tables (perhaps for different species or geographical locations). However, the majority of dendrochronologists

favored a straight ASCII data format for exchange of tree-ring data, and noted that not all laboratories had access to relational database managers. The data managers of the ITRDB, however, do maintain the ITRDB in a relational database.

6. Enhancements to the ITRDB Program Library

The ITRDB Program Library was developed and first distributed in August of 1992, and has since become one of the most valuable software tools yet developed for dendrochronological purposes. Versions 1.1+ of this software featured programs that would allow researchers to develop standardized ring-width index chronologies from raw tree-ring measurement data. Included were programs for the conversion, verification, quality control checking, indexing, and archiving of raw data and their final chronologies. Numerous other features, such as species and researcher address databases, full online documentation, and a user-friendly main menu, made this software especially appealing to researchers unsure of proper techniques for the development and archiving of tree-ring data. This effort to develop standardized software in dendrochronology was initiated to facilitate contributions to the ITRDB by removing a primary obstacle. Most dendrochronological software developed previously was difficult to use, and lacked documentation.

A secondary goal of the current project was to improve the ITRDB Program Library. Enhancements to the Library were needed to (1) facilitate the quality control assessment undertaken by the ITRDB, (2) add features most often requested by the dendrochronological community, (3) improve portions of the software most often mentioned by current users as being problematic, (4) update the documentation of the ITRDB software, and improve its online access, and (5) improve its user interface to provide a more esthetically appealing software package. In May 1995, a beta version of the Program Library (Version 2.0) was released, and is currently being tested by seven volunteers in the dendrochronological community. Results of the beta testing are expected by the end of September, 1995, and will be used to correct problems or improve the software based on suggestions from the reviewers.

The new Program Library Version 2.0 features several important improvements:

1. For the first time, a user-friendly measurement program is included, developed originally by Paul Krusic of the Tree-Ring Laboratory at Columbia University, and subsequently modified by Richard L. Holmes as part of the current ITRDB project.
2. A new utility has been added to convert among the numerous data formats used in dendrochronology. Written by Oriol Bosch of the Department of Ecology at the University of Barcelona, Spain, program CORING provides additional conversion flexibility to the end-user, and augments the program CONVERT5 already included.
3. A major critique of dendrochronological software was the lack of a PC-based, user-friendly program for graphically displaying tree-ring time series. Program

ITRDB View, written by Thierry Varem-Sanders of the Canadian Forest Service in Edmonton, Alberta, is a major addition to tree-ring software, and also allows the user to create journal-quality hardcopy graphics.

4. Certain features of the DPL and ARSTAN have been modified and updated to create more user-friendly programs. Both programs now allow the user (1) run DOS commands, (2) provide full access to DOS via a DOS shell, and (3) full access to the ITRDB Help program.

5. To create a more user-friendly environment, full mouse capabilities have been added to all programs written by Henri D. Grissino-Mayer, including the opening Menu, the Help facility, CONVERT5, VERIFY5, the HEADER program, and the programs that access the species lists and address database.

6. Full documentation is now provided for all programs included in the ITRDB Program Library. Documentation has been updated, and is included on all distributed copies of the Library as ASCII files. This allows the user to print the documentation to create easily accessible user's manuals.

7. Information on all contributors to the ITRDB is now available via the ITRDB Main Menu. This listing of contributors is our way to acknowledge those researchers who took the time to donate their data, and also provides the necessary information in case other researchers wish to contact the original developers of the contributed data.

7. Meeting of the ITRDB committee

Travel money and modest support was requested for a long-overdue meeting of the ITRDB Advisory Committee at the International Conference on Tree Rings, Environment, and Humanity, held May 17-21, 1994, in Tucson, Arizona. Two meetings were held. The first was scheduled for May 16th, but this date was unfortunate because many participants to the conference were still away on field trips. Therefore, a second, well-attended meeting was held on May 20th. These meetings addressed several issues, including (1) clarifying the role of the ITRDB in the WDC, (2) disseminating information on the current state of the ITRDB, (3) nominating and electing new Advisory Committee members to the ITRDB, and (4) creating an Advisory Subcommittee that would report directly to NOAA on the progress of the ITRDB.

Dr. Harold C. Fritts, then Chairman of the ITRDB, provided introductory remarks for both meetings that outlined the 20 year history of the ITRDB. Dr. Jonathan Overpeck, Director of the World Data Center - A for Paleoclimatology (of which the ITRDB is a component), then addressed the meeting, providing an overview of the role of the ITRDB in the WDC and to the IGBP-PAGES International Geosphere-Biosphere Programme, Past Global Changes Core Project). Dr. Overpeck announced the development of PaleoVu, software for browsing and displaying a variety of paleoclimatic data, such as tree-ring, pollen, radiocarbon, and ice core data. Henri D. Grissino-Mayer then provided an overview of the ITRDB Internet forum and the Outreach Program

completed during fiscal year 1992-1993. Mr. Grissino-Mayer also briefed attendants on the bibliographic database maintained by the ITRDB.

To ensure the ITRDB would continue to be one of the premier paleoclimatic databases, attendees suggested new personnel be added to the ITRDB Advisory Committee to reflect the growing dendrochronological community. In addition, previous members Dr. Linda Brubaker of the University of Washington had resigned, and Dr. Jonathan Pilcher of the Queen's University in Belfast, Northern Ireland, terminated his position in 1994. Dr. Dieter Eckstein of the University of Hamburg will retire from the committee in 1996, while Dr. Stepan Shiyatov of the Ural Division of the Russian Academy of Sciences will be resigning in 1997. Dr. Harold C. Fritts also offered his resignation, but this resignation was refused. The membership of the ITRDB in attendance then elected new Advisory Committee members consisting of the following dendrochronologists:

- Sylvain Archambault, Centre d'etudes nordiques, Universite Laval, Quebec, Quebec, CANADA;
- Edward R. Cook, Tree-Ring Research Laboratory, Columbia University, Palisades, New York, USA;
- Esther Jansma, Dutch Centre of Archaeological Dendrochronology, State Department of Archaeology, Amersfoort, THE NETHERLANDS;
- Jonathan G. Palmer, Lincoln University, Plant Science Department, Canterbury, NEW ZEALAND;
- Fritz H. Schweingruber, Swiss Federal Institute of Forestry Research, Birmensdorf, SWITZERLAND;
- David W. Stahle, Tree-Ring Laboratory, University of Arkansas, Fayetteville, Arkansas, USA;
- Ricardo Villalba, Laboratorio de Dendrocronologia, CRICYT-Mendoza, Casilla de Correo, Mendoza, ARGENTINA.

This expanded committee provides wider worldwide geographical coverage among dendrochronologists for the ITRDB, and also represents numerous subfields within dendrochronology (e.g., archeology and ecology). After an additional year of service to the ITRDB, Dr. Fritts then resigned his position with the Advisory Committee. A subsequent election by members of the ITRDB then elected Henri D. Grissino-Mayer as the eighth serving member of the Committee. This committee also has the special function of reporting to NOAA annually on the functioning of the ITRDB. The committee later drafted and submitted a report to NOAA concerning how well the ITRDB has served the dendrochronological community.

8. The 1994 meeting in Travemunde, Germany

Funding was also requested to allow a representative of the ITRDB to attend the European Dendrochronological Workshop held September 10–14, 1994, in Travemunde, Germany. The ITRDB, although known to the European community since its inception, has not received a proportionate amount of contributions considering the amount of dendrochronological research conducted by European scientists. Attendance by an ITRDB representative would increase the visibility of the ITRDB in the European dendrochronological community, a scientific community that faces unique, challenging problems concerning the security of tree-ring data. Attendance would show the community that the ITRDB was trying to help resolve these complicated issues, although the Europeans themselves would eventually have to conceive possible solutions.

Henri D. Grissino-Mayer attended the meeting in Travemunde as the ITRDB representative. He was given the opportunity on several occasions to directly address the entire audience of European scientists concerning the ITRDB and its role and function in the international community. Although all ideas and intentions were well received, the Europeans continued to express their concern that the ITRDB did not meet their specific needs, especially concerning security of their tree-ring data. This issue originated during the last two years when it was learned that private European research companies had been accessing European tree-ring data via the ITRDB for their own purposes. These companies take away research opportunities from the original developers of the data, often do not acknowledge the original developers, and often conduct research and publish findings that the original contributors consider questionable.

Prior to the Travemunde meeting, the European community had decided to create a "European catalogue" of tree-ring data held by the various European laboratories. This catalogue would contain all the necessary information about the data sets, but would not contain the actual data. Therefore, any scientist wishing to access any data held in the catalogue first must contact the original developer of the tree-ring data. This ensured the security of the data from private companies, and gave a large measure of control of the data to the original developer. These procedures seem to work well for this community, but is counter to the original purpose of the World Data Center system as administered by the International Council of Scientific Unions (ICSU). The WDC and ICSU specifically mandate that geophysical data, including paleoclimatic data, be freely accessible to all scientists. Unfortunately, this mandate, originally established in the 1950s, did not consider the complex nature of tree-ring data, and its applicability to a wide range of research questions. However, we continue to move towards free exchange of all tree-ring data.

The creation of the European catalogue complicates matters for the ITRDB. Some scientists at the Travemunde meeting suggested the ITRDB should administer the European catalogue, but this idea, though well received, was not feasible given that all data contributed to the ITRDB must be freely accessible to anyone who asks. The ITRDB will continue to work with the European community to resolve this critical issue. While the creation of this catalogue may temporarily undermine the influx of contributions to the ITRDB from the European laboratories, we believe that, in the long run, Europeans will support the ITRDB effort.

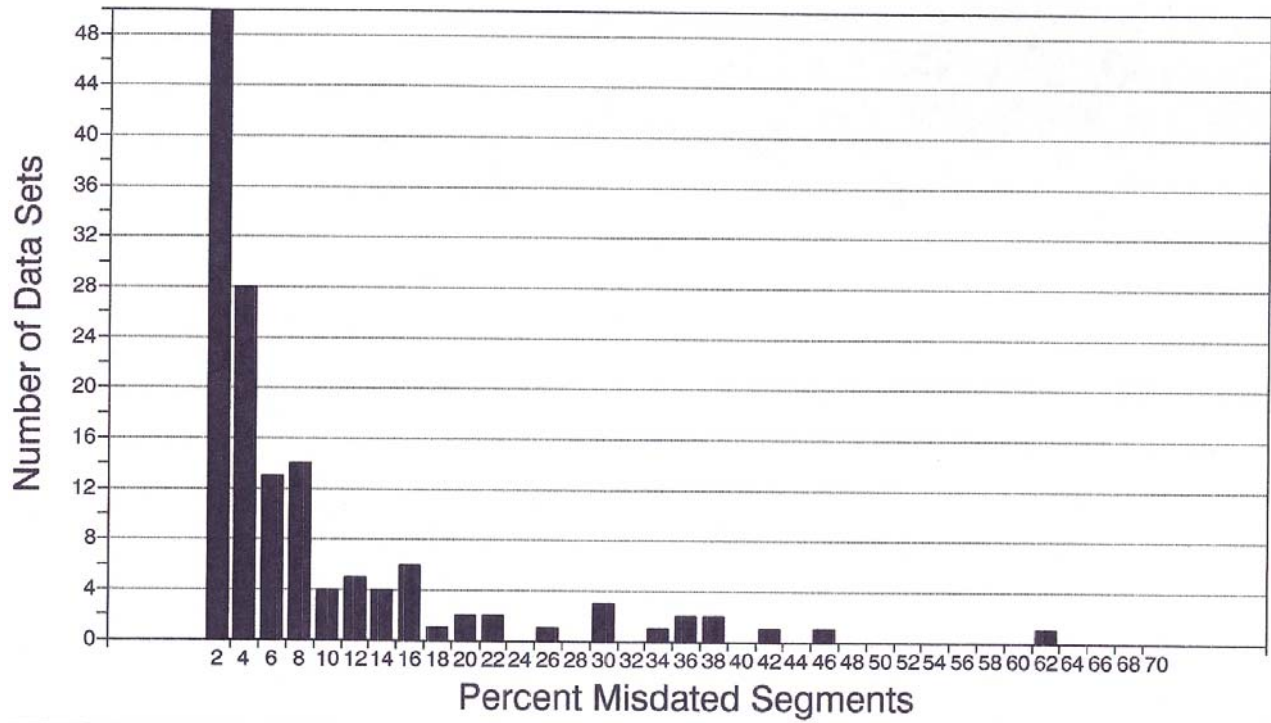


Figure 1. Plot of the percentage of misdated segments in all 886 ring-width data sets archived by the ITRDB. A distinct cutoff exists near the 10% level, which can be used to preliminarily assess the quality of a contributed tree-ring data set.

TABLE 1. New tree-ring measurement data and/or tree-ring chronologies to the ITRDB as of May 30, 1995. The 446 FORAST tree-ring measurement data sets are not listed, but can be obtained from the NGDC. M = measurement data, C = chronology file.

Alaska, USA	AK2.RWL	Yakutat	1655-1986	M	Klaus Felix Kaiser
	AK3.RWL	Tok River	1807-1986	M	
	AK4.RWL	Taku Glacier 1	1895-1986	M	
	AK5.RWL	Swede Point	1848-1986	M	
	AK6.RWL	Starrigawan	1605-1986	M	
	AK7.RWL	Russeljord 1	1828-1986	M	
	AK8.RWL	Russelifford 2	1923-1986	M	
	AK9.RWL	Russeljford 3	1885-1986	M	
	AK10.RWL	Russeljford 4	1934-1986	M	
	AK11.RWL	Russeljford 5	1932-1985	M	
	AK12.RWL	Pony Point	1731-1986	M	
	AK13.RWL	Taku Glacier 2	1785-1986	M	
	AK14.RWL	Isthmus	1789-1986	M	
	AK 15.RWL	Gulkana	1854-1986	M	
	AK16.RWL	Girdwood	1729-1986	M	
	AK17.RWL	Fork Twin Creek	1721-1986	M	
	AK18.RWL	Brassiere Hill 1	1758-1986	M	
	AK19.RWL	Craig	1599-1986	M	
	AK20.RWL	Chitina	1616-1986	M	
	AK 21.RWL	Cordova Airport	1672-1986	M	
	AK22.RWL	Boulder Creek	1828-1986	M	
	AK23.RWL	Berner's Bay	1824-1986	M	
	AK24.RWL	Brassiere Hill 2	1758-1986	M	
	Arkansas, USA	AR049.RWL	Bayou Devieu	1133-1985	
AR049.CRN		Bayou Devieu	1133-1985	C	
AR049A.CRN		Bayou Devieu	1135-1985	C	
AR049R.CRN		Bayou Devieu	1137-1985	C	
AR050.RWL		Black Swamp	1019-1980	M	David W. Stahle, Malcolm K. Cleaveland
AR050.CRN		Black Swamp	1019-1980	C	
AR050A.CRN		Black Swamp	1021-1980	C	
AR050R.CRN		Black Swamp	1023-1980	C	

	AR051.RWL	Little Maumelle	1532-1985	M	David W. Stahle,
	AR051.CRN	Little Maumelle	1532-1985	C	Malcolm K. Cleaveland,
	AR051A.CRN	Little Maumelle	1533-1985	C	John G. Hehr
	AR051R.CRN	Little Maumelle	1539-1985	C	
	AR052.RWL	Mayberry Slough	998-1990	M	
	AR052.CRN	Mayberry Slough	998-1990	C	
	AR052A.CRN	Mayberry Slough	1000-1990	C	
	AR052R.CRN	Mayberry Slough	1002-1990	C	
	AR053.RWL	Moro Bayou	1262-1985	M	
	AR053.CRN	Moro Bayou	1262-1985	C	
	AR053A.CRN	Moro Bayou	1264-1985	C	
	AR053R.CRN	Moro Bayou	1266-1985	C	
Arizona, USA	AZ549.RWL	Peter's Flat	1557-1991	M	Henri D. Grissino-Mayer,
	AZ549.CRN	Peter's Flat	1557-1991	C	Rex K. Adams,
	AZ549A.CRN	Peter's Flat	1557-1991	C	Thomas W. Swetnam
	AZ549R.CRN	Peter's Flat	1563-1991	C	
	AZ550.RWL	Fort Grant	1249-1991	M	Henri D. Grissino-Mayer,
	AZ550.CRN	Fort Grant	1249-1991	C	Christopher H. Baisan
	AZ550R.CRN	Fort Grant	1251-1991	C	
	AZ551.CRN	Flys Peak PSME	1703-1983	C	Keith R. Briffa,
	AZ551X.CRN	Flys Peak PSME	1703-1983	C	Fritz H. Schweingruber
	AZ552.CRN	Flys Peak PCEN	1828-1983	C	
	AZ552X.CRN	Flys Peak PCEN	1828-1983	C	
	AZ553.CRN	Snow Bowl	1453-1983	C	
	AZ553X.CRN	Snow Bowl	1453-1983	C	
	AZ554.CRN	Baldy Peak	1556-1983	C	
	AZ554X.CRN	Baldy Peak	1556-1983	C	
	AZ555.CRN	Mt. Lemon	1568-1983	C	
	AZ555X.CRN	Mt. Lemon	1568-1983	C	
California, USA	CA536.RWL	San Bernardino 1	1654-1988	M	David L Peterson
	CA536.CRN	San Bernardino 1	1654-1988	C	
	CA537.FML	San Bernardino 2	1725-1988	M	
	CA537.CRN	San Bernardino 2	1725-1988	C	
	CA538.RWL	San Bernardino 3	1784-1988	M	
	CA538.CRN	San Bernardino 3	1784-1988	C	
	CA539.RWL	San Bernardino 4	1560-1988	M	
	CA539.CRN	San Bernardino 4	1560-1988	C	
	CA540.RWL	San Bernardino 5	1757-1988	M	

CA540.CRN	San Bernardino	5	1757-1988	C	
CA541.RWL	San Bernardino	6	1787-1988	M	
CA541.CRN	San Bernardino	6	1787-1988	C	
CA542.RWL	San Bernardino	7	1802-1988	M	
CA542.CRN	San Bernardino	7	1802-1988	C	
CA543.RWL	San Bernardino	8	1793-1988	M	
CA543.CRN	San Bernardino	8	1793-1988	C	
CA544.RWL	San Bernardino	9	1707-1988	M	
CA544.CRN	San Bernardino	9	1707-1988	C	
CA545.RWL	San Bernardino	10	1772-1988	M	
CA545.CRN	San Bernardino	10	1772-1988	C	
CA546.RWL	San Bernardino	11	1741-1988	M	
CA546.CRN	San Bernardino	11	1741-1988	C	
CA547.RWL	San Bernardino	12	1684-1988	M	
CA547.CRN	San Bernardino	12	1684-1988	C	
CA548.RWL	San Bernardino	13	1800-1988	M	
CA548.CRN	San Bernardino	13	1800-1988	C	
CA549.RWL	San Bernardino	14	1885-1988	M	
CA549.CRN	San Bernardino	14	1885-1988	C	
CA550.RWL	San Bernardino	15	1621-1988	M	
CA550.CRN	San Bernardino	15	1621-1988	C	
CA551.RWL	San Bernardino	16	1781-1988	M	
CA551.CRN	San Bernardino	16	1781-1988	C	
CA552.RWL	San Bernardino	17	1628-1988	M	
CA552.CRN	San Bernardino	17	1628-1988	C	
CA553.RWL	San Bernardino	18	1540-1988	M	
CA553.CRN	San Bernardino	18	1540-1988	C	
CA554.RWL	San Bernardino	19	1701-1988	M	
CA554.CRN	San Bernardino	19	1701-1988	C	
CA555.RWL	Yolla Bolly		1177-1988	M	Brendan Buckley
CA555.CRN	Yolla Bolly		1177-1988	C	
CA555A.CRN	Yolla Bolly		1179-1988	C	
CA555R.CRN	Yolla Bolly		1182-1988	C	
CA556.CRN	Lone Lake		1548-1983	C	Keith R. Briffa,
CA556X.CRN	Lone Lake		1548-1983	C	Fritz H. Schweingruber
CA557.CRN	Lassen N.P.		1525-1983	C	
CA557X.CRN	Lassen N.P.		1525-1983	C	
CA558.CRN	Fryday Ridge		1642-1983	C	
CA558X.CRN	Fryday Ridge		1642-1983	C	

	CA559.CRN	Squaw Valley	1712-1983	C	
	CA559X.CRN	Squaw Valley	1712-1983	C	
	CA560.CRN	Yosemite N.P.	1513-1983	C	
	CA560X.CRN	Yosemite N.P.	1513-1983	C	
CANADA	CANA100.RWL	Chenal de Quatre	1765-1970	M	Harold C. Fritts,
	CANA100.CRN	Chenal de Quatre	1765-1970	C	Chuck W. Stockton
	CANA101.RWL	Claire River	1760-1970	M	
	CANA101.CRN	Claire River	1760-1970	C	
	CANA102.RWL	Revellon Coupe	1783-1970	M	
	CANA102.CRN	Revellon Coupe	1783-1970	C	
	CANA103.RWL	Peace River 1	1804-1970	M	
	CANA103.CRN	Peace River 1	1804-1970	C	
	CANA104.RWL	Peace River 2	1698-1970	M	
	CANA104.CRN	Peace River 2	1698-1970	C	
	CANA105.RWL	Athabaska River	1708-1970	M	
	CANA105.CRN	Athabaska River	1708-1970	C	
	CANA106.RWL	Lac Duparquet	1186-1987	M	Sylvain Archambault,
	CANA106.CRN	Lac Duparquet	1186-1987	C	Yves Bergeron,
	CANA107.RWL	Capilano 1	1687-1992	M	J. Dobry, K. Klinka
	CANA107.CRN	Capilano 1	1687-1992	C	
	CANA107A.CRN	Capilano 1	1687-1992	C	
	CANA107R.CRN	Capilano 1	1689-1992	C	
	CANA108.RWL	Capilano 2	1754-1992	M	
	CANA108.CRN	Capilano 2	1754-1992	C	
	CANA108A.CRN	Capilano 2	1756-1992	C	
	CANA108R.CRN	Capilano 2	1658-1992	C	
	CANA109.RWL	Seymour 1	1539-1992	M	
	CANA109.CRN	Seymour 1	1539-1992	C	
	CANA109A.CRN	Seymour 1	1539-1992	C	
	CANA109R.CRN	Setmour 1	1543-1992	C	
	CANA110.RWL	Seymour 2	1344-1993	M	
	CANA110.CRN	Seymour 2	1344-1993	C	
	CANA110A.CRN	Seymour 2	1344-1992	C	
	CANA110R.CRN	Seymour 2	1345-1992	C	
	CANA111.CRN	Vancouver	1413-1983	C	Keith R. Briffa,
	CANA111X.CRN	Vancouver	1413-1983	C	Fritz H. Schweingruber
	CANA112.CRN	Kootenai Pass	1701-1983	C	
	CANA112X.CRN	Kootenai Pass	1701-1983	C	
	CANA113.CRN	Arrowsmith	1629-1983	C	

	CANA113X.CRN	Arrowsmith	1629-1983	C	
	CANA114.CRN	Kokanee Glacier	1804-1983	C	
	CANA114X.CRN	Kokanee Glacier	1804-1983	C	
	CANA4.RWL	Sakiw Creek	1787-1986	M	Klaus Felix Kaiser
	CANA5.RWL	Cassiar Highway	1711-1986	M	
	CANA6.RWL	Christmas Creek	1705-1986	M	
	CANA7BA.RWL	Nelson House BA	1938-1994	M	Ian Campbell, T. Gower,
	CANA7BM.RWL	Nelson House BM	1938-1994	M	T. Varem-Sanders
	CANA7ED.RWL	Nelson House ED	1938-1994	M	
	CANA7EW.RWL	Nelson House EW	1938-1994	M	
	CANA7LD.RWL	Nelson House LD	1938-1994	M	
	CANA7LW.RWL	Nelson House LW	1938-1994	M	
	CANA7MND.RWL	Nelson House MND	1938-1994	M	
	CANA7MXD.RWL	Nelson House MXD	1938-1994	M	
	CANA7RD.RWL	Nelson House RD	1938-1994	M	
	CANA7REW.RWL	Nelson House REW	1938-1994	M	
	CANA7RLW.RWL	Nelson House RLW	1938-1994	M	
	CANA7RW.RWL	Nelson House RW	1938-1994	M	
	CANA8BA.RWL	Prince Albert BA	1938-1994	M	
	CANA8BM.RWL	Prince Albert BM	1938-1994	M	
	CANA8ED.RWL	Prince Albert ED	1938-1994	M	
	CANA8EW.RWL	Prince Albert EW	1938-1994	M	
	CANA8LD.RWL	Prince Albert LD	1938-1994	M	
	CANA8LW.RWL	Prince Albert LW	1938-1994	M	
	CANA8MND.RWL	Prince Albert MND	1938-1994	M	
	CANA8MXD.RWL	Prince Albert MXD	1938-1994	M	
	CANA8RD.RWL	Prince Albert RD	1938-1994	M	
	CANA8REW.RWL	Prince Albert REW	1938-1994	M	
	CANA8RLW.RWL	Prince Albert RLW	1938-1994	M	
	CANA8RW.RWL	Prince Albert RW	1938-1994	M	
Colorado, USA	C0552.CRN	Red Mtn. Pass	1626-1983	C	Keith R. Briffa,
	C0552X.CRN	Red Mtn. Pass	1626-1983	C	Fritz H. Schweingruber
	C0553.CRN	Pikes Peak	1530-1983	C	
	C0553X.CRN	Pikes Peak	1530-1983	C	
	C0554.CRN	Cottonwood Pass	1565-1983	C	
	C0554X.CRN	Cottonwood Pass	1565-1983	C	
France	FRAN10.RWL	Jura Mountains	1825-1990	M	G. Didier Bert
Georgia, USA	GA002.RWL	Altamaha River	929-1985	M	David W. Stahle,
	GA002.CRN	Altamaha River	929-1985	C	Malcolm K. Cleaveland

	GA002A.CRN	Altamaha River	930-1985	C	John G. Hehr
	GA002R.CRN	Altamaha River	933-1985	C	
	GA003.RWL	Ebenezer Creek	990-1985	M	
	GA003.CRN	Ebenezer Creek	990-1985	C	
	GA003A.CRN	Ebenezer Creek	991-1985	C	
	GA003R.CRN	Ebenezer Creek	995-1985	C	
	GA004.RWL	Ocmulgee River	1202-1985	C	
	GA004.CRN	Ocmulgee River	1202-1985	C	
	GA004A.CR	Ocmulgee River	1204-1985	C	
	GA004R.CRN	Ocmulgee River	1206-1985	C	
Idaho, USA	ID007.CRN	Cascade Radar	1716-1983	C	Keith R. Briffa,
	ID007X.CRN	Cascade Radar	1716-1983	C	Fritz H. Schweingruber
	ID008.CRN	Galena Pass	1530-1983	C	
	ID008X.CRN	Galena Pass	1530-1983	C	
Illinois, USA	IL016.RWL	Cache River	1468-1985	M	David W. Stahle
	IL016.CRN	Cache River	1468-1985	C	
	IL016A.CRN	Cache River	1469-1985	C	
	IL016R.CRN	Cache River	1471-1985	C	
Japan	JAPA1.RWL	Miyajima	1881-1987	M	Klaus Felix Kaiser
Louisiana, USA	LA001.RWL	Big Cypress	997-1988	M	David W. Stahle,
	LA001.CRN	Big Cypress	997-1988	C	Malcolm K. Cleaveland,
	LA001A.CRN	Big Cypress	997-1988	C	John G. Hehr
	LA001R.CRN	Big Cypress	1002-1988	C	
Lithuania	LITHOO1.F!WL	Daunoriai	1777-1991	M	Rutile Piksryte
Maine, USA	ME027.RWL	Portage	1872-1994	M	Annie Halter,
	ME027.CRN	Portage	1872-1994	C	W.H. Livingstone,
	ME027A.CRN	Portage	1872-1994	C	Alan S. White
	ME027R.CRN	Portage	1873-1994	C	
	ME028.RWL	St. Francis	1896-1994	M	
	ME028.CRN	St. Francis	1896-1994	C	
	ME028A.CRN	St. Francis	1896-1994	C	
	ME028R.CRN	St. Francis	1898-1994	C	
	ME029.RWL	West Enfield	1864-1994	M	
	ME029.CRN	West Enfield	1864-1994	C	
	ME029A.CRN	West Enfield	1864-1994	C	
	ME029R.CRN	West Enfield	1866-1994	C	
	ME030.RWL	Carroll	1880-1994	M	
	ME030.CRN	Carroll	1880-1994	C	
	ME030A.CRN	Carroll	1880-1994	C	

	ME030R.CRN	Carroll	1881-1994	C	
	ME031.RWL	Burnham	1873-1994	M	
	ME031.CRN	Burnham	1873-1994	C	
	ME031A.CRN	Burnham	1873-1994	C	
	ME031R.CRN	Burnham	1875-1994	C	
	ME032.RWL	Grindstone	1863-1994	M	
	ME032.CRN	Grindstone	1863-1994	C	
	ME032A.CRN	Grindstone	1863-1994	C	
	ME032R.CRN	Grindstone	1867-1994	C	
	ME033.RWL	Acadia NP	1840-1992	M	Andy Bartholomay,
	ME033.CRN	Acadia NP	1840-1992	C	Robert T. Eckert
	ME033A.CRN	Acadia NP	1840-1992	C	
	ME033R.CRN	Acadia NP	1841-1992	C	
	ME034.RWL	Acadia NP 6	1840-1992	M	
	ME034.CRN	Acadia NP 6	1840-1992	C	
	ME034A.CRN	Acadia NP 6	1840-1992	C	
	ME034R.CRN	Acadia NP 6	1842-1992	C	
	ME035.RWL	Acadia NP 8	1886-1992	M	
	ME035.CRN	Acadia NP 8	1886-1992	C	
	ME035A.CRN	Acadia NP 8	1886-1992	C	
	ME034R.CRN	Acadia NP 8	1887-1992	C	
Missouri, USA	M0037.RVT	Allred Lake	1185-1992	M	David W. Stable,
	MO037.CRN	Allred Lake	1185-1992	C	Malcolm K. Cleaveland
	M0037A.CRN	Allred Lake	1186-1992	C	
	MO037R.CRN	Allred Lake	1188-1992	C	
Mississippi, USA	MS001.RWL	Pearl River	1546-1992	M	David W. Stable,
	MS001.CRN	Pearl River	1546-1992	C	Malcolm K. Cleaveland
	MS001A.CRN	Pearl River	1548-1992	C	
	MS001R.CRN	Pearl River	1550-1992	C	
Montana, USA	MT105.CRN	Hododoo Pass	1758-1983	C	Keith R. Briffa,
	MT105X.CRN	Hododoo Pass	1758-1983	C	Fritz H. Schweingruber
	MT106.CRN	Lost Trail Pass	1785-1983	C	
	MT106X.CRN	Lost Trail Pass	1785-1983	C	
	MT107.CRN	Skalkaho Pass	1782-1983	C	
	MT107X.CRN	Skalkaho Pass	1782-1983	C	
	MT108.CRN	Highland Outlook	1496-1983	C	
	MT108X.CRN	Highland Outlook	1496-1983	C	
North Carolina,	NC 5.RWL	Bluff Mountain	1713-1993	M	A.C. Barefoot,

USA	NC 6.RWL	New Hill PITA	1891-1994	M	W.L. Hafley
	NC 7.RWL	New Hill PIPA	1891-1994	M	
	NC 8.RWL	New Hill PIEC	1879-1994	M	
	NC008.RWL	Black River	365-1985	M	David W. Stahle,
	NC008.CRN	Black River	365-1985	C	Malcolm K. Cleaveland,
	NC008A.CRN	Black River	368-1985	C	John G. Hehr
	N0008R.CRN	Black River	372-1985	C	
	NC009.RWL	Lassiter Swamp	1524-1985	M	
	NC009.CRN	Lassiter Swamp	1524-1985	C	
	NC009A.CRN	Lassiter Swamp	1526-1985	C	
	NC009R.CRN	Lassiter Swamp	1528-1985	C	
	New Mexico, USA	NM569.CRN	Ski Valley	1828-1983	C
NM569X.CRN		Ski Valley	1828-1983	C	Fritz H. Schweingruber
NM570.CRN		Sierra Blanca	1554-1983	C	
NM570X.CRN		Sierra Blanca	1554-1983	C	
NM571.CRN		Sandia Crest	1735-1983	C	
NM571X.CRN		Sandia Crest	1735-1983	C	
Oregon, USA	OR042.CRN	Crater Lake	1564-1983	C	Kith R. Briffa,
	OR042X.CRN	Crater Lake	1564-1983	C	Fritz H. Schweingruber
	OR043.CRN	Barlow Pass	1504-1983	C	
	OR043X.CRN	Barlow Pass	1504-1983	C	
	OR044.CRN	Mt. Ashland	1739-1983	C	
	OR044X.CRN	Mt. Ashland	1739-1983	C	
	OR045.CRN	Mt. Hood	1706-1983	C	
	OR045X.CRN	Mt. Hood	1706-1983	C	
Russia	RUSS014.RWL	Esso Village	1690-1984	M	Stepan G. Shiyatov
	RUSS014.CRN	Esso Village	1690-1984	C	
	RUSS015.RWL	Tolbachek	1710-1983	M	
	RUSS015.CRN	Tolbachek	1710-1983	C	
Slovenia	SLOV001.RWL	Bistra	1751-1991	M	Katarina Cufar,
	SLOV001.CRN	Bistra	1751-1991	C	Tom Levanic
	SLOV002.RWL	Javornik	1859-1994	M	
	SLOV002.CRN	Javornik	1859-1994	C	
	SLOV003.RWL	Ravnik	1890-1993	M	
	SLOV003.CRN	Ravnik	1890-1993	C	
Spain	SPAI008.RWL	Tajo	1610-1988	M	Genova Fuster,
	SPAI008.CRN	Tajo	1610-1988	C	Fernandez-Cancio,
	SPAI008A.CRN	Tajo	1610-1988	C	Perez Antelo

SPAI008R.CRN	Tajo	1610-1988	C	
SPAI009.RWL	Boqueron	1688-1988	M	
SPAI009.CRN	Boqueron	1688-1988	C	
SPAI009A.CRN	Boqueron	1688-1988	C	
SPAI009R.CRN	Boqueron	1692-1988	C	
SPAI010.RWL	Tierra Muerta	1615-1988	M	
SPAI010.CRN	Tierra Muerta	1615-1988	C	
SPAI010A.CRN	Tierra Muerta	1615-1988	C	
SPAI010R.CRN	Tierra Muerta	1621-1988	C	
SPAI011.RWL	Torreton	1485-1988	M	
SPAI011.CRN	Torreton	1485-1988	C	
SPAI011A.CRN	Torreton	1485-1988	C	
SPAI011R.CRN	Torreton	1489-1988	C	
SPAI012.RWL	Siete Picos	1527-1988	M	
SPAI012.CRN	Siete Picos	1527-1988	C	
SPAI012A.CRN	Siete Picos	1527-1988	C	
SPAI012R.CRN	Siete Picos	1530-1988	C	
SPAI013.RWL	NavaFria I	1685-1988	M	
SPAI013.CRN	NavaFria I	1685-1988	C	
SPAI013A.CRN	NavaFria I	1685-1988	C	
SPAI014.RWL	NavaFria II	1787-1988	M	Genova Fuster,
SPAI014.CRN	NavaFria II	1787-1988	C	Fernandez-Cancio,
SPAI014A.CRN	NavaFria II	1787-1988	C	Perez Antelo
SPAI014R.CRN	NavaFria II	1788-1988	C	
SPAI015.RWL	NavaFria III	1791-1988	M	
SPAI015.CRN	NavaFria III	1791-1988	C	
SPAI015A.CRN	NavaFria III	1791-1988	C	
SPAI015R.CRN	NavaFria III	1794-1988	C	
SPAI016.RWL	Penahorcada	1667-1988	M	
SPAI016.CRN	Penahorcada	1667-1988	C	
SPAI016A.CRN	Penahorcada	1667-1988	C	
SPAI016R.CRN	Penahorcada	1668-1988	C	
SPAI017.RWL	Cercelas	1760-1988	M	
SPAI017.CRN	Cercelas	1760-1988	C	
SPAI018.RWL	Andrinal	1687-1988	M	
SPAI018.CRN	Andrinal	1687-1988	C	
SPAI018A.CRN	Andrinal	1687-1988	C	
SPAI018R.CRN	Andrinal	1689-1988	C	

	SPAI019.RWL	Riscopol	1523-1988	M	
	SPAI019.CRN	Riscopol	1523-1988	C	
	SPAI019A.CRN	Riscopol	1526-1988	C	
	SPAI019R.CRN	Riscopol	1535-1988	C	
	SPAI020.RWL	Penota	1763-1988	M	
	SPAI020.CRN	Penota	1763-1988	C	
	SPAI020A.CRN	Penota	1766-1988	C	
	SPAI020R.CRN	Penota	1771-1988	C	
	SPAI021.RWL	Pedriza	1715-1988	M	
	SPAI021.CRN	Pedriza	1715-1988	C	
	SPAI021A.CRN	Pedriza	1715-1988	C	
	SPAI021R.CRN	Pedriza	1717-1988	C	
Tennessee, USA	TN010.RWL	Reelfoot Lake	1677-1990	M	David W. Stahle,
	TN010.CRN	Reelfoot Lake	1677-1990	C	Malcolm K. Cleaveland
	TN010A.CRN	Reelfoot Lake	1677-1990	C	
	TN010R.CRN	Reelfoot Lake	1677-1990	C	
UTAH, USA	UT510.CRN	Electric Lake	1542-1983	C	Keith R. Briffa,
	UT510X.CRN	Electric Lake	1542-1983	C	Fritz H. Schweingruber
	UT511.CRN	Cedar Breaks	1581-1983	C	
	UT511X.CRN	Cedar Breaks	1581-1983	C	
	UT512.CRN	Hidden Peak	1511-1983	C	
	UT512X.CRN	Hidden Peak	1511-1983	C	
Virginia, USA	VA020.RWL	Brush Mountain	1822-1992	M	Elaine K. Sutherland,
	VA020.CRN	Brush Mountain	1822-1992	C	H.D. Grissino-Mayer,
	VA020A.CRN	Brush Mountain	1825-1992	C	Connie Woodhouse
	VA020R.CRN	Brush Mountain	1828-1992	C	
	VA021.RWL	Blackwater River	32-1985	M	David W. Stahle,
	VA021.CRN	Blackwater River	32-1985	C	Malcolm K. Cleaveland,
	VA021A.CRN	Blackwater River	33-1985	C	John G. Hehr
	VA021R.CRN	Blackwater River	37-1985	C	
	VA022.RWL	Chickahominy R.	1662-1984	M	
	VA022.CRN	Chickahominy R.	1662-1984	C	
	VA022A.CRN	Chickahominy R.	1662-1984	C	
	VA022R.CRN	Chickahominy R.	1662-1984	C	
	VA023.RWL	Dragon Run	1372-1984	M	
	VA023.CRN	Dragon Run	1372-1984	C	
	VA023A.CRN	Dragon Run	1372-1984	C	

	VA023R.CRN	Dragon Run	1377-1984	C	
Washington, USA	WA2.RWL	White Pass	1791-1986	M	Klaus Felix Kaiser
	WA3.RWL	Swauk Pass	1788-1986	M	
	WA4.RWL	Rimrock	1885-1986	M	
	WA5.RWL	Rimrock Slope	1921-1986	M	
	WA6.RWL	Goat Mountain	1630-1986	M	
	WA081.CRN	Mt. St. Helens	1609-1983	C	Keith Briffa,
	WA081X.CRN	Mt. St. Helens	1609-1983	C	Fritz H. Schweingruber
	WA082.CRN	Hurricane Ridge	1698-1983	C	
	WA082X.CRN	Hurricane Ridge	1698-1983	C	
	WA083.CRN	Sherman Creek	1605-1983	C	
	WA083X.CRN	Sherman Creek	1605-1983	C	
	WA084.CRN	Mt. Angeles	1750-1983	C	
	WA084X.CRN	Mt. Angeles	1750-1983	C	
Wyoming, USA	WY021.CRN	Powder River Pass	1496-1983	C	Keith Briffa,
	WY021X.CRN	Powder River Pass	1496-1983	C	Fritz H. Schweingruber
	WY022.CRN	Medicine Bow Peak	1401-1983	C	
	WY022X.CRN	Medicine Bow Peak	1401-1983	C	
	WY023.CRN	Sylvan Pass	1388-1983	C	
	WY023X.CRN	Sylvan Pass	1388-1983	C	
	WY024.CRN	Granite Pass	1508-1983	C	
	WY024X.CRN	Granite Pass	1508-1983	C	
	WY025.CRN	Togwatee Pass	1672-1983	C	
	WY025X.CRN	Togwatee Pass	1672-1983	C	

TABLE 2. List of contributors of tree-ring data to the ITRDB between May 1994 and May 1995.

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TABLE 3. Species for which tree-ring data were contributed to the ITRDB between May 1993 and May 1995, arranged by Latin name. This listing includes those species sampled for the FORAST project.

silver fir	<i>Abies alba</i> Mill.
Pacific silver fir	<i>Abies amabilis</i> Dougl. ex Forbes
balsam fir	<i>Abies balsamea</i> (L.) Mill.
Fraser fir	<i>Abies fraseri</i> (Pursh) Poir.
subalpine fir	<i>Abies lasiocarpa</i> (Hook.) Nutt.
California red fir	<i>Abies magnifica</i> A. Murr.
red maple	<i>Acer rubrum</i> L.
sugar maple	<i>Acer saccharum</i> Marsh.
yellow birch	<i>Betula alleghaniensis</i> Britton
white birch	<i>Betula papyrifera</i> Marsh.
shagbark hickory	<i>Carya ovata</i> (Mill.) K. Koch
American beech	<i>Fagus grandifolia</i> Ehrh.
white ash	<i>Fraxinus americana</i> L.
black ash	<i>Fraxinus nigra</i> Marsh.
eastern redcedar	<i>Juniperus virginiana</i> L.
Dahurian larch	<i>Larix gmelinii</i> var. <i>japonica</i> (Regel) Pilg.
western larch	<i>Larix occidentalis</i> Nutt.
Sweetgum	<i>Liquidambar styraciflua</i> L.
tulip poplar	<i>Liriodendron tulipifera</i> L.
Norway spruce	<i>Picea abies</i> (L.) Karst.
Engelmann spruce	<i>Picea engelmannii</i> Parry
white spruce	<i>Picea glauca</i> (Moench.) Voss
red spruce	<i>Picea rubens</i> Sarg.
Sitka spruce	<i>Picea sitchensis</i> (Bong.) Carr.
foxtail pine	<i>Pinus balfouriana</i> Grev. & Balf.
jack pine	<i>Pinus banksiana</i> Lamb.
lodgepole pine	<i>Pinus contorta</i> Dougl. ex Loud.
shortleaf pine	<i>Pinus echinata</i> Mill.
Japanese red pine	<i>Pinus densiflora</i> Sieb. & Zucc.
bristlecone pine	<i>Pinus longaeva</i> D.K. Bailey
Austrian pine	<i>Pinus nigra</i> Arnold
longleaf pine	<i>Pinus palustris</i> Mill.
ponderosa pine	<i>Pinus ponderosa</i> Laws.
Table Mountain pine	<i>Pinus pungens</i> Lamb.
pitch pine	<i>Pinus rigida</i> Mill.
southwestern white pine	<i>Pinus strobiformis</i> Engelm.
eastern white pine	<i>Pinus strobus</i> L.
Scots pine	<i>Pinus sylvestris</i> L.
loblolly pine	<i>Pinus taeda</i> L.

Virginia pine	<i>Pinus virginiana</i> Mill.
black cherry	<i>Prunus serotina</i> Ehrh.
bigcone Douglas-fir	<i>Pseudotsuga macrocarpa</i> (Vasey) Mayr
Douglas-fir	<i>Pseudotsuga menziesii</i> (Mirb.) Franco
white oak	<i>Quercus alba</i> L.
scarlet oak	<i>Quercus coccinea</i> Muenchh.
southern red oak	<i>Quercus falcata</i> Michx.
swamp chestnut oak	<i>Quercus michauxii</i> Walt.
chestnut oak	<i>Quercus prinus</i> L.
red oak	<i>Quercus rubra</i> L.
post oak	<i>Quercus stellata</i> Wangenh.
black oak	<i>Quercus velutina</i> Lam.
Baldcypress	<i>Taxodium distichum</i> (L.) Rich.
western redcedar	<i>Thuja plicata</i> Donn ex D. Don
northern white-cedar	<i>Thuja occidentalis</i> L.
basswood	<i>Tilia americana</i> L.
eastern hemlock	<i>Tsuga canadensis</i> (L.) Carr.
mountain hemlock	<i>Tsuga mertensiana</i> (Bong.) Carr.

TABLE 4. An example of a text file now available for each of the ITRDB chronologies, with descriptive statistics, site information, and crossdating assessment. Samples 27-66 are omitted for brevity.

```

Chronology file name   : AZ512.CRN
Measurement file name  : AZ512.RWL
Date checked           : 08NOV94
Technician's name      : MARIETTE SEKLECKI
Supervisor's name      : HENRI GRISSINO-MAYER
Beginning year         : 1752
Ending year            : 1989
Principal investigators: GRISSINO-MAYER
Site name              : EMERALD PEAK, PINALENO MOUNTAINS
Site location          : ARIZONA
Species information    : ABLA CORKBARK FIR
Latitude               : 3242 N
Longitude              : 10953 W
Elevation              : 3120 M
Series intercorrelation: 0.796
Avg mean sensitivity   : 0.264
Avg standard deviation : 0.478
Avg autocorrelation   : 0.643
Number dated series    : 66
Segment length tested  : 50
Number problem segments: 1
Pct problem segments   : 0.30

```

```

Are there obvious misdated series? NO
Number possible misdated series   : N/A
Percent misdated series           : 0.00
Do they affect chronology quality? N/A
Recommend withhold from ITRDB?    N/A

```

Comments:

GRU351 #39 LOW CORRELATION PROBABLY DUE TO ERRATIC RING SEQUENCES

1 PART 5: CORRELATION BY SEGMENTS OF SERIES: 18:54 Tue 08 NOV 1994

Correlations of 50-year dated segments, lagged 25 years
Flags: __A = correlation under 0.3281 but highest as dated;
 __B = correlation higher at other than dated position

Seq Series Interval 1750 1775 1800 1825 1850 1875 1900 1925 1950

			1799	1824	1849	1874	1899	1924	1949	1974	1999
1	GRU012	1892 1989	-	-	-	-	-	.75	.76	.87	.88
2	GRU021	1860 1989	-	-	-	-	.66	.70	.84	.91	.93
3	GRU022	1835 1989	-	-	-	.56	.61	.70	.74	.83	.88
4	GRU031	1810 1988	-	-	.64	.66	.78	.80	.82	.83	.81
5	GRU032	1807 1989	-	-	.64	.67	.81	.88	.84	.83	.83
6	GRU033	1752 1989	.42	.50	.70	.76	.80	.83	.86	.86	.84
7	GRU101	1864 1970	-	-	-	-	.75	.88	.90	.83	-
8	GRU102	1909 1989	-	-	-	-	-	-	.85	.85	.78
9	GRU131	1878 1989	-	-	-	-	-	.91	.91	.88	.69
10	GRU132	1875 1989	-	-	-	-	-	.89	.91	.90	.78
11	GRU133	1877 1989	-	-	-	-	-	.90	.89	.88	.83
12	GRU161	1885 1989	-	-	-	-	-	.89	.92	.91	.86
13	GRU162	1870 1989	-	-	-	-	.89	.91	.94	.94	.94
14	GRU163	1888 1989	-	-	-	-	-	.86	.91	.89	.88
15	GRU181	1823 1989	-	-	.75	.78	.87	.91	.93	.93	.87
16	GRU182	1886 1989	-	-	-	-	-	.91	.93	.94	.91
17	GRU183	1799 1989	-	.60	.59	.83	.89	.92	.93	.92	.85
18	GRU191	1861 1989	-	-	-	-	.70	.73	.87	.88	.88
19	GRU192	1887 1989	-	-	-	-	-	.70	.75	.87	.86
20	GRU201	1843 1989	-	-	-	.59	.67	.83	.89	.85	.83
21	GRU202	1848 1989	-	-	-	.69	.73	.78	.89	.86	.83
22	GRU211	1869 1989	-	-	-	-	.45	.50	.91	.77	.75
23	GRU212	1869 1989	-	-	-	-	.46	.53	.84	.84	.85
24	GRU221	1878 1989	-	-	-	-	-	.86	.87	.76	.78
25	GRU222	1872 1989	-	-	-	-	.76	.82	.88	.83	.83
26	GRU241	1890 1989	-	-	-	-	-	.83	.87	.92	.90

DESCRIPTIVE STATISTICS:

Seq	Series	Interval	No. Years	No. Segmt	No. Flags	Corr with Master	Mean msmt	Max msmt	Std dev	Auto corr	Mean sens	Max value	Std dev	Auto corr	AR
												//----- Unfiltered -----\\	//----- Filtered -----\\		
1	GRU012	1892 1989	98	4	0	0.815	1.26	2.14	0.394	0.299	0.295	1.95	0.393	0.023	1
2	GRU021	1860 1989	130	5	0	0.802	1.20	2.07	0.329	0.543	0.206	2.05	0.417	-0.024	1
3	GRU022	1835 1989	155	6	0	0.719	1.01	2.26	0.439	0.799	0.204	2.01	0.359	-0.085	1
4	GRU031	1810 1988	179	7	0	0.758	0.80	2.73	0.530	0.857	0.272	1.94	0.344	-0.029	1
5	GRU032	1807 1989	183	7	0	0.788	0.86	2.71	0.392	0.723	0.250	1.96	0.338	-0.007	1
6	GRU033	1752 1989	238	9	0	0.735	0.72	1.91	0.339	0.740	0.247	2.10	0.352	-0.021	1
7	GRU101	1864 1970	107	4	0	0.789	1.00	2.45	0.422	0.706	0.238	2.17	0.359	-0.027	1
8	GRU102	1909 1989	81	3	0	0.795	1.38	2.61	0.411	0.512	0.242	1.93	0.447	-0.049	1
9	GRU131	1878 1989	112	4	0	0.800	1.05	3.05	0.699	0.856	0.308	1.96	0.385	-0.031	1
10	GRU132	1875 1989	115	4	0	0.835	1.15	4.24	0.772	0.841	0.298	2.08	0.388	-0.048	1
11	GRU133	1877 1989	113	4	0	0.861	1.14	3.07	0.755	0.825	0.296	2.10	0.439	-0.030	1
12	GRU161	1885 1989	105	4	0	0.878	1.10	2.48	0.583	0.743	0.282	1.97	0.488	-0.004	1

13	GRU162	1870	1989	120	5	0	0.916	1.14	5.16	0.562	0.523	0.256	2.07	0.472	-0.014	1	
14	GRU163	1888	1989	102	4	0	0.875	1.35	2.63	0.511	0.612	0.246	1.94	0.431	-0.043	1	
15	GRU181	1823	1989	167	7	0	0.853	0.86	1.67	0.305	0.493	0.291	2.11	0.409	-0.027	1	
16	GRU182	1886	1989	104	4	0	0.913	0.54	1.13	0.219	0.464	0.350	1.89	0.415	-0.039	1	
17	GRU183	1799	1989	191	8	0	0.826	0.89	1.75	0.285	0.438	0.281	1.97	0.332	-0.025	1	
18	GRU191	1861	1989	129	5	0	0.812	0.69	1.64	0.259	0.458	0.298	1.99	0.385	-0.002	1	
19	GRU192	1887	1989	103	4	0	0.787	1.12	3.10	0.633	0.772	0.301	1.97	0.402	0.019	2	
20	GRU201	1843	1989	147	6	0	0.768	0.83	5.55	0.527	0.366	0.342	2.19	0.413	0.017	1	
21	GRU202	1848	1989	142	6	0	0.802	1.10	2.36	0.403	0.481	0.297	2.12	0.467	-0.047	1	
22	GRU211	1869	1989	121	5	0	0.673	0.83	2.60	0.493	0.769	0.333	1.88	0.349	0.011	2	
23	GRU212	1869	1989	121	5	0	0.735	1.19	4.60	0.865	0.760	0.351	1.98	0.340	-0.020	1	
24	GRU221	1878	1989	112	4	0	0.820	0.93	2.52	0.602	0.754	0.350	1.99	0.361	0.021	1	
25	GRU222	1872	1989	118	5	0	0.814	1.58	4.65	0.887	0.660	0.324	2.08	0.420	-0.019	1	
26	GRU241	1890	1989	100	4	0	0.870	1.01	2.03	0.357	0.175	0.358	1.92	0.309	-0.034	1	

Total or mean:				8558	334	1	0.796	1.13	5.55	0.478	0.643	0.264	2.20	0.370	-0.019		--