**Appendix A**: Database built-up.

Following a keyword search (tree AND ring AND mortality AND growth) on Web of Science (Thomson Reuters, USA), 250 studies potentially suitable for a database on growth patterns before tree mortality were selected. Subsequently, publications were selected to those that (i) concerned woody species (244/250), (ii) attributed forest decline to tree mortality (165/244), (iii) presented precisely dated growth ring or basal area increment (BAI) data (135/165), and (iv) involved field studies with mature dead (not simply declining) and surviving trees from the same location (82/135). Studies that clearly attributed the cause of tree mortality to a single 'external' disturbance such as wind-throw – for which we do not expect any relationship between growth and mortality – were further excluded (73/82). The corresponding authors of these 73 publications were contacted to request if they were willing to make their data available for this meta-study, resulting in the collection of 57 datasets to which 6 unpublished datasets meeting the same criteria could be added. Finally, 5 datasets were excluded because cross-dating was not possible, ending with 58 datasets in total (Table A1). Geographical coordinates from the study sites and the cause(s) of tree mortality were obtained from the original publications, and the contributing authors of each publication were asked to confirm this information as well as the existence of proper control trees, *i.e.* sampled dead trees formerly growing next to sampled living trees.

**Table A1**: Main characteristics of the tree-ring datasets compiled in the global database, including the number (nb) of dead and living trees considered. The main sources of mortality were determined from field observations and the following codes were used: D: Drought; B: Biotic agents that predispose (pred.; fungi, mistletoe, defoliator insects) or contribute (cont.; bark beetles, wood-borers) to tree mortality; Others (competition, frost or not Specified). Ranges in tree DBH and age correspond to 95% intervals, or minimum and maximum values when only two trees were sampled. NA indicates that the data is not available. Cambial ages are defined at coring height. Ring-width data was available from cross-sections or from cores. At some sites, only the outermost rings of the cores were measured (Partial; in contrast to Complete).

| species | sites | article | Main mortality source | Nb dead trees | Nb living trees | DBH range (cm) | Cambial age range (years) | Coring height (m) | Period of mortality | Data |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Abies alba*** Mill. | Ravnik | Bigler et al. 2004 | B (pred.) | 12 | 10 | 28-54 | 75-181 | 1.3 | 1988-1998 | Complete |
| | Issole2 | Cailleret et al. 2014 | D | 8 | 12 | 15-30 | 63-140 | 1.3 | 2003-2007 | Complete |
| | Ventoux_TC | Cailleret et al. 2014 | DB (cont.) | 68 | 149 | 16-44 | 47-169 | 1.3 | 1998-2007 | Complete |
| | Ventoux_Dvx1 | Cailleret et al. 2014 | DB (cont.) | 7 | 12 | 18-33 | 53-94 | 1.3 | 2004-2007 | Complete |
| | Ventoux_Dvx2 | Cailleret et al. 2014 | DB (cont.) | 10 | 17 | 20-39 | 48-85 | 1.3 | 2003-2007 | Complete |
| | Ventoux_Dvx3 | Cailleret et al. 2014 | DB (cont.) | 9 | 14 | 17-29 | 45-73 | 1.3 | 2002-2005 | Complete |
| | Vesubie3 | Cailleret et al. 2014 | D | 8 | 9 | 23-37 | 82-112 | 1.3 | 2003-2008 | Complete |
| | Paco_Ezpela_High | Linares et al. 2012 | D | 2 | 3 | 28-35 | 72-115 | 1.3 | 1996-1999 | Complete |
| | Paco_Ezpela_Low | Linares et al. 2012 | D | 3 | 6 | 38-43 | 92-155 | 1.3 | 1998-2000 | Complete |
| | Canalicchio | Lombardi et al. 2008 | Others | 44 | 2 | 10-53 | 43-140 | 1.3 | 1955-1999 | Complete |
| ***Abies balsamea*** (L.) Mill. | Megantic | Filion et al. 1998 | B (pred.) | 44 | 103 | 4-30 | 29-98 | 0.3 | 1913-1987 | Complete |
| | Amqui_1 | Coyea and Margolis 1994 | B (pred.) | 5 | 9 | 10-17 | 62-87 | 1.3 | 1982-1988 | Complete |
| | Amqui_2 | Coyea and Margolis 1994 | B (pred.) | 1 | 3 | 10-14 | 54-84 | 1.3 | 1982 | Complete |
| | Chicoutimi_134 | Coyea and Margolis 1994 | B (pred.) | 8 | 9 | 17-27 | 54-109 | 1.3 | 1974-1987 | Complete |
| | Chicoutimi_950 | Coyea and Margolis 1994 | B (pred.) | 7 | 8 | 12-22 | 36-79 | 1.3 | 1979-1988 | Complete |
| | Degelis_1 | Coyea and Margolis 1994 | B (pred.) | 5 | 7 | 13-23 | 43-99 | 1.3 | 1979-1989 | Complete |
| | Degelis_2 | Coyea and Margolis 1994 | B (pred.) | 10 | 9 | 14-22 | 52-64 | 1.3 | 1977-1989 | Complete |
| | Depot_d'aigle_1 | Coyea and Margolis 1994 | B (pred.) | 1 | 3 | 17-18 | 40-46 | 1.3 | 1989 | Complete |
| | Foret_Montmorency_1 | Coyea and Margolis 1994 | B (pred.) | 7 | 6 | 9-13 | 37-48 | 1.3 | 1983-1987 | Complete |
| | Lac_Gonzague_78 | Coyea and Margolis 1994 | B (pred.) | 5 | 9 | 12-16 | 62-80 | 1.3 | 1978-1989 | Complete |
| | Lac_Humqui_1 | Coyea and Margolis 1994 | B (pred.) | 9 | 10 | 12-22 | 50-64 | 1.3 | 1972-1989 | Complete |
| | Lac_Jacques_Cartier_79 | Coyea and Margolis 1994 | B (pred.) | 2 | 7 | 10-14 | 46-58 | 1.3 | 1977-1986 | Complete |
| | Lac_Jacques_Cartier_2 | Coyea and Margolis 1994 | B (pred.) | 7 | 9 | 8-17 | 40-61 | 1.3 | 1977-1985 | Complete |
| | LaMalbaie_970 | Coyea and Margolis 1994 | B (pred.) | 8 | 11 | 11-19 | 58-83 | 1.3 | 1982-1988 | Complete |
| | LaMalbaie_145 | Coyea and Margolis 1994 | B (pred.) | 8 | 12 | 14-22 | 42-89 | 1.3 | 1972-1985 | Complete |
| | New_Richmond_1 | Coyea and Margolis 1994 | B (pred.) | 5 | 5 | 9-17 | 33-114 | 1.3 | 1981-1989 | Complete |
| | Parc_LaVerendrye | Coyea and Margolis 1994 | B (pred.) | 11 | 9 | 14-28 | 45-69 | 1.3 | 1976-1989 | Complete |
| ***Abies cephalonica*** Loudon | Karpenissi | Papadopoulos et al. 2007 | D | 8 | 12 | 32-51 | 109-165 | 1.3 | 2000-2003 | Complete |
| | Agios_Nikolaos | Papadopoulos et al. 2007 | D | 5 | 6 | 25-32 | 96-143 | 1.3 | 2003 | Complete |
| ***Abies concolor*** (Gordon) Lindl. | LMCC | Das et al. 2007 | Others | 39 | 36 | 1-90 | NA | 1 | 1984-2001 | Partial |
| | LogABCO | Das et al. 2007 | Others | 13 | 11 | 5-43 | NA | 1 | 1989-2001 | Partial |

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|---|---|---|---|---|---|---|---|---|---|---|
| ex Hidebr. | LogPILA | Das et al. 2007 | Others | 8 | 11 | 2-36 | NA | 1 | 1992-2001 | Partial |
| | LogSEGI | Das et al. 2007 | Others | 45 | 50 | 1-90 | NA | 1 | 1990-2001 | Partial |
| | AC_SUAB | Das et al. 2007 | Others | 23 | 20 | 1-124 | NA | 1 | 1985-2001 | Partial |
| | AC_SUCR | Das et al. 2007 | Others | 28 | 34 | 2-79 | NA | 1 | 1986-2001 | Partial |
| | AC_SUPI | Das et al. 2007 | Others | 14 | 13 | 1-54 | NA | 1 | 1988-2001 | Partial |
| | AC_BWM | Kane and Kolb 2014 | D | 23 | 23 | 12-54 | NA | 1.3 | 1996-2007 | Partial |
| | AC_SIT | Kane and Kolb 2014 | D | 2 | 2 | 13-17 | NA | 1.3 | 1997-2004 | Partial |
| | AC_SFP | Kane and Kolb 2014 | D | 1 | 1 | 19-19 | NA | 1.3 | 2004 | Partial |
| ***Abies lasiocarpa*** (Hook.) Nutt | AL_TCRA | Bigler et al. 2007 | D | 4 | 7 | 16-28 | 170-276 | 1.3 | 1920-2003 | Complete |
| | AL_TCLA | Bigler et al. 2007 | D | 3 | 1 | 26-28 | 158-250 | 1.3 | 1944-1975 | Complete |
| | AL_TCRB | Bigler et al. 2007 | D | 11 | 10 | 18-35 | 118-251 | 1.3 | 1937-2002 | Complete |
| | AL_TCLB | Bigler et al. 2007 | D | 1 | 2 | 19-23 | 125-139 | 1.3 | 1988 | Complete |
| | AL_CCRB | Bigler et al. 2007 | D | 1 | 1 | 30-35 | 250-378 | 1.3 | 1980 | Complete |
| | AL_PRLA | Bigler et al. 2007 | D | 6 | 7 | 13-23 | 190-296 | 1.3 | 1935-1987 | Complete |
| | AL_STLB | Bigler et al. 2007 | D | 3 | 2 | 22-30 | 174-223 | 1.3 | 1955-1999 | Complete |
| | AL_BCLA | Bigler et al. 2007 | D | 6 | 9 | 16-27 | 207-299 | 1.3 | 1947-1972 | Complete |
| | AL_MPA | Bigler et al. 2007 | D | 4 | 5 | 20-35 | 94-191 | 1.3 | 1940-2002 | Complete |
| | AL_ZLB | Bigler et al. 2007 | D | 11 | 15 | 17-31 | 76-258 | 1.3 | 1922-2003 | Complete |
| | AL_ZLA | Bigler et al. 2007 | D | 6 | 4 | 20-33 | 138-196 | 1.3 | 1947-2003 | Complete |
| | Adams_Lake | Antos et al. 2008 | Others | 18 | 21 | NA | NA | 1.3 | 1936-1995 | C-sections |
| | Damfino_Creek | Antos et al. 2008 | B (pred.) | 48 | 22 | NA | NA | 1.3 | 1875-1993 | C-sections |
| | Siccamous | Antos et al. 2008 | B (cont.) | 54 | 23 | NA | NA | 1.3 | 1925-1993 | C-sections |
| ***Abies sibirica*** Ledeb. | East_Sayan | Kharuk et al. 2013 | DB (cont.) | 15 | 19 | 14-26 | 73-146 | 1.3 | 1990-2004 | C-sections |
| ***Acer saccharum*** Marshall | Temiscamingue | Hartmann et al. 2007 | B (pred.) | 56 | 322 | 20-48 | NA | 1.3 | 1986-2004 | Complete |
| ***Austrocedrus chilensis*** (D.Don) Pic.Serm. & Bizzarri | CE1 | Amoroso et al. 2012 | DB (pred.) | 13 | 17 | 7-48 | 54-99 | 0.3 | 1961-1999 | Complete |
| | CE2 | Amoroso et al. 2012 | DB (pred.) | 13 | 12 | 9-41 | 52-97 | 0.3 | 1969-1995 | Complete |
| | CR1 | Amoroso et al. 2012 | DB (pred.) | 8 | 27 | 6-38 | 54-74 | 0.3 | 1986-2005 | Complete |
| | CR2 | Amoroso et al. 2012 | DB (pred.) | 10 | 16 | 8-31 | 53-82 | 0.3 | 1980-2001 | Complete |
| | EU1 | Amoroso et al. 2012 | DB (pred.) | 17 | 15 | 6-44 | 56-85 | 0.3 | 1949-2003 | Complete |
| | EU2 | Amoroso et al. 2012 | DB (pred.) | 12 | 13 | 8-40 | 53-73 | 0.3 | 1986-2000 | Complete |
| | K1 | Amoroso et al. 2012 | DB (pred.) | 16 | 11 | 5-40 | 51-91 | 0.3 | 1961-2000 | Complete |
| | PP1 | Amoroso et al. 2012 | DB (pred.) | 14 | 33 | 5-49 | 51-69 | 0.3 | 1964-2003 | Complete |
| | PP2 | Amoroso et al. 2012 | DB (pred.) | 44 | 21 | 5-31 | 49-94 | 0.3 | 1960-2002 | Complete |
| | PP4 | Amoroso et al. 2012 | DB (pred.) | 7 | 12 | 7-41 | 60-91 | 0.3 | 1968-1996 | Complete |
| | RQ1 | Amoroso et al. 2012 | DB (pred.) | 29 | 12 | 6-45 | 59-109 | 0.3 | 1952-2001 | Complete |
| | RQ2 | Amoroso et al. 2012 | DB (pred.) | 17 | 6 | 10-43 | 51-95 | 0.3 | 1967-1999 | Complete |
| | Confluencia | Villalba and Veblen 1998 | D | 26 | 2 | NA | 49-177 | 1.3 | 1941-1957 | C-sections |
| | Centinela | Villalba and Veblen 1998 | D | 5 | 4 | NA | 103-295 | 1.3 | 1939-1958 | C-sections |
| | Paso_del_viento | Villalba and Veblen 1998 | D | 5 | 1 | NA | 103-211 | 1.3 | 1943-1959 | C-sections |
| ***Castanea sativa*** Mill. | Eisack_Valley | Waldboth and Oberhuber 2009 | DB (pred.) | 18 | 14 | 71-109 | NA | 1.3 | 1970-2001 | Complete |
| ***Cupressus nootkatensis*** | BL_Prince_Rupert | Stan et al. 2011 | Others | 16 | 13 | 19-54 | NA | 0.3 | 1948-2001 | Complete |
| | HC_Prince_Rupert | Stan et al. 2011 | Others | 17 | 16 | 19-75 | NA | 0.3 | 1990-2005 | Complete |

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|---|---|---|---|---|---|---|---|---|---|---|
| D.Don | SC_Prince_Rupert | Stan et al. 2011 | Others | 15 | 16 | 18-50 | NA | 0.3 | 1957-2001 | Complete |
| | WB_Prince_Rupert | Stan et al. 2011 | Others | 6 | 12 | 28-63 | NA | 0.3 | 1989-2002 | Complete |
| ***Fagus sylvatica*** L. | Borsberg | Gillner et al. 2013 | DB (pred.) | 15 | 26 | 22-79 | 49-186 | 1.3 | 1982-2003 | Complete |
| | Montedimezzo | Lombardi et al. 2008 | Others | 37 | 4 | 9-66 | 30-184 | 1.3 | 1947-1998 | Complete |
| ***Nothofagus betuloides*** (Mirb.) Oerst. | Navarino_Island | Lombardi et al. 2011 | Others | 33 | 13 | 7-46 | 72-286 | 1.3 | 1838-2005 | Complete |
| ***Nothofagus dombeyi*** (Mirb.) Oerst. | Cerro_Otto | Suarez et al. 2004 | D | 44 | 41 | 11-46 | 21-109 | 1.3 | 1998 | Complete |
| ***Picea abies*** (L.) H.Karst. | DP1 | Aakala and Kuuluvainen 2011 | DB (cont.) | 17 | 13 | 13-34 | 116-265 | 1.3-6 | 1999-2003 | Complete |
| | DP2 | Aakala and Kuuluvainen 2011 | DB (cont.) | 13 | 9 | 13-29 | 103-247 | 1.3-6 | 2001-2006 | Complete |
| | DP3 | Aakala and Kuuluvainen 2011 | DB (cont.) | 13 | 9 | 11-28 | 137-249 | 1.3-6 | 2000-2005 | Complete |
| | DP4 | Aakala and Kuuluvainen 2011 | DB (cont.) | 6 | 7 | 11-33 | 123-243 | 1.3-6 | 2001-2005 | Complete |
| | DP5 | Aakala and Kuuluvainen 2011 | DB (cont.) | 11 | 8 | 13-29 | 113-177 | 1.3-6 | 1999-2007 | Complete |
| | Boedmeren | Bigler and Bugmann 2004 | Others | 7 | 11 | 26-56 | 103-393 | 1.3 | 1940-1994 | Complete |
| | Dischma | Bigler and Bugmann 2004 | Others | 12 | 19 | 11-55 | 46-272 | 1.3 | 1982-2000 | Complete |
| | Fluehla | Bigler and Bugmann 2004 | Others | 16 | 22 | 14-45 | 69-319 | 1.3 | 1972-1998 | Complete |
| | Scatle | Bigler and Bugmann 2004 | Others | 6 | 8 | 16-39 | 100-300 | 1.3 | 1955-1997 | Complete |
| | Bystra | Janda et al. submitted | B (cont.) | 12 | 15 | 22-52 | 68-294 | 1 | 2003-2010 | Complete |
| | Hlinna | Janda et al. submitted | B (cont.) | 43 | 78 | 10-52 | 34-226 | 1 | 2000-2012 | Complete |
| | Medodoly | Janda et al. submitted | B (cont.) | 33 | 10 | 24-60 | 102-214 | 1 | 2009-2012 | Complete |
| | Pilsko | Janda et al. submitted | B (cont.) | 14 | 20 | 33-62 | 130-224 | 1 | 2007-2012 | Complete |
| | Ticha | Janda et al. submitted | B (cont.) | 33 | 57 | 11-60 | 24-202 | 1 | 2007-2011 | Complete |
| | Sipoo201 | Makinen et al. 2001 | D | 6 | 13 | NA | NA | 1.3 | 1977-1997 | Complete |
| | Sipoo202 | Makinen et al. 2001 | D | 4 | 7 | NA | NA | 1.3 | 1989-1997 | Complete |
| | Sipoo203 | Makinen et al. 2001 | D | 8 | 13 | NA | NA | 1.3 | 1988-1997 | Complete |
| | Sipoo204 | Makinen et al. 2001 | D | 4 | 8 | NA | NA | 1.3 | 1991-1995 | Complete |
| | Sipoo205 | Makinen et al. 2001 | D | 14 | 30 | NA | NA | 1.3 | 1987-1997 | Complete |
| | Hollola206 | Makinen et al. 2001 | D | 2 | 5 | NA | NA | 1.3 | 1995 | Complete |
| | Hollola207 | Makinen et al. 2001 | D | 3 | 4 | NA | NA | 1.3 | 1992-1997 | Complete |
| | Hollola208 | Makinen et al. 2001 | D | 3 | 6 | NA | NA | 1.3 | 1994-1996 | Complete |
| | Merimasku | Makinen et al. 2001 | D | 12 | 19 | NA | NA | 1.3 | 1983-1997 | Complete |
| | Askainen | Makinen et al. 2001 | D | 8 | 17 | NA | NA | 1.3 | 1997 | Complete |
| | Vahto | Makinen et al. 2001 | D | 7 | 13 | NA | NA | 1.3 | 1993-1997 | Complete |
| | Paimio | Makinen et al. 2001 | D | 3 | 4 | NA | NA | 1.3 | 1990-1994 | Complete |
| | Lammi | Makinen et al. 2001 | D | 12 | 19 | NA | NA | 1.3 | 1986-1996 | Complete |
| ***Picea engelmanii*** Parry ex Engelm. | PE_TCRA | Bigler et al. 2007 | D | 1 | 1 | 27-32 | 237-293 | 1.3 | 1957 | Complete |
| | PE_TCLB | Bigler et al. 2007 | D | 2 | 2 | 26-32 | 167-229 | 1.3 | 2000-2003 | Complete |
| | PE_CCLB | Bigler et al. 2007 | D | 1 | 1 | 25-29 | 180-228 | 1.3 | 1962 | Complete |
| | PE_CCRB | Bigler et al. 2007 | D | 1 | 2 | 22-26 | 277-404 | 1.3 | 1958 | Complete |
| | PE_CCRA | Bigler et al. 2007 | D | 1 | 2 | 21-26 | 192-238 | 1.3 | 1963 | Complete |
| | PE_PRLA | Bigler et al. 2007 | D | 1 | 1 | 26-28 | 334-366 | 1.3 | 1998 | Complete |
| | PE_PRLB | Bigler et al. 2007 | D | 5 | 5 | 22-48 | 262-465 | 1.3 | 1928-1983 | Complete |
| | PE_STLB | Bigler et al. 2007 | D | 1 | 1 | 21-22 | 214-225 | 1.3 | 1979 | Complete |
| | PE_BCLA | Bigler et al. 2007 | D | 4 | 11 | 19-28 | 235-313 | 1.3 | 1938-1996 | Complete |

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|---|---|---|---|---|---|---|---|---|---|---|
| | PE_MPA | Bigler et al. 2007 | D | 7 | 7 | 21-54 | 134-243 | 1.3 | 1957-2002 | Complete |
| | PE_MPB | Bigler et al. 2007 | D | 2 | 2 | 36-50 | 300-435 | 1.3 | 1944-1960 | Complete |
| | PE_ZLB | Bigler et al. 2007 | D | 1 | 1 | 22-31 | 209-237 | 1.3 | 1961 | Complete |
| | PE_ZLA | Bigler et al. 2007 | D | 7 | 10 | 21-40 | 176-235 | 1.3 | 1976-1991 | Complete |
| ***Picea glauca*** (Moench) Voss | Site1_Tri | Caccianiga et al. 2008 | B (cont.) | 19 | 8 | 22-48 | 166-334 | <0.3 | 1944-1997 | C-sections |
| | Site2_Oxy | Caccianiga et al. 2008 | B (cont.) | 18 | 18 | 13-35 | 119-301 | <0.3 | 1770-2001 | C-sections |
| | Site3_Sib | Caccianiga et al. 2008 | B (cont.) | 15 | 7 | 7-42 | 80-328 | <0.3 | 1815-1995 | C-sections |
| ***Picea mariana*** (Mill.) Britton, Sterns & Poggenb. | D3 | Westwood et al. 2012 | B (pred.) | 5 | 5 | 10-15 | 103-117 | 1.3 | 1996-2004 | Complete |
| | P3 | Westwood et al. 2012 | B (pred.) | 5 | 5 | 11-22 | 104-117 | 1.3 | 1998-2007 | Complete |
| | D2 | Westwood et al. 2012 | B (pred.) | 4 | 5 | 12-17 | 104-118 | 1.3 | 2003-2007 | Complete |
| | P2 | Westwood et al. 2012 | B (pred.) | 5 | 5 | 11-20 | 91-118 | 1.3 | 1983-2006 | Complete |
| ***Pinus banksiana*** Lamb. | PMB | Metsaranta and Lieffers 2008 | Others | 123 | 167 | 2-12 | 20-66 | 1.3 | 1957-2002 | Complete |
| | PSK | Metsaranta and Lieffers 2008 | Others | 94 | 133 | 3-16 | 16-83 | 1.3 | 1933-2003 | Complete |
| | RMB | Metsaranta and Lieffers 2008 | Others | 68 | 92 | 4-18 | 19-70 | 1.3 | 1955-2001 | Complete |
| | RSK | Metsaranta and Lieffers 2008 | Others | 56 | 88 | 4-19 | 21-82 | 1.3 | 1943-2001 | Complete |
| ***Pinus brutia*** Ten. | Limnionas (Diss1) | Sarris unpub | D | 5 | 1 | 10-16 | 25-47 | 1.3 | 1999-2000 | Complete |
| ***Pinus contorta*** Douglas ex Loudon | PC_CCLB | Bigler et al. 2007 | Others | 2 | 4 | 31-38 | 185-216 | 1.3 | 1973-1994 | Complete |
| | PC_STLB | Bigler et al. 2007 | Others | 5 | 6 | 23-37 | 169-256 | 1.3 | 1916-1977 | Complete |
| | Col_M3 | Smith et al. 2012 | B (cont.) | 8 | 1 | 21-40 | 95-182 | 1.3 | 1982-2008 | Complete |
| | Col_M6 | Smith et al. 2012 | B (cont.) | 17 | 10 | 13-30 | 64-124 | 1.3 | 1975-1994 | Complete |
| | Col_P1 | Smith et al. 2012 | B (cont.) | 20 | 5 | 11-31 | 81-181 | 1.3 | 1979-2005 | Complete |
| | Col_P2 | Smith et al. 2012 | B (cont.) | 12 | 1 | 15-42 | 90-136 | 1.3 | 1978-2005 | Complete |
| ***Pinus flexilis*** E.James | PF_SFP | Kane and Kolb 2014 | D | 13 | 11 | 12-58 | NA | 1.3 | 1996-2005 | Partial |
| | PF_SIT | Kane and Kolb 2014 | D | 7 | 7 | 11-47 | NA | 1.3 | 1997-2006 | Partial |
| | Col_P3 | Smith et al. 2012 | D | 9 | 1 | 16-28 | 48-121 | 1.3 | 1975-2002 | Complete |
| ***Pinus halepensis*** Mill. | Yatir_forest | Klein unpub | D | 11 | 18 | 9-27 | 33-47 | 1.3 | 2007-2008 | Complete |
| | Lahav | Dorman et al. 2015 | D | 19 | 8 | 16-26 | 43-51 | 1.3 | 2005-2010 | Complete |
| ***Pinus lambertiana*** Douglas | PL_SUAB | Das et al. 2007 | Others | 23 | 20 | 3-53 | NA | 1 | 1976-2001 | Partial |
| | PL_SUCR | Das et al. 2007 | Others | 59 | 58 | 1-98 | NA | 1 | 1982-2001 | Partial |
| | PL_SUPI | Das et al. 2007 | Others | 36 | 31 | 1-87 | NA | 1 | 1987-2001 | Partial |
| ***Pinus mugo*** Turra | Swiss_National_Park_Engadine_Valley | Cherubini et al. 2002 | B (pred.) | 25 | 63 | NA | 89-191 | 1 | 1973-1995 | Complete |
| ***Pinus ponderosa*** Douglas ex C.Lawson | Flagstaff_1 | Kane and Kolb 2010 | B (cont.) | 4 | 4 | 17-50 | NA | 1.3 | 2000-2007 | Partial |
| | Flagstaff_139 | Kane and Kolb 2010 | B (cont.) | 4 | 4 | 20-51 | NA | 1.3 | 2003-2006 | Partial |
| | Flagstaff_214 | Kane and Kolb 2010 | B (cont.) | 4 | 4 | 17-36 | NA | 1.3 | 2003-2006 | Partial |
| | Flagstaff_243 | Kane and Kolb 2010 | B (cont.) | 4 | 4 | 20-29 | NA | 1.3 | 2001-2004 | Partial |
| | Flagstaff_276 | Kane and Kolb 2010 | B (cont.) | 2 | 2 | 15-33 | NA | 1.3 | 2002-2004 | Partial |
| | Flagstaff_278 | Kane and Kolb 2010 | B (cont.) | 3 | 3 | 22-35 | NA | 1.3 | 2005-2007 | Partial |
| | Flagstaff_280 | Kane and Kolb 2010 | B (cont.) | 4 | 4 | 18-40 | NA | 1.3 | 2001-2007 | Partial |
| ***Pinus sibirica*** Du Tour | BI2012 | Kharuk et al. 2013 | DB (cont.) | 18 | 25 | 22-53 | 115-234 | 1.3 | 1998-2010 | C-sections |
| ***Pinus sylvestris*** L. | Gliswald_Gamsen | Bigler et al. 2006 | D | 21 | 25 | 8-30 | 44-89 | 1.3 | 1990-2001 | Complete |
| | Rohrberg_Eyholz | Bigler et al. 2006 | D | 25 | 27 | 11-31 | 45-118 | 1.3 | 1988-1998 | Complete |
| | Valsain | Gea-Izquierdo et al. 2014 | D | 15 | 12 | 43-69 | NA | 1.3 | 1977-2012 | Complete |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Valsain_high | Gea-Izquierdo et al. 2014 | D | 16 | 16 | 32-61 | NA | 1.3 | 1987-2011 | Complete |
| | Arcalis_dry_transect | Heres et al. 2012 | D | 24 | 19 | 25-41 | NA | 1.3 | 1994-2008 | Complete |
| | Prades_dry_transect | Heres et al. 2012 | D | 11 | 19 | 24-38 | NA | 1.3 | 1997-2008 | Complete |
| | Tschirgant | Oberhuber et al. 2001 | DB (pred.) | 58 | 106 | 9-24 | 83-186 | 1.3 | 1959-1996 | Complete |
| | Pfynwald | Rohner unpub | D | 53 | 52 | 8-26 | 60-140 | 1.3 | 1981-2006 | Complete |
| | Solano_de_la_Vega_High | Sanguesa-Barreda et al. 2013 | DB (pred.) | 1 | 2 | 27-29 | 78-84 | 1.3 | 1993 | Complete |
| | Solano_de_la_Vega_Low | Sanguesa-Barreda et al. 2013 | DB (pred.) | 3 | 23 | 15-20 | 34-64 | 1.3 | 2001-2006 | Complete |
| | Puerto_de_Gidar_Low | Sanguesa-Barreda et al. 2013 | DB (pred.) | 3 | 6 | 22-28 | 40-109 | 1.3 | 2003-2004 | Complete |
| | Puerto_de_Gidar_High | Sanguesa-Barreda et al. 2013 | DB (pred.) | 4 | 6 | 21-27 | 31-58 | 1.3 | 1994-2002 | Complete |
| ***Populus tremuloides*** Michx. | PT_BWM | Kane and Kolb 2014 | D | 7 | 7 | 10-31 | NA | 1.3 | 1999-2007 | Partial |
| | PT_SIT | Kane and Kolb 2014 | D | 4 | 5 | 16-22 | NA | 1.3 | 2001-2005 | Partial |
| | PT_SFP | Kane and Kolb 2014 | D | 46 | 48 | 16-38 | NA | 1.3 | 1996-2007 | Partial |
| ***Pseudotsuga menziesii*** (Mirb.) Franco | PM_SIT | Kane and Kolb 2014 | D | 28 | 28 | 10-45 | NA | 1.3 | 1998-2006 | Partial |
| | PM_SFP | Kane and Kolb 2014 | D | 29 | 28 | 11-86 | NA | 1.3 | 1996-2006 | Partial |
| | PM_BWM | Kane and Kolb 2014 | D | 6 | 6 | 32-43 | NA | 1.3 | 2001-2006 | Partial |
| ***Quercus cerris*** L. | Vojvodina | Stojanović et al. 2015 | D | 10 | 8 | NA | NA | 8 | 2012-2013 | C-sections |
| ***Quercus macrocarpa*** Michx. | Glacial_Lakes_State_Park | Wyckoff and Bowers 2010 | D | 21 | 15 | 15-30 | NA | 0.3 | 2002 | Partial |
| | Maplewood_State_Park | Wyckoff and Bowers 2010 | D | 5 | 6 | 24-30 | NA | 0.3 | 2002 | Partial |
| ***Quercus petraea*** (Matt.) Liebl. | Sikfokut | Meszaros unpub | Others | 25 | 156 | 2-36 | 52-104 | 1.3 | 1954-2010 | Complete |
| | Runcu | Petritan et al. unpub | Others | 96 | 110 | 32-72 | 144-208 | 1.3 | 1965-2013 | Complete |
| ***Quercus pyrenaica*** Willd. | QP_Valsain | Gea-Izquierdo et al. 2014 | D | 11 | 10 | 34-53 | NA | 1.3 | 2003-2011 | Complete |
| ***Quercus robur*** L. | Cigonca | Levanic et al. 2011 | D | 1 | 1 | 44-44 | 120-121 | 4-5 | 2001 | C-sections |
| | Chojnow_Forest_District | Tulik 2014 | D | 2 | 2 | 14-17 | 33-36 | 1.3 | 2008 | C-sections |
| ***Quercus rubra*** L. | Red_Star-Ozarks | Haavik et al. 2011 | DB (cont.) | 17 | 73 | 14-31 | 63-85 | 1.3 | 1977-2007 | Complete |
| | Mule_Farm-Ozarks | Haavik et al. 2011 | DB (cont.) | 27 | 88 | 22-49 | 64-120 | 1.3 | 1991-2007 | Complete |
| | Ozarks-Cowell | Haavik et al. 2011 | DB (cont.) | 17 | 69 | 16-33 | 57-99 | 1.3 | 1979-2003 | Complete |
| | Ozarks-Stack_Rock | Haavik et al. 2011 | DB (cont.) | 19 | 71 | 18-42 | 64-95 | 1.3 | 1978-2007 | Complete |
| | Ouachitas-Dry_Creek_Mountain | Haavik et al. 2011 | DB (cont.) | 12 | 74 | 18-34 | 64-106 | 1.3 | 1989-2007 | Complete |
| | Ouachitas-Flatside | Haavik et al. 2011 | DB (cont.) | 18 | 62 | 17-33 | 63-85 | 1.3 | 1989-2007 | Complete |
| | Ouachitas-Talimena | Haavik et al. 2011 | DB (cont.) | 17 | 86 | 15-35 | 76-121 | 1.3 | 1996-2007 | Complete |
| ***Tamarix chinensis*** Lour. | Allen's_Patch | Hultine et al. 2013 | B (pred.) | 15 | 15 | 5-10 | 16-25 | 1.5 | 2004-2009 | C-sections |
| | Army_Drain | Hultine et al. 2013 | B (pred.) | 6 | 6 | 6-12 | 30-51 | 1.5 | 2005-2008 | C-sections |
| | Moab | Hultine et al. 2013 | B (pred.) | 10 | 10 | 7-14 | 17-36 | 1.5 | 2008-2010 | C-sections |

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## Appendix B

**Table B1** Species-specific hydraulic safety margin (HSM50), wood density (WD), axial and total amount of wood parenchyma (Par.), Huber Value (Hub. Val.), maximum longevity (Long.), drought-tolerance (DrTol) and shade-tolerance (ShTol) taken from the ForClim model (FC) and from Niinemets and Valladeres (2006; NV06)

| species | group | HSM50 (MPa)* | WD ($g.cm^{-3}$) | Axial Par. (%) | Total Par. (%) | Hub. Val. ($10^{-5}$) | Long. (ys) | DrTol FC | DrTol NV06 | ShTol FC† | ShTol NV06 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Abies alba* | Gymno | -0.35 | 0.35 | 0.15 | 10.15 | 5.88 | 356 | 0.23 | 1.81 | 9 | 4.6 |
| *Abies balsamea* | Gymno | - | 0.41 | 0 | 5.68 | - | 150 | 0.09 | 1 | 9 | 5.01 |
| *Abies cephalonica* | Gymno | 1.55 | - | - | - | - | 114 | - | - | - | - |
| *Abies concolor* | Gymno | - | 0.4 | 0 | 9.48 | - | 550 | - | 1.91 | - | 4.33 |
| *Abies lasiocarpa* | Gymno | 1.84 | 0.32 | - | - | 33.4 | 250 | 0.37 | 2.02 | 7 | 4.83 |
| *Abies sibirica* | Gymno | - | 0.31 | - | - | - | 800 | - | 1.41 | - | 4.09 |
| *Acer saccharum* | Angio | 1.66 | 0.68 | 0.1 | 18 | 11.3 | 420 | 0.23 | 2.25 | 8.6 | 4.76 |
| *Austrocedrus chilensis* | Gymno | 8.74 | 0.43 | - | - | - | 850 | 0.42 | - | 1 | - |
| *Castanea sativa* | Angio | - | 0.46 | - | - | - | 1834 | 0.33 | 3.46 | 5 | 3.15 |
| *Cupressus nootkatensis* | Gymno | - | 0.46 | - | - | - | 601 | - | 2 | - | 4.15 |
| *Fagus sylvatica* | Angio | 0.83 | 0.59 | 6.17 | 25.99 | - | 930 | 0.25 | 2.4 | 9 | 4.56 |
| *Nothofagus betuloides* | Angio | - | 0.47 | - | - | - | - | 0.1 | - | 4 | - |
| *Nothofagus dombeyi* | Angio | 1.73 | 0.56 | - | - | 51.3 | 700 | 0.31 | - | 1 | - |
| *Picea abies* | Gymno | -0.36 | 0.37 | 0.60 | 10.75 | 73.7 | 600 | 0.15 | 1.75 | 5 | 4.45 |
| *Picea engelmannii* | Gymno | - | 0.35 | 0 | 5.91 | - | 550 | 0.41 | 2.58 | 7 | 4.53 |
| *Picea glauca* | Gymno | - | 0.45 | 0 | 7.1 | 62.9 | 350 | 0.24 | 2.88 | 7.6 | 4.15 |
| *Picea mariana* | Gymno | - | 0.43 | - | - | - | 250 | 0.21 | 2 | 7.5 | 4.08 |
| *Pinus banksiana* | Gymno | - | 0.46 | 0 | 8.1 | - | 150 | 0.31 | 4 | 3.2 | 1.36 |
| *Pinus brutia* | Gymno | - | - | - | - | - | - | 0.45 | - | 3 | - |
| *Pinus contorta* | Gymno | 1.97 | 0.43 | 0 | 5.7 | 73.5 | 300 | 0.37 | 4.04 | 1 | 1.73 |
| *Pinus flexilis* | Gymno | 1.71 | 0.42 | - | - | - | 1700 | - | 4.72 | - | 1.56 |
| *Pinus halepensis* | Gymno | 0.51 | 0.46 | - | - | 75.9 | 150 | - | 4.97 | - | 1.35 |
| *Pinus lambertiana* | Gymno | - | 0.38 | 0 | 5.7 | - | 600 | - | 2.67 | - | 2.66 |
| *Pinus mugo* | Gymno | 1.79 | - | - | - | - | - | 0.37 | 4.23 | 1 | 1.72 |
| *Pinus ponderosa* | Gymno | 0.67 | 0.42 | 0 | 6.78 | 49.4 | 726 | 0.53 | 4.32 | 3 | 1.64 |
| *Pinus sibirica* | Gymno | - | 0.44 | - | - | - | 850 | - | 3.13 | - | 1.93 |
| *Pinus sylvestris* | Gymno | 1.33 | 0.40 | 1.4 | 6.9 | 62.0 | 760 | 0.37 | 4.34 | 1 | 1.67 |
| *Populus tremuloides* | Angio | 0.73 | 0.40 | - | - | 19.1 | 213 | 0.19 | 1.77 | 2.9 | 1.21 |
| *Pseudotsuga menziesii* | Gymno | 1.82 | 0.46 | 0 | 6.7 | 41.5 | 627 | 0.41 | 2.62 | 3 | 2.78 |
| *Quercus cerris* | Angio | - | 0.70 | - | - | - | 616 | 0.33 | 4.29 | 3 | 2.55 |
| *Quercus macrocarpa* | Angio | - | 0.67 | 20.6 | 32.6 | - | 440 | 0.29 | 3.85 | 5.3 | 2.71 |
| *Quercus petraea* | Angio | 0.33 | 0.57 | 14 | 37 | - | 866 | 0.25 | 3.02 | 3 | 2.73 |
| *Quercus pyrenaica* | Angio | - | 0.84 | 15 | 48 | - | 316 | 0.33 | - | 3 | - |
| *Quercus robur* | Angio | -0.14 | 0.57 | 17.54 | 33.95 | - | 930 | 0.33 | 2.95 | 1 | 2.45 |
| *Quercus rubra* | Angio | 0.31 | 0.66 | 17.52 | 32.69 | 17.5 | 326 | 0.24 | 2.88 | 5.4 | 2.75 |
| *Tamarix chinensis* | Angio | - | - | - | - | - | - | - | 4.1 | - | 1.35 |

* The lethal water potential of angiosperms correspond to the potential at 88-90% of loss of conductivity (Urli et al. 2013; Li et al. 2016), while it is closer to the potential at 50% of loss of conductivity for gymnosperms (Brodribb and Cochard 2009). However,

considering the low availability of HSM88/90 data for angiosperms, and a high correlation between HSM50 and HSM88 values across species (r=0.96; p<0.001 on 16 species), we decided to analyze HSM50 values for both species groups. See also Anderegg et al. (2016).

† Shade tolerance values from ForClim [1-9] were re-ordered so that high values correspond to species with high tolerance. 'FC' parameters were taken from the ForClim model: Bugmann and Solomon (2000), Morin et al. (2011), and Martin-Benito et al. (in prep.), while 'NV06' parameters were issue from Niinemets and Valladeres (2006).

HSM50 and Huber values were available from the Xylem Functional Traits Database (Choat et al. 2012). WD from Chave et al. (2009), and Total and Axial Parenchyma values from Morris et al. (2016) and Rodríguez-Calcerrada et al. (2015).

**Table B2**: Correlations among species parameters and wood anatomical variables: hydraulic safety margin (HSM50), wood density (WD), axial and total amount of wood parenchyma (Par.), Huber Value (Hub. Val.), maximum longevity (Long.), drought-tolerance (DrTol) and shade-tolerance (ShTol) available from the ForClim model (FC) and from Niinemets and Valladeres (2006; NV06)

| | HSM50 | WD | Tot. Par. | Ax. Par. | Hub. Value | Long. | DrTol_ FC | DrTol_ NV06 | ShTol_ FC | ShTol_ NV06 |
|---|---|---|---|---|---|---|---|---|---|---|
| HSM50 | | | | | | | | | | |
| WD | ns | | | | | | | | | |
| Tot. Par. | ns | 0.88 *** | | | | | | | | |
| Ax. Par. | ns | 0.75 *** | 0.91 *** | | | | | | | |
| Hub. Value | ns | ns | -0.59 (*) | ns | | | | | | |
| Long. | ns | ns | ns | ns | ns | | | | | |
| DrTol_FC | 0.44 (*) | ns | ns | ns | ns | ns | | | | |
| DrTol_NV06 | ns | ns | ns | ns | 0.61 * | ns | 0.69 *** | | | |
| ShTol_FC | ns | ns | ns | ns | -0.55 (*) | ns | -0.48 * | -0.69 *** | | |
| ShTol_NV06 | ns | ns | ns | ns | Ns | ns | -0.45 * | -0.78 *** | 0.89 *** | |

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## Appendix C

Following the methodology of Bigler (2016), two modeling approached were used to analyze the species-specific relationships between the longevity of dead trees and their mean early growth rate (first 50 years of tree's life). Here, we only considered trees older than 50 years.

1) For every species, we fitted one generalized linear mixed model (GLMM) with Poisson distribution (tree longevity data were count; log link function) in which tree longevity was function of early growth rate (fixed effect) and site (random effect on the intercept). The sign and extent of the relationship was based on the estimates of the fixed effect of the GL(M)Ms. In this case, we assumed that the relationship is species-specific and not dependent on site conditions.
2) For every site, we fitted one generalized linear model (GLM) with Poisson distribution in which tree longevity was function of mean early growth rate. Here, each relationship is site- and species-specific.

There was no universal intra-specific trade-off or synergy between early growth and longevity of dead trees. At both species and site levels, the estimates of the GL(M)Ms (slope) were equally distributed among positive and negative values (Fig. C1a, b) using both RW data and BAI data (Table C1). For most of the species and sites, the uncertainty in the sign and magnitude of the relationship was rather high because of the low number of dead trees sampled (especially when sampling size is below 20 trees; Fig. C1c, d). Moreover, most of the samples did not cover the entire range in life-history strategies of the species in terms of early growth rates and tree age (Fig. C2a, b). Both conditions were almost never fulfilled which prevented further analysis on the species traits related with positive or negative relationships, but relationships tend to be non-significant or negative when the sample covered at least 60% of the range in early growth rates.

**Table C1**: Number of species that showed negative, positive or non-significant relationship (estimate of the fixed effect of the GL(M)M) between mean early growth rate and tree longevity.

| | by species | | by site | |
|---|---|---|---|---|
| | RW data (n=22) | BAI data (n=16) | RW data (n=97) | BAI data (n=71) |
| Negative; $p \leq 0.05$ | 6 | 3 | 20 | 13 |
| Positive; $p \leq 0.05$ | 4 | 4 | 10 | 7 |
| Non-significant; $p > 0.05$ | 12 | 9 | 67 | 51 |

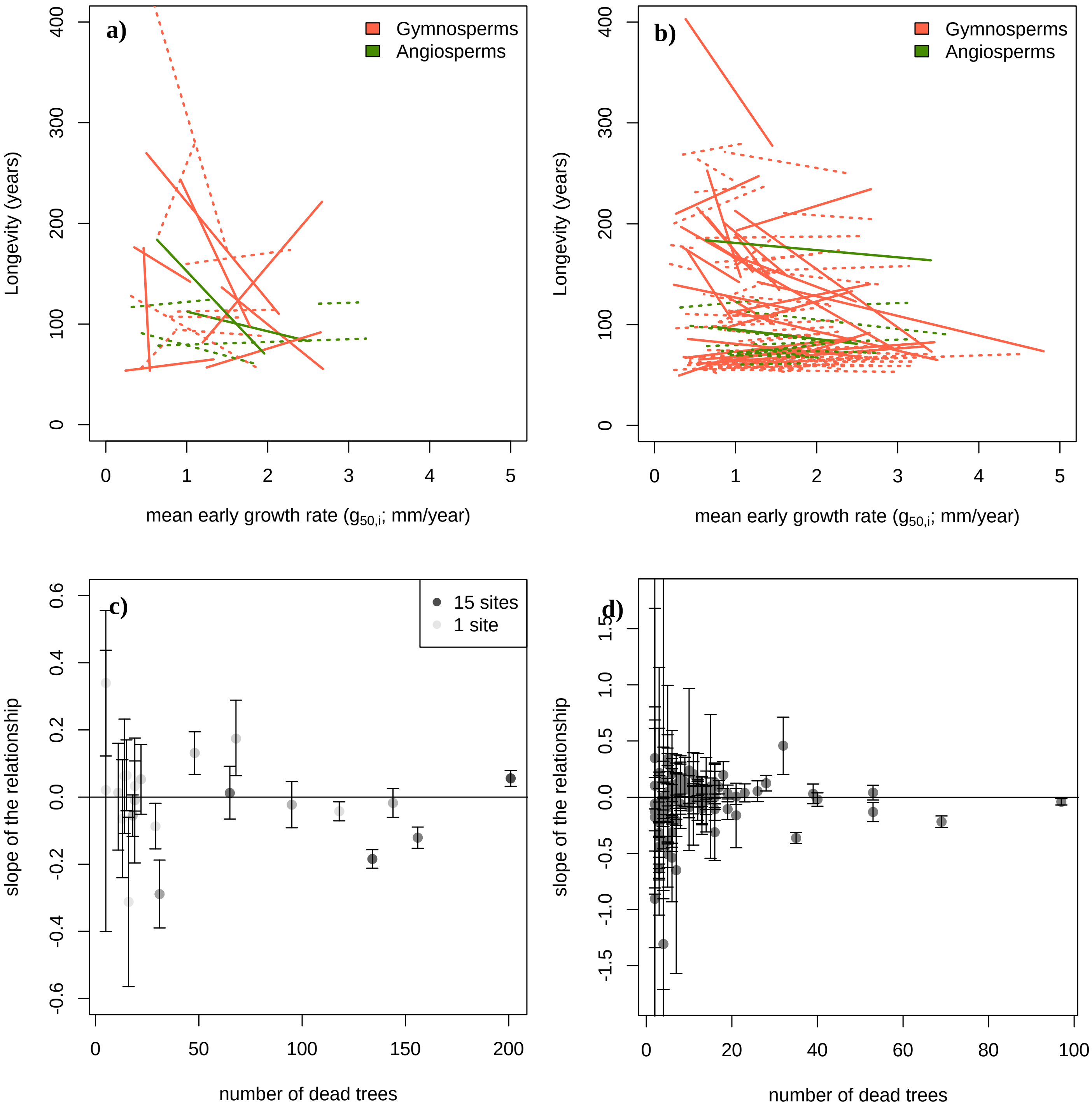

**Figure C1:** Species-specific (a; n=22) and site-specific (b; n=97) relationships between longevity of dead trees and mean early growth rate ($g_{50,i}$) calculated using RW data. Regression lines (predicted values) are based on the GLMMs (a) and GLMs (b). Solid and dotted lines respectively indicate significant and non-significant changes in tree longevity with early growth. Change in the slope of the species-specific (c) and site-specific (d) linear regressions with the number of dead trees considered. 95% confidence intervals of the slope values are represented with error bars. The number of sites considered in the species-specific relationships is indicated with gray colors, from 1 site (light gray) to 15 sites (black).

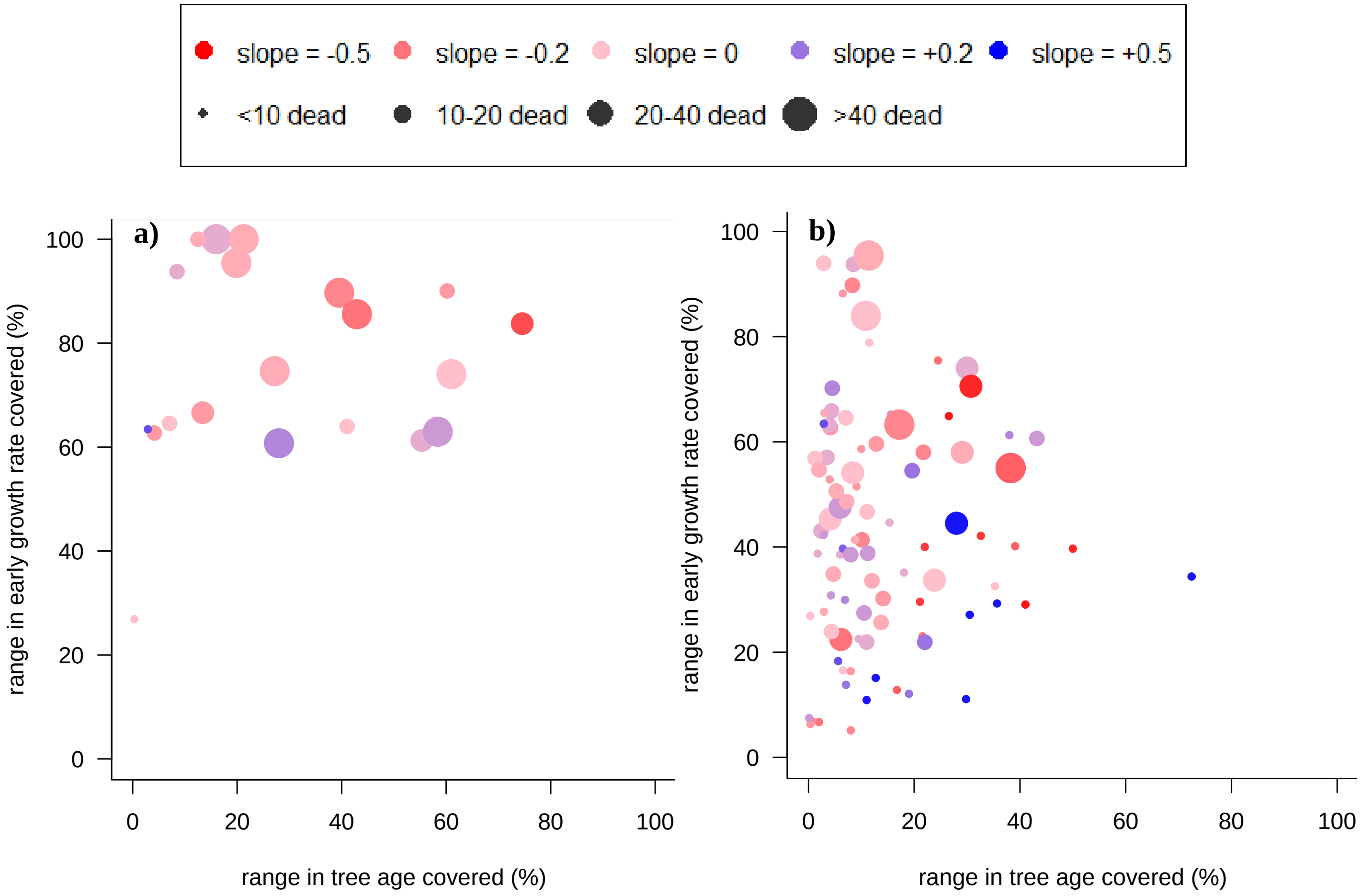

**Figure C2**: Change in the slope (symbol color) of the species-specific (a) and site-specific (b) relationships with, the percentage of the range in species-specific tree age and in early growth rates covered in the dataset (y-axis), and the number of dead trees sampled (size of the symbols). The maximal range of species-specific early growth rates is calculated using both dead and living trees, while the range in tree age was based on the maximum longevity available in Table B1.

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**Appendix D**: Effect of the sampling scheme used to generate the pairs of dying and surviving trees on the $g_{f,i}$ values

Growth ratios were standardized by comparing growth of dying and surviving trees with similar DBH at the year of death (*sampling initial*). To assess if $g_{f,i}$ values changed with the sampling method used, we generated two other samplings: (1) dying and surviving trees had similar DBH at the time when the growth ratio fell below or dropped above one (i.e., year of death – $\Delta t_i$; *sampling* $\Delta t$), and (2) dying and surviving trees had similar DBH 20 years before death (median $\Delta t = 20$; *sampling median* $\Delta t$). The frequency distributions in $g_{f,i}$ values did not differ between the three sampling approaches used (Fig. D1).

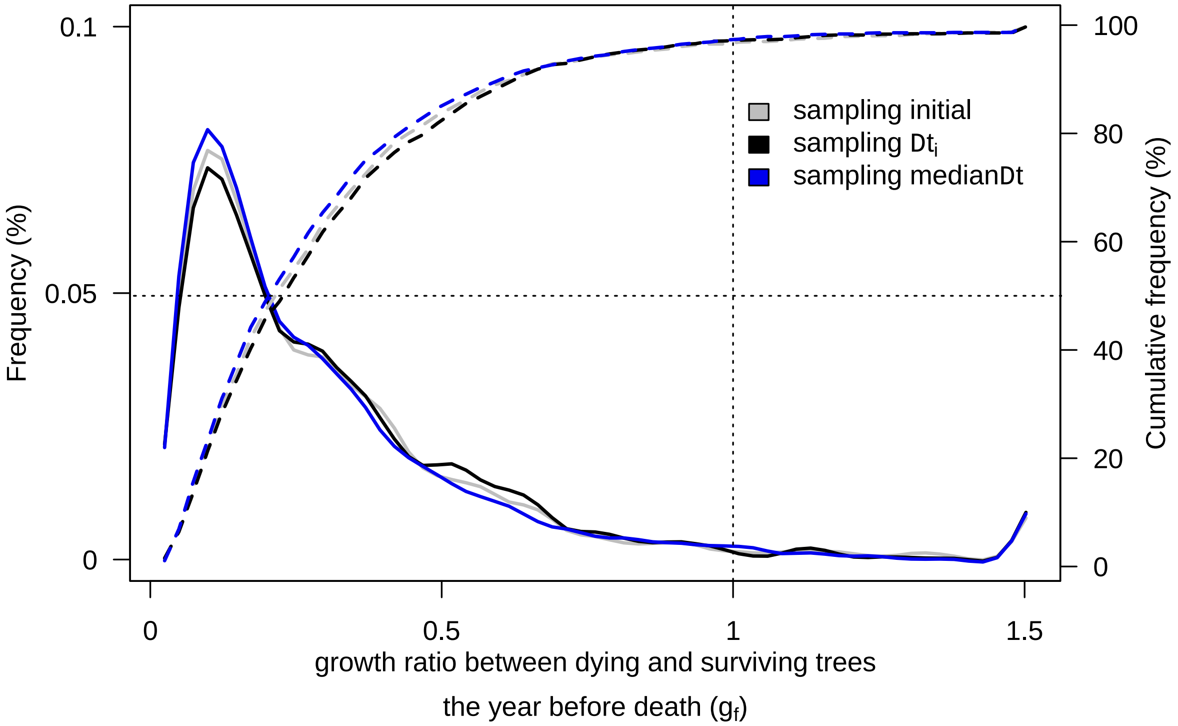

**Figure D1:** Change in the distribution in $g_{f,i}$ according to the sampling scheme used (ring-width data; solid lines). Cumulative frequencies are represented with dashed lines.

**Appendix E**: Quartile coefficients of dispersion of $\Delta t_i$, $g_{f,i}$, and $g_{50,i}$ values calculated for (a) the overall database, (b) each taxonomic group (c) each family, (d) each main source of mortality, (e) each species, and (f) each site. Due to the high number of species and sites studied, we only reported summary statistics of their quartile coefficients of dispersion.

| | | $\Delta t_i$ | $g_{f,i}$ | $g_{50,i}$ |
|---|---|---|---|---|
| **a) Overall** | | **0.76** | **0.56** | **0.42** |
| **b) Taxonomic group** | Gymnosperms | 0.73 | 0.58 | 0.43 |
| | Angiosperms | 0.74 | 0.45 | 0.37 |
| **c) Family** | Pinaceae | 0.71 | 0.58 | 0.43 |
| | Sapindaceae | 0.53 | 0.43 | - |
| | Cupressaceae | 0.80 | 0.59 | - |
| | Fagaceae | 0.71 | 0.41 | 0.36 |
| | Salicaceae | 0.81 | 0.58 | - |
| | Tamaricaceae | 0.50 | 0.44 | 0.17 |
| **d) Main mortality source** | Drought | 0.83 | 0.56 | 0.39 |
| | Drought + Biotic | 0.73 | 0.53 | 0.32 |
| | Biotic | 0.74 | 0.51 | 0.36 |
| | Others | 0.64 | 0.58 | 0.41 |
| **e) Species** | minimum | 0 | 0 | 0 |
| | 1st quartile | 0.47 | 0.27 | 0.18 |
| | median | 0.65 | 0.44 | 0.28 |
| | mean | 0.59 | 0.40 | 0.30 |
| | 3rd quartile | 0.75 | 0.54 | 0.40 |
| | max | 0.98 | 0.63 | 0.82 |
| **f) Site** | minimum | 0 | 0 | 0 |
| | 1st quartile | 0.26 | 0.16 | 0.12 |
| | median | 0.50 | 0.33 | 0.22 |
| | mean | 0.46 | 0.32 | 0.25 |
| | 3rd quartile | 0.68 | 0.46 | 0.36 |
| | max | 0.98 | 0.84 | 0.83 |

**Appendix F**: Summary of the fitted mixed effect models for the duration of the period with reduced/increased growth before death ($\Delta t_i$), the growth rate of dying trees relative to surviving trees the year before death ($g_{f,i}$), and averaged over the first 50 years of tree's life ($g_{50,i}$). $\Delta t_i$ and $g_{f,i}$ were calculated using ring-width data (RW), while basal area increment (BAI) was used for $g_{50,i}$. A Poisson model was used for $\Delta t_i$ while linear models were fitted to log-transformed $g_{f,i}$ and $g_{50,i}$ values.

Here, in contrast to Table 2, we only considered trees for which DBH information was available.

*Top*: For $\Delta t_i$, chi-square values and the probability of the chi-square tests of the variable effects were derived from type-II variance analysis. Sum of squares and significance of the variable effects on $g_{f,i}$ and $g_{50,i}$ were calculated using type-III variance analysis.
*Center*: The value and significance levels of model coefficients. The intercept corresponds to the reference species group (angiosperms) and the reference mortality source (drought).
*Bottom*: $R^2$ marginal and $R^2$ conditional indicate the variance explained by fixed effects and by both fixed and random effects, respectively.

| | $\Delta t_i$ (Chi Sq.) n=1000 | | $g_{f,i}$ (Sum Sq.) n=1000 | |
|---|---|---|---|---|
| | RW | BAI | log(RW) | log(BAI) |
| Taxon (d.f. = 1) | 6.50 * | 6.06 * | 2.97 * | 8.66 * |
| Mortality group (d.f. = 3) | 28.0 *** | 33.8 *** | 21.6 *** | 16.3 ** |
| | | | | |
| Intercept | 2.80 *** | 2.64 *** | -0.7 *** | -0.6 *** |
| Gymnosperms | 0.51 * | 0.45 * | -0.24 * | -0.39 ** |
| Drought - Biotic | -0.14 | -0.10 | 0.13 | 0.05 |
| Biotic | -0.8 *** | -0.8 *** | 0.34 ** | 0.19 |
| Others | 0.13 | 0.20 | -0.30 ** | -0.33 * |
| | | | | |
| $R^2$ marginal | 0.07 | 0.09 | 0.08 | 0.06 |
| $R^2$ conditional | 0.27 | 0.29 | 0.20 | 0.16 |

*P < 0.05; **P < 0.01; ***P < 0.001

n: number of mortality events considered in each model

d.f.: degrees of freedom

**Appendix G.** Summary of the fitted mixed effect models for the duration of the period with reduced/increased growth before death ($\Delta t_i$), the growth rate of dying trees relative to surviving trees the year before death ($g_{f,i}$), and averaged over the first 50 years of tree's life ($g_{50,i}$). $\Delta t_i$ and $g_{f,i}$ were calculated using ring-width data (RW), while basal area increment (BAI) was used for $g_{50,i}$. A Poisson model was used for $\Delta t_i$ while linear models were fitted to log-transformed $g_{f,i}$ and $g_{50,i}$ values.

Here, as more than one tree could die during a given mortality event, $g_i$ were calculated for each pair of dying tree / surviving trees with a similar DBH (no aggregation of the dead trees per mortality event).

*Top*: For $\Delta t_i$, chi-square values and the probability of the chi-square tests of the variable effects were derived from type-II variance analysis. Sum of squares and significance of the variable effects on $g_{f,i}$ and $g_{50,i}$ were calculated using type-III variance analysis.

*Center*: The value and significance levels of model coefficients. The intercept corresponds to the reference species group (angiosperms) and the reference mortality source (drought).

*Bottom*: $R^2$ marginal and $R^2$ conditional indicate the variance explained by fixed effects and by both fixed and random effects, respectively.

| | $\Delta t_i$ (Chi Sq.) RW - n=2970 | $g_{f,i}$ (Sum Sq.) log(RW) - n=2970 | $g_{50,i}$ (Sum Sq.) log(BAI) - n=1264 |
|---|---|---|---|
| Taxon (d.f. = 1) | 12.1 *** | 4.93 * | 0.82 (ns) |
| Mortality group (d.f. = 3) | 9.60 * | 23.4 *** | 9.32 ** |
| | | | |
| Intercept | 2.39 *** | -0.65 *** | 0.13 (ns) |
| Gymnosperms | 0.61 *** | -0.24 * | 0.14 (ns) |
| Drought - Biotic | 0.06 (ns) | 0.11 | -0.30 * |
| Biotic | -0.32 * | 0.23 * | -0.25 * |
| Others | 0.25 (ns) | -0.32 ** | -0.53 *** |
| | | | |
| $R^2$ marginal | 0.04 | 0.05 | 0.06 |
| $R^2$ conditional | 0.24 | 0.19 | 0.19 |

n: number of dead trees considered in each model

d.f.: degrees of freedom

(ns) not significant; (*)$P < 0.1$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

**Appendix H.** Summary of the fitted mixed effect models for the duration of the period with reduced/increased growth before death ($\Delta t_i$), the growth rate of dying trees relative to surviving trees the year before death ($g_{f,i}$), and averaged over the first 50 years of tree's life ($g_{50,i}$). $\Delta t_i$ and $g_{f,i}$ were calculated using ring-width data (RW), while basal area increment (BAI) was used for $g_{50,i}$. A Poisson model was used for $\Delta t_i$ while linear models were fitted to log-transformed $g_{f,i}$ and $g_{50,i}$ values.

Here, we divided the class 'biotic agents' into two groups: 'Contributing and inciting biotic agents' (bark beetles being predominant; wood-borers were also observed in *Quercus rubra*) and 'Predisposing biotic agents' (fungi, defoliators, mistletoe).

*Top*: For $\Delta t_i$, chi-square values and the probability of the chi-square tests of the variable effects were derived from type-II variance analysis. Sum of squares and significance of the variable effects on $g_{f,i}$ and $g_{50,i}$ were calculated using type-III variance analysis.

*Center*: The value and significance levels of model coefficients. The intercept corresponds to the reference species group (angiosperms) and the reference mortality source (drought).

*Bottom*: $R^2$ marginal and $R^2$ conditional indicate the variance explained by fixed effects and by both fixed and random effects, respectively.

| | $\Delta t_i$ (Chi Sq.) RW - n=1496 | $g_{f,i}$ (Sum Sq.) log(RW) - n=1496 | $g_{50,i}$ (Sum Sq.) log(BAI) - n=612 |
|---|---|---|---|
| Taxon (d.f. = 1) | 9.98 ** | 4.97 ** | 0.22 (ns) |
| Mortality group (d.f. = 5) | 13.0 * | 27.6 *** | 5.34 * |
| | | | |
| Intercept | 2.41 *** | -0.63 *** | 0.16 (ns) |
| Gymnosperms | 0.60 ** | -0.27 ** | 0.10 (ns) |
| Drought – Cont. biotic | 0.28 (ns) | 0.26 * | -0.37 * |
| Drought – Pred. biotic | -0.10 (ns) | 0.02 (ns) | -0.06 (ns) |
| Pred. biotic | -0.41 * | 0.07 (ns) | -0.30 * |
| Cont. biotic | -0.13 (ns) | 0.41 ** | -0.18 (ns) |
| Others | 0.33 (*) | -0.31 ** | -0.49 ** |
| | | | |
| $R^2$ marginal | 0.03 | 0.07 | 0.07 |
| $R^2$ conditional | 0.26 | 0.18 | 0.27 |

n: number of mortality events considered in each model d.f.: degrees of freedom

(ns) not significant; (*)$P < 0.1$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$