Supplementary Materials

Table S1 Post-hoc Dunn Test Results for Pairwise Comparisons of Climatic Variables Between Populations considering the period 1952-2021. Site codes are FA (Fago), PE (Paco Ezpela), VI (Villanúa)

Variable	Group 1	Group 2	Test result	p-value	Significance
P	FA	PE	1.434	0.455	ns
P	FA	VI	4.741	<0.001	***
P	PE	VI	3.307	0.003	**
Tmax	FA	PE	-0.477	1.000	ns
Tmax	FA	VI	-10.305	<0.001	***
Tmax	PE	VI	-9.828	<0.001	***
Tmean	FA	PE	-1.171	0.725	ns
Tmean	FA	VI	-10.687	<0.001	***
Tmean	PE	VI	-9.516	<0.001	***
Tmin	FA	PE	-2.011	0.133	ns
Tmin	FA	VI	-11.086	<0.001	***
Tmin	PE	VI	-9.075	<0.001	***

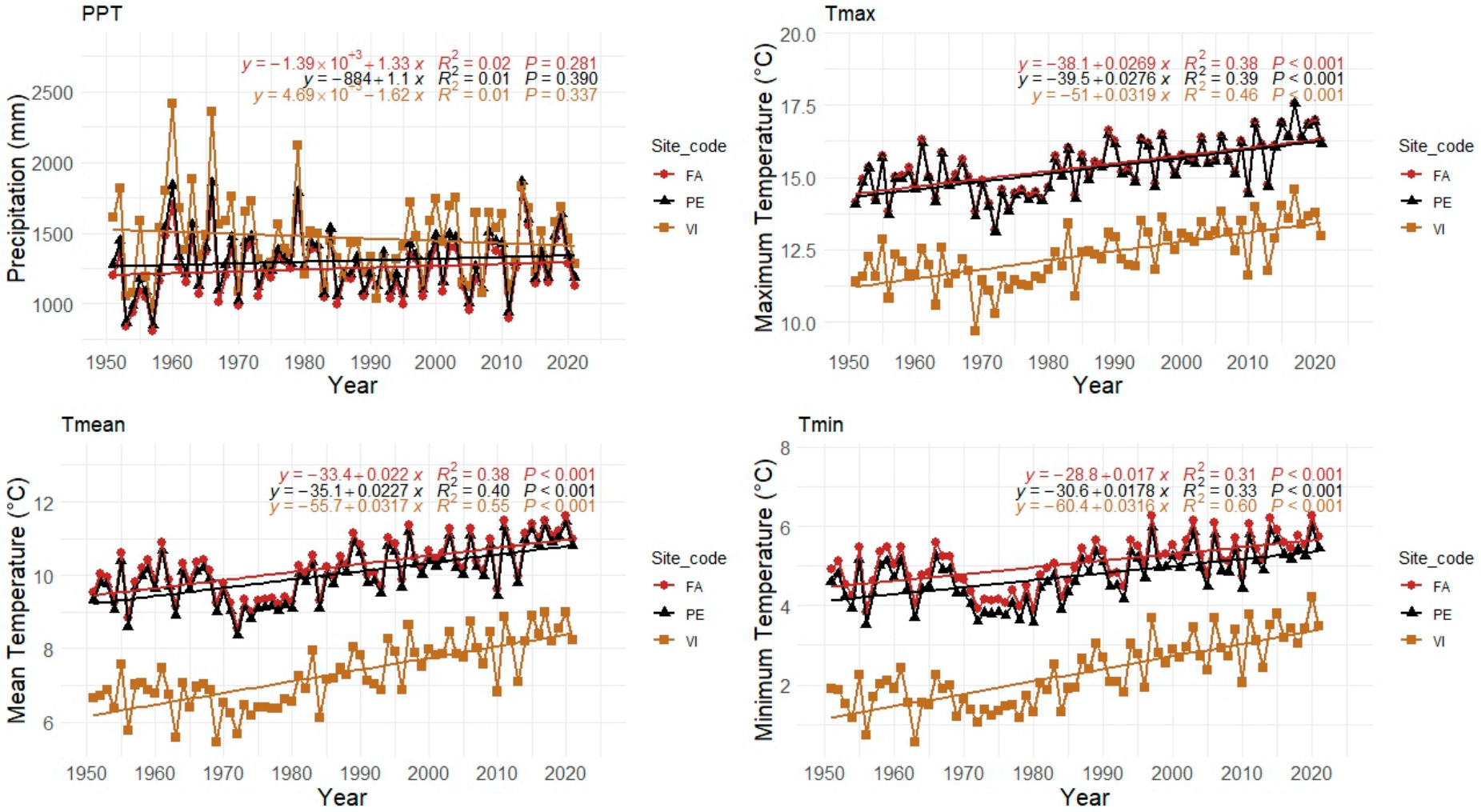

Figure S 1 Climate trends at the four sites. Site codes are FA (Fago), PE (Paco Ezpela), VI (Villanua). Linear regression lines are also indicated.

Table S2 Detrending statistics for standard and residual chronologies of Abies Alba (AA) and Pinus sylvestris (PS) study sites considering Tree Ring Widht (TRW), Early Wood Density (EWD) and Late Wood Density (LWD) for the full time series. Site codes are FA (Fago), PE (Paco Ezpela), VI (Villanúa). Values are mean±SE

Variable	Site	Species	Time span	No. sampled trees (No. radii)	EPS	Intercor*	AC*	MS*
TRW	FA	AA	1878 – 2023	26(50)	0.945	0.650±0.133	0.690±0.173	0.23
	PE	AA	1878 - 2023	34(49)	0.949	0.557±0.125	0.781±0.120	0.26
	VI	AA	1868 - 2023	35(67)	0.943	0.514±0.125	0.823±0.090	0.19
	VI	PS	1913-2023	31(42)	0.960	0.595±0.128	0.721±0.121	0.33
EWD	FA	AA	1887 – 2023	10(10)	0.560	0.298±1.162	0.413±0.215	0.11
	PE	AA	1890 - 2023	11(11)	0.523	0.216±0.135	0.414±0.310	0.13
	VI	AA	1888 - 2023	9(9)	0.564	0.230±0.105	0.613±0.157	0.12
	PS	AA	1931 - 2023	9(9)	0.541	0.183±0.090	0.367±0.207	0.12
LWD	FA	AA	1887 – 2023	10(10)	0.71	0.343±0.200	0.472±0.185	0.07
	PE	AA	1890 - 2023	11(11)	0.61	0.289±0.107	0.511±0.194	0.07
	VI	AA	1888 - 2023	9(9)	0.80	0.494±0.224	0.476±0.168	0.06
	VI	PS	1931 - 2023	9(9)	0.58	0.249±0.207	0.403±0.235	0.11

Variables' abbreviations: mean inter-series correlation (Intercor), first-order autocorrelation (AC), and mean sensitivity (MS).
* Calculated for the full span period on raw (AC, Intercor, MS) or standardized (EPS) ring-width and density values.

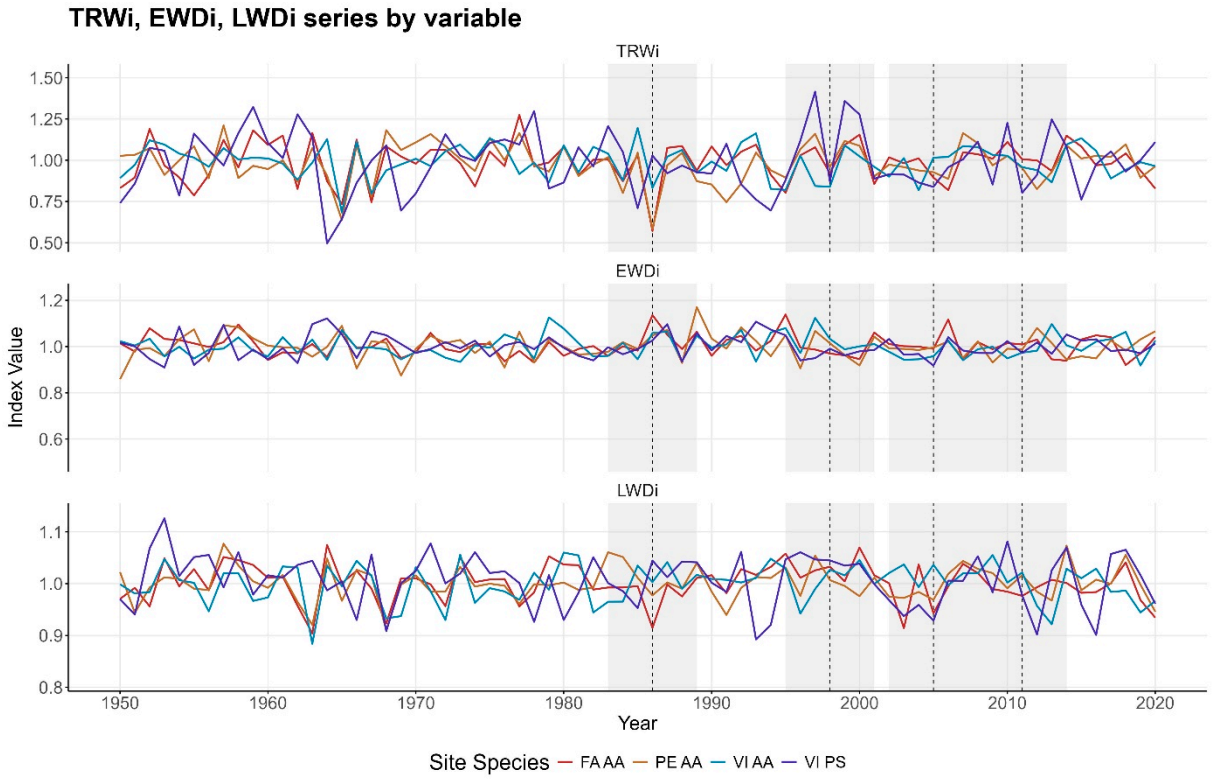

Figure S 2 Detrended series of Tree-Ring Width Index (TRWi), Earlywood Density Index (EWDi) and Latewood Density Index (LWDi), for Abies alba (AA) and Pinus sylvestris (PS) trees in the study sites in the Spanish Pyrenees: FA (Fago), PE (Paco Ezpela), VI (Villanúa). Vertical dashed lines indicate studied drought years (1986, 1995, 2005, 2011), and grey shaded areas correspond to the three years before and after each drought year used to calculate resistance, recovery, and resilience indices.

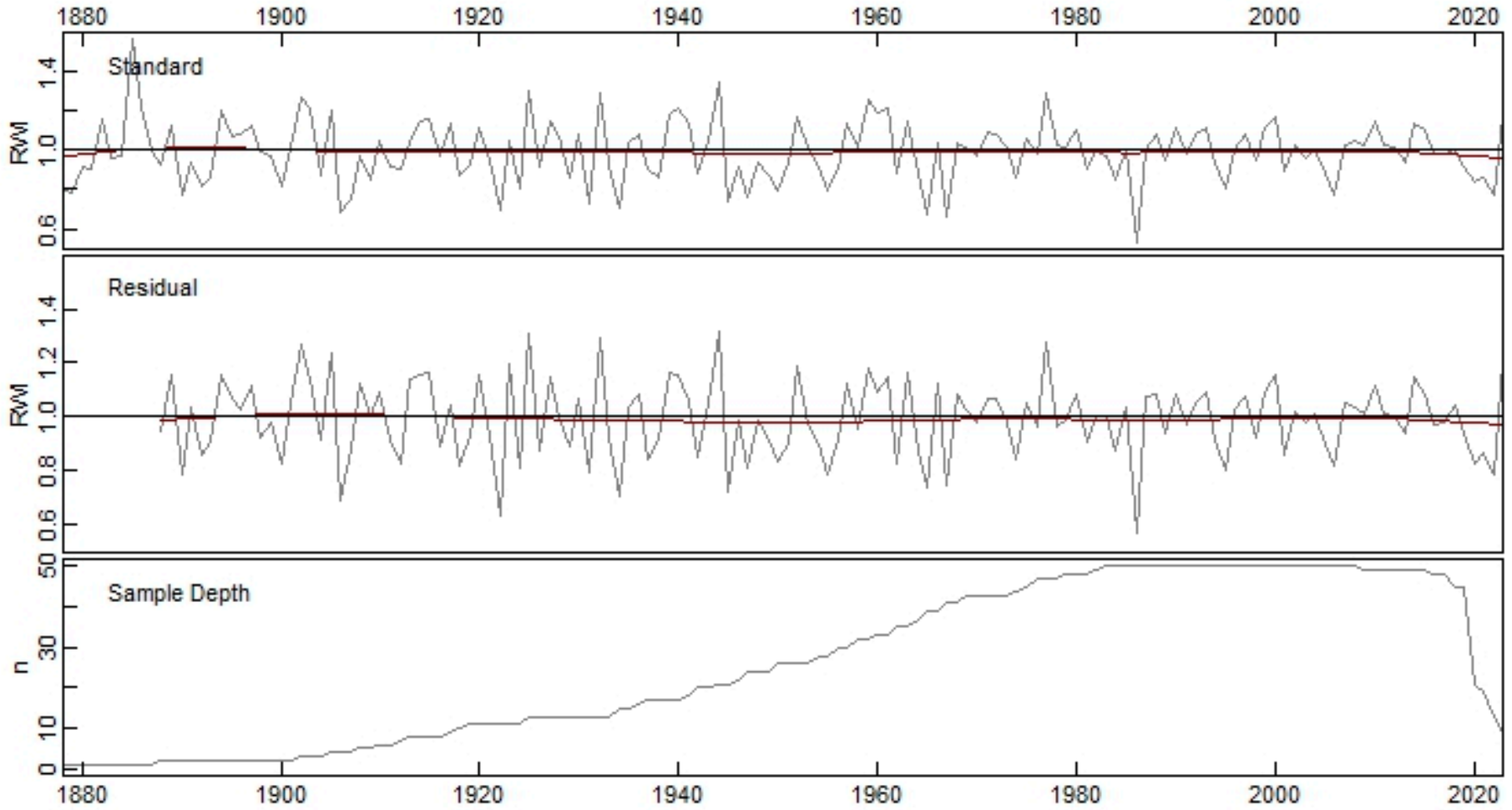

Figure S 3 Tree-ring chronology for the Abies Alba (AA) site Fago (FA) based on standardized and residual ring-width indices (RWI). The last plot shows the number of measured samples.

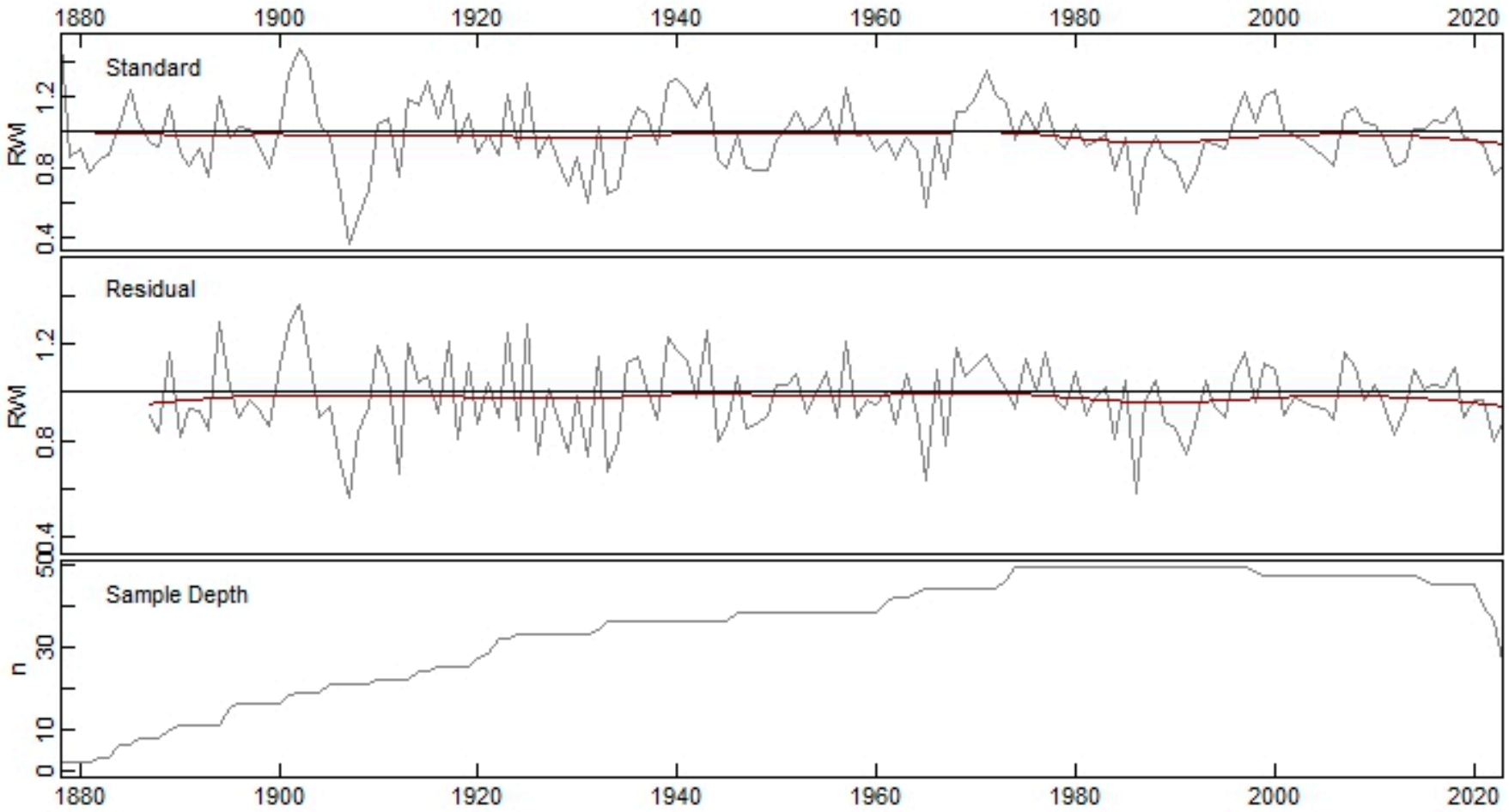

Figure S 4 Tree-ring chronology for the Abies Alba (AA) site Paco Ezpela (PE) based on standardized ring-width index (RWI). The last plot shows the number of measured samples.

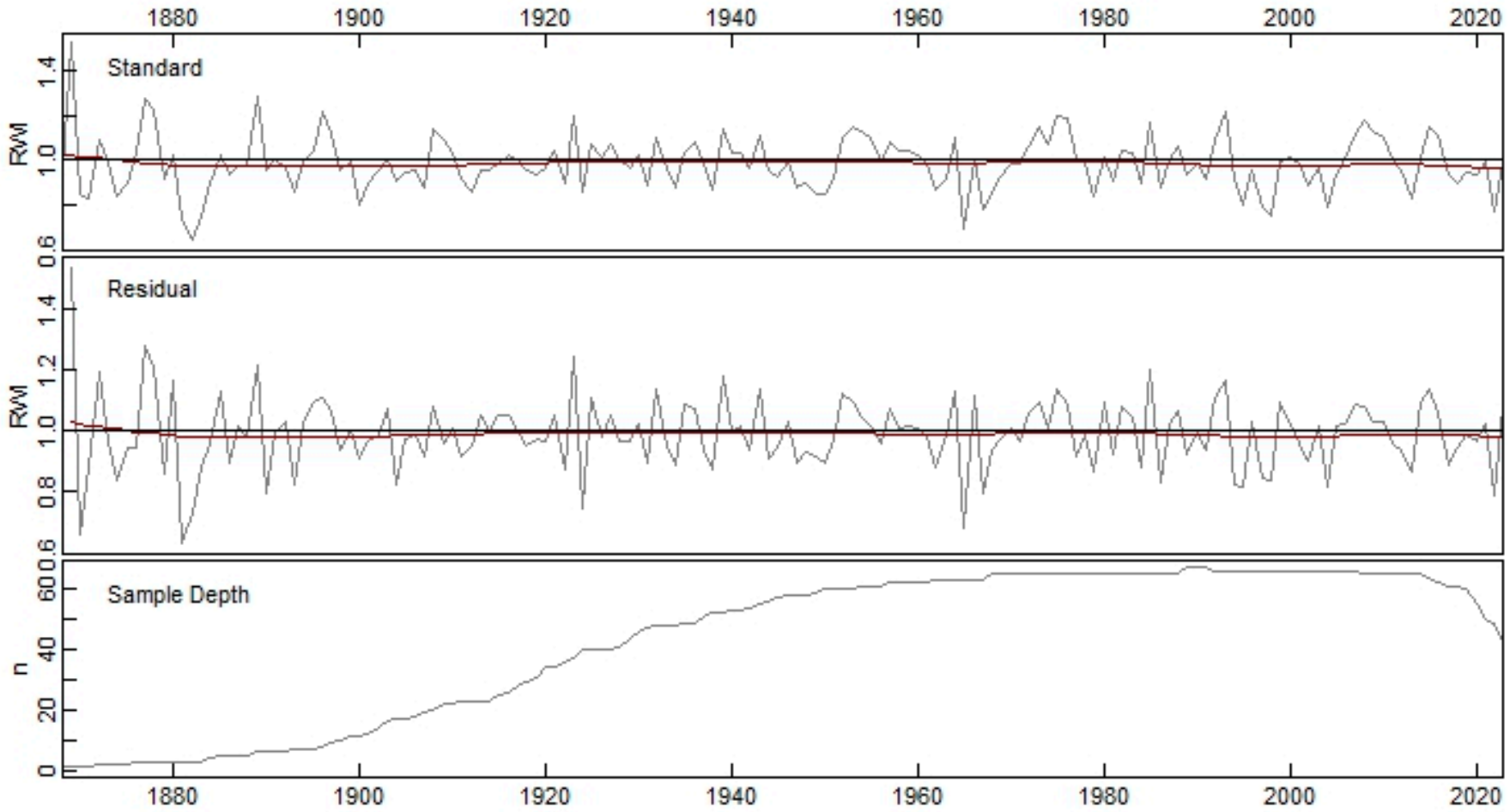

Figure S 5 Tree-ring chronology for the Abies Alba (AA) site Villanua (VI) based on standardized ring-width index (RWI). The last plot shows the number of measured samples.

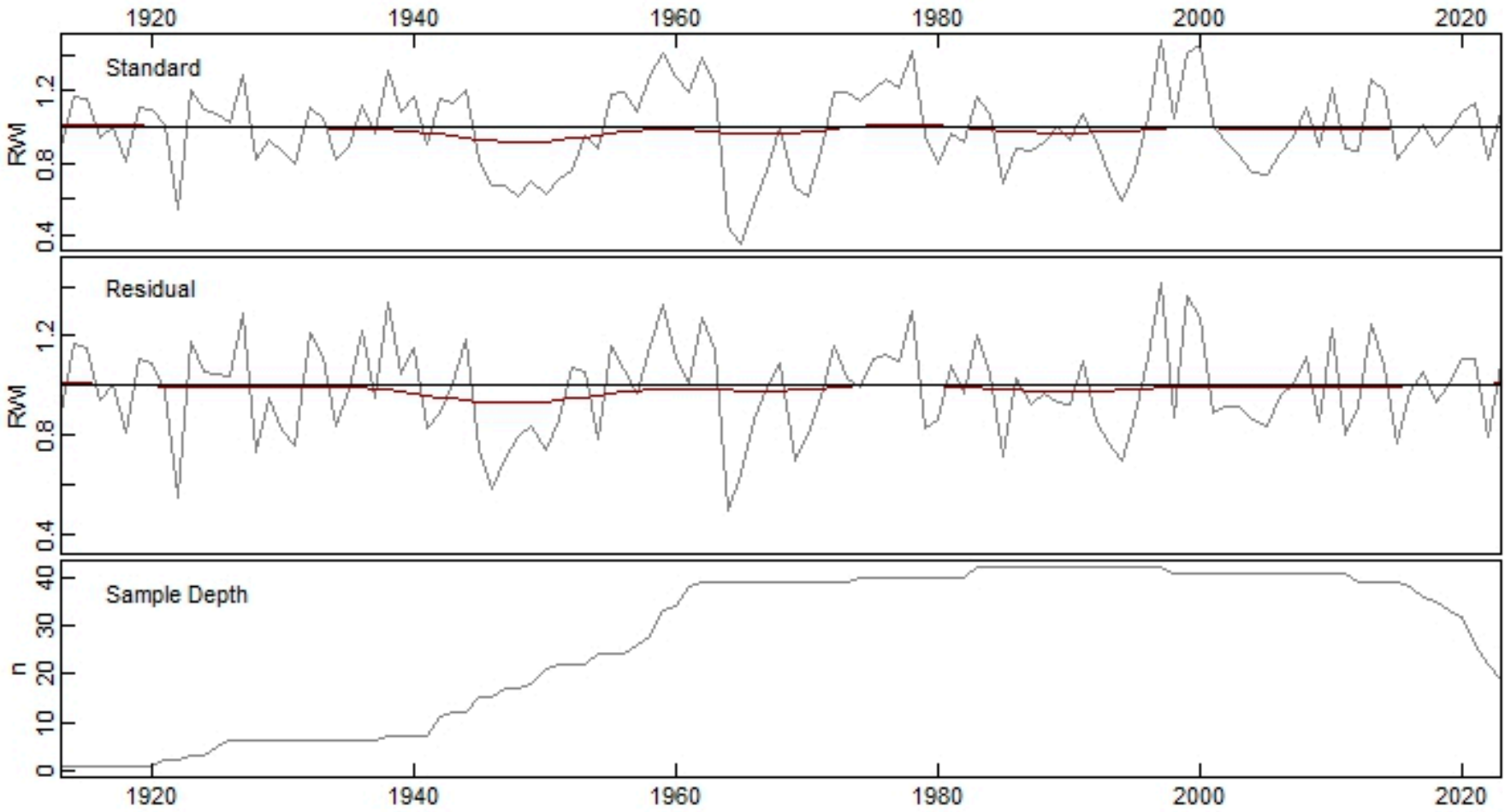

Figure S 6 Tree-ring chronology for the Pinus sylvestris (PS) site Villanua (VI) based on standardized ring-width index (RWI). The last plot shows the number of measured samples.

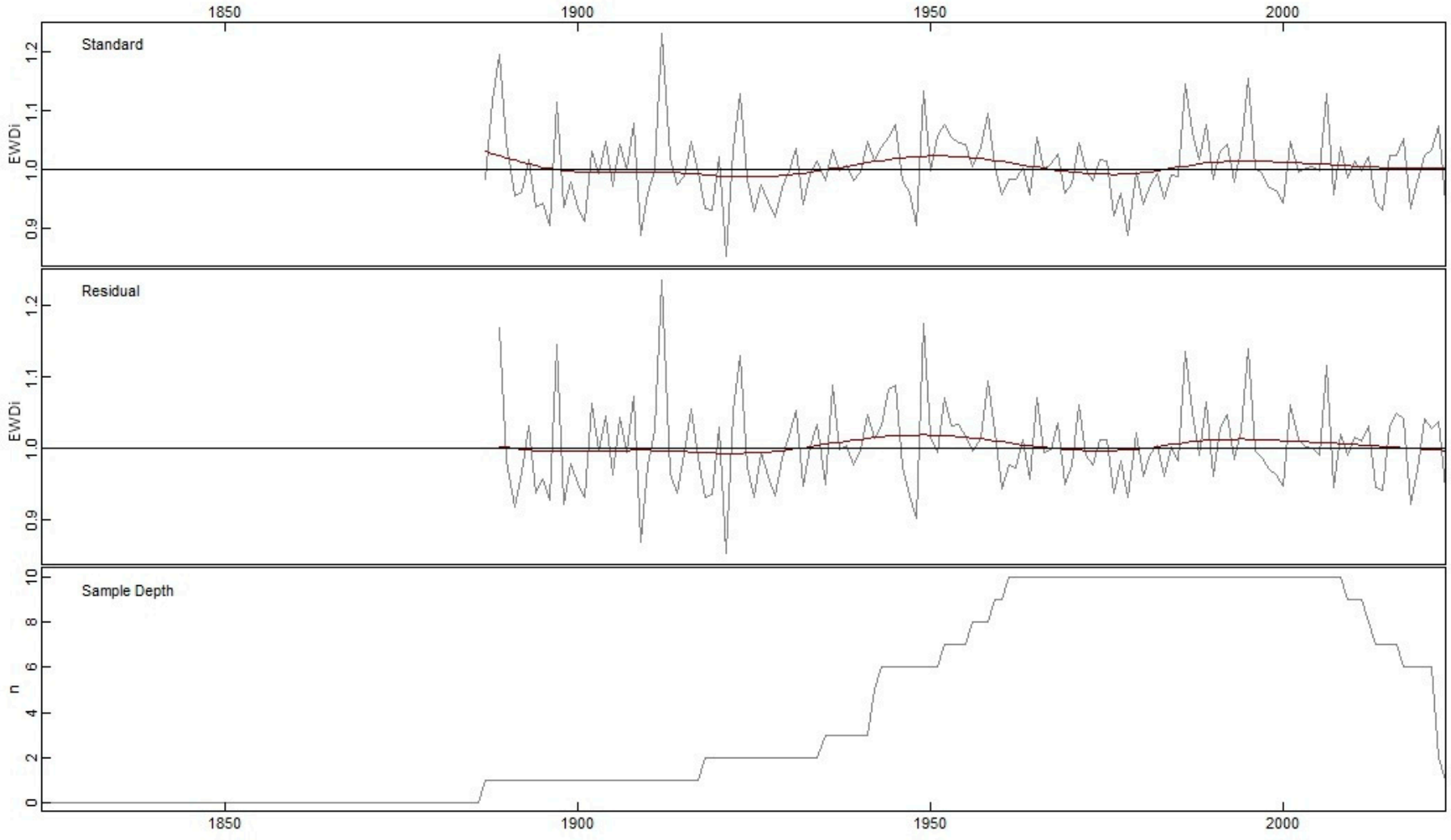

Figure S 7 Earlywood density chronology for the Abies Alba (AA) site Fago (FA) based on standardized Earlywood density index (EWDi). The last plot shows the number of measured samples.

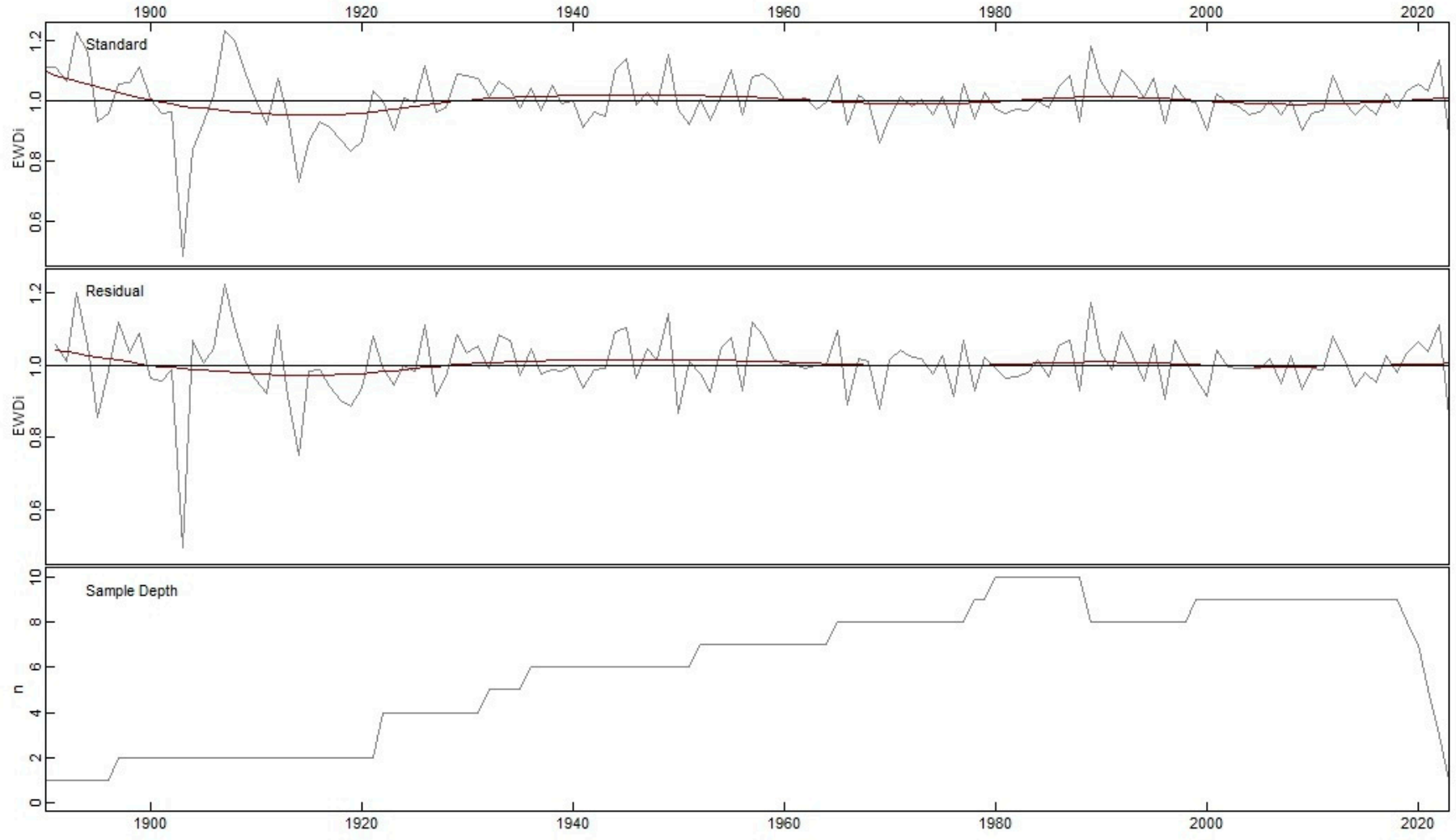

Figure S 8 Earlywood density chronology for the Abies Alba (AA) site Paco Ezpela (PE) based on standardized Earlywood density index (EWDi). The last plot shows the number of measured samples.

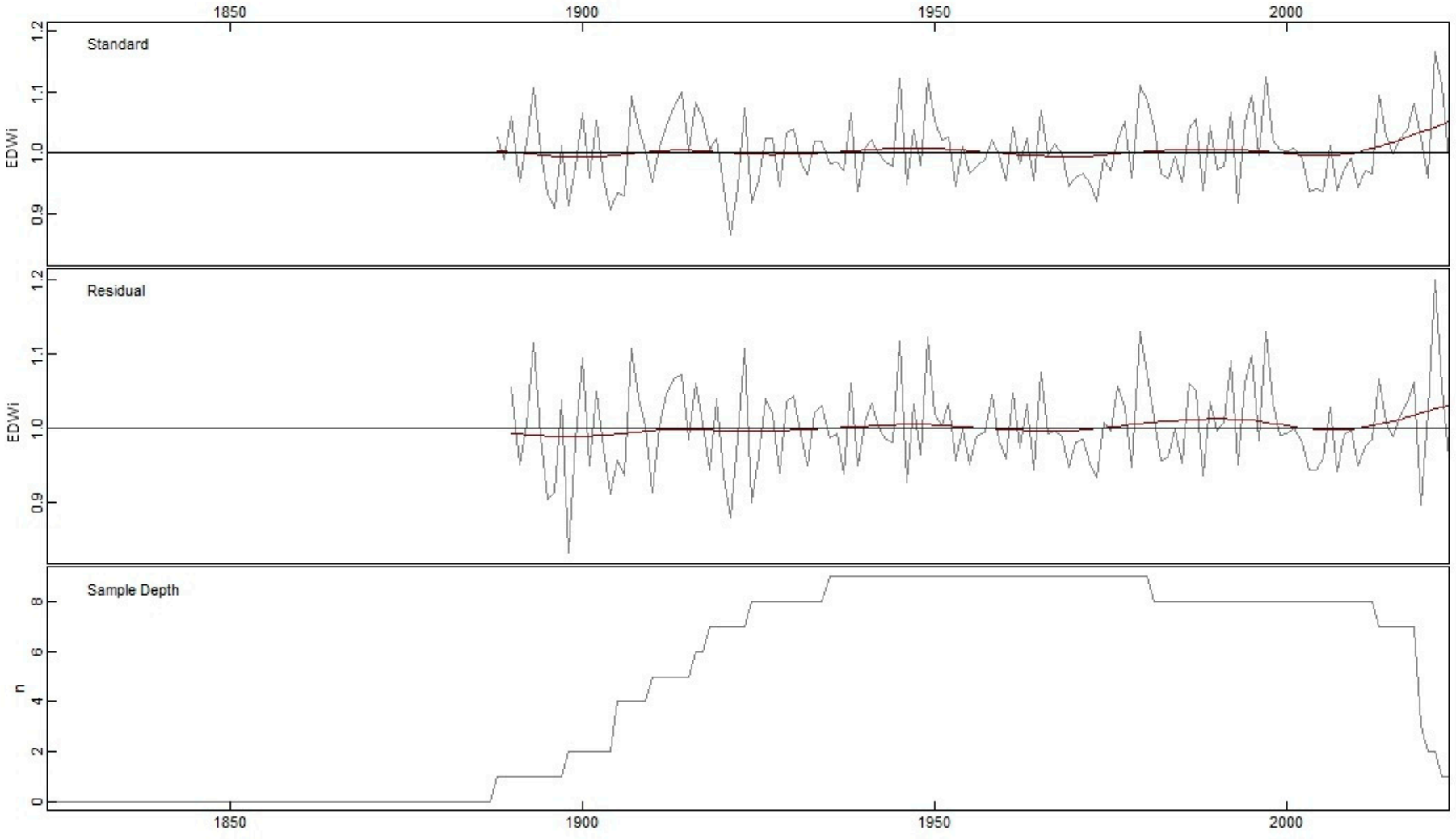

Figure S 9 Earlywood density chronology for the Abies Alba (AA) site Villanua (VI) based on standardized Earlywood density index (EWDi). The last plot shows the number of measured samples.

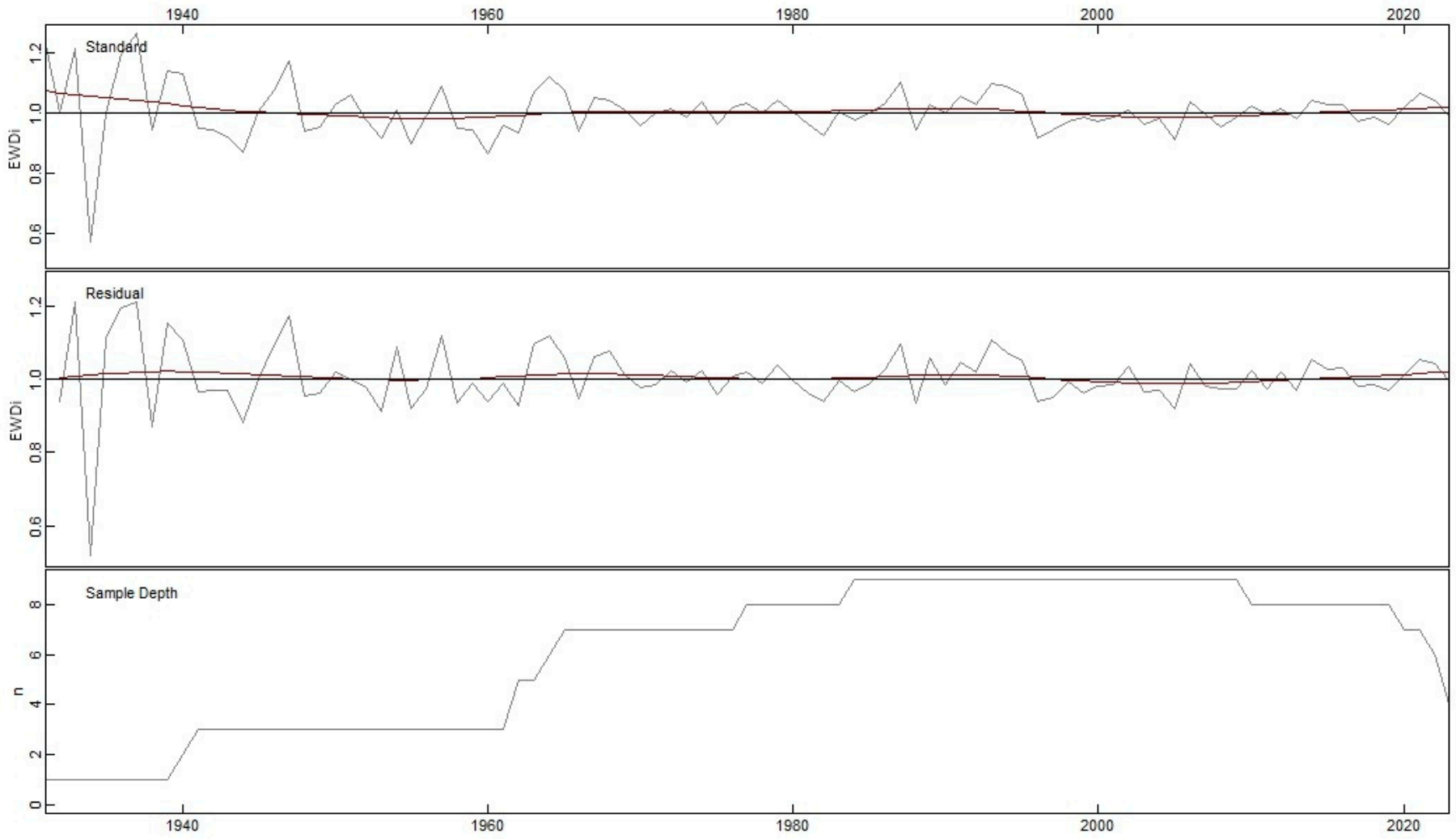

Figure S 10 Earlywood density chronology for the Pinus sylvestris (PS) site Villanua (VI) based on standardized Earlywood density index (EWDi). The last plot shows the number of measured samples.

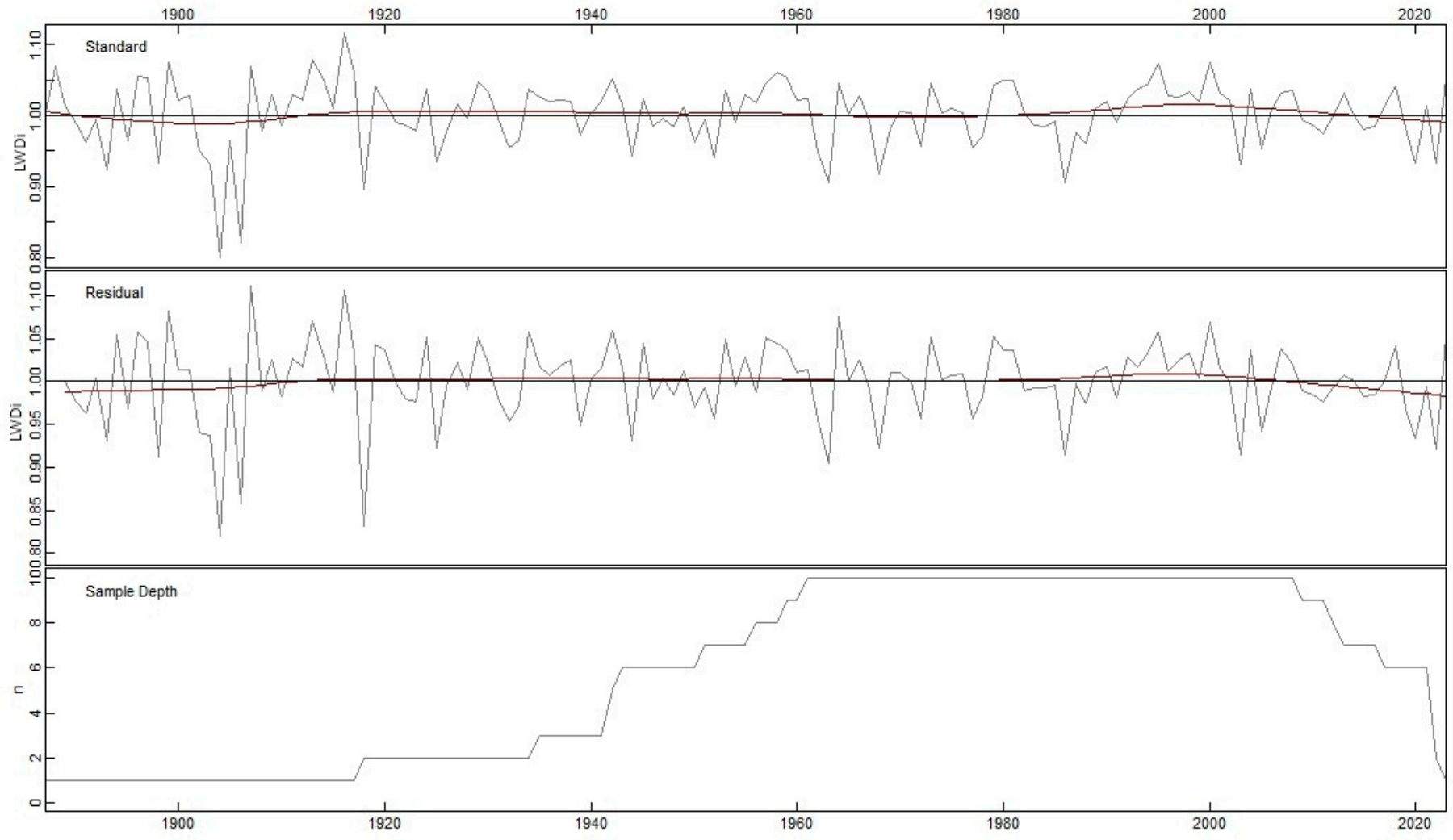

Figure S 11 Latewood density chronology for the Abies Alba (AA) site Fago (FA) based on standardized Latewood density index (LWDi). The last plot shows the number of measured samples.

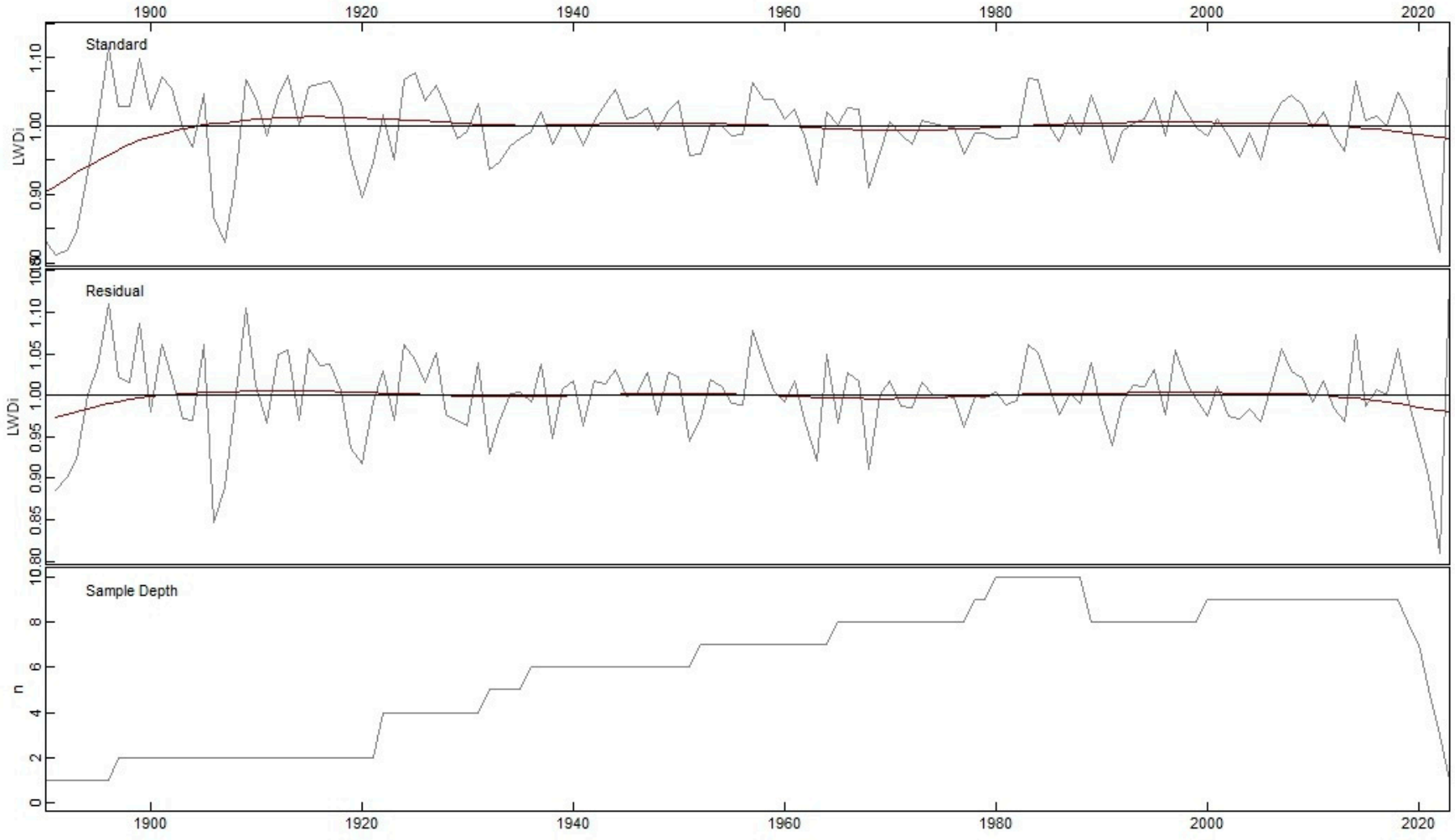

Figure S 12 Latewood density chronology for the Abies Alba (AA) site Paco Ezpela (PE) based on standardized Latewood density index (LWDi). The last plot shows the number of measured samples.

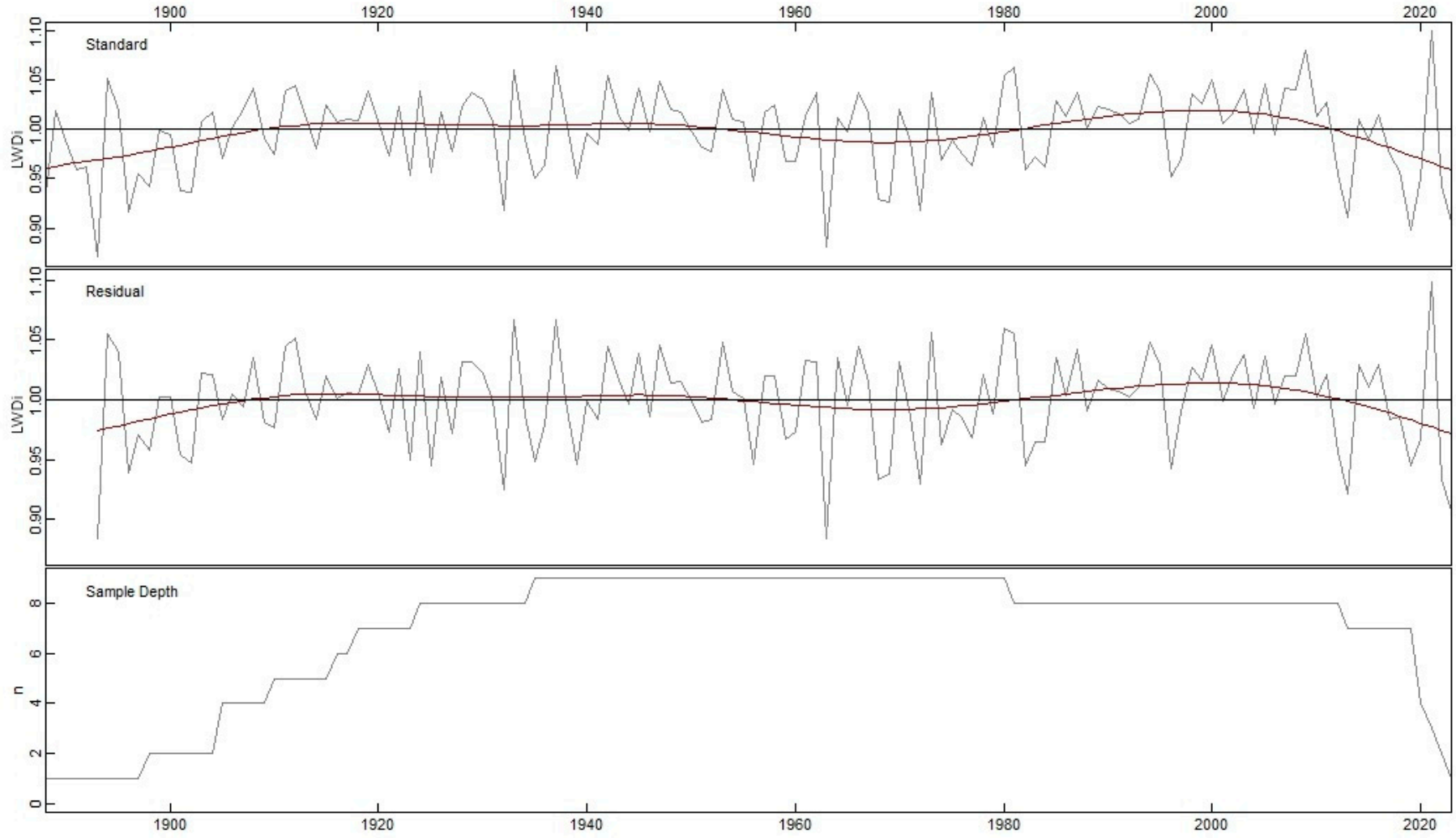

Figure S 13 Latewood density chronology for the Abies Alba (AA) site Villanua (VI) based on standardized Latewood density index (LWDi). The last plot shows the number of measured samples.

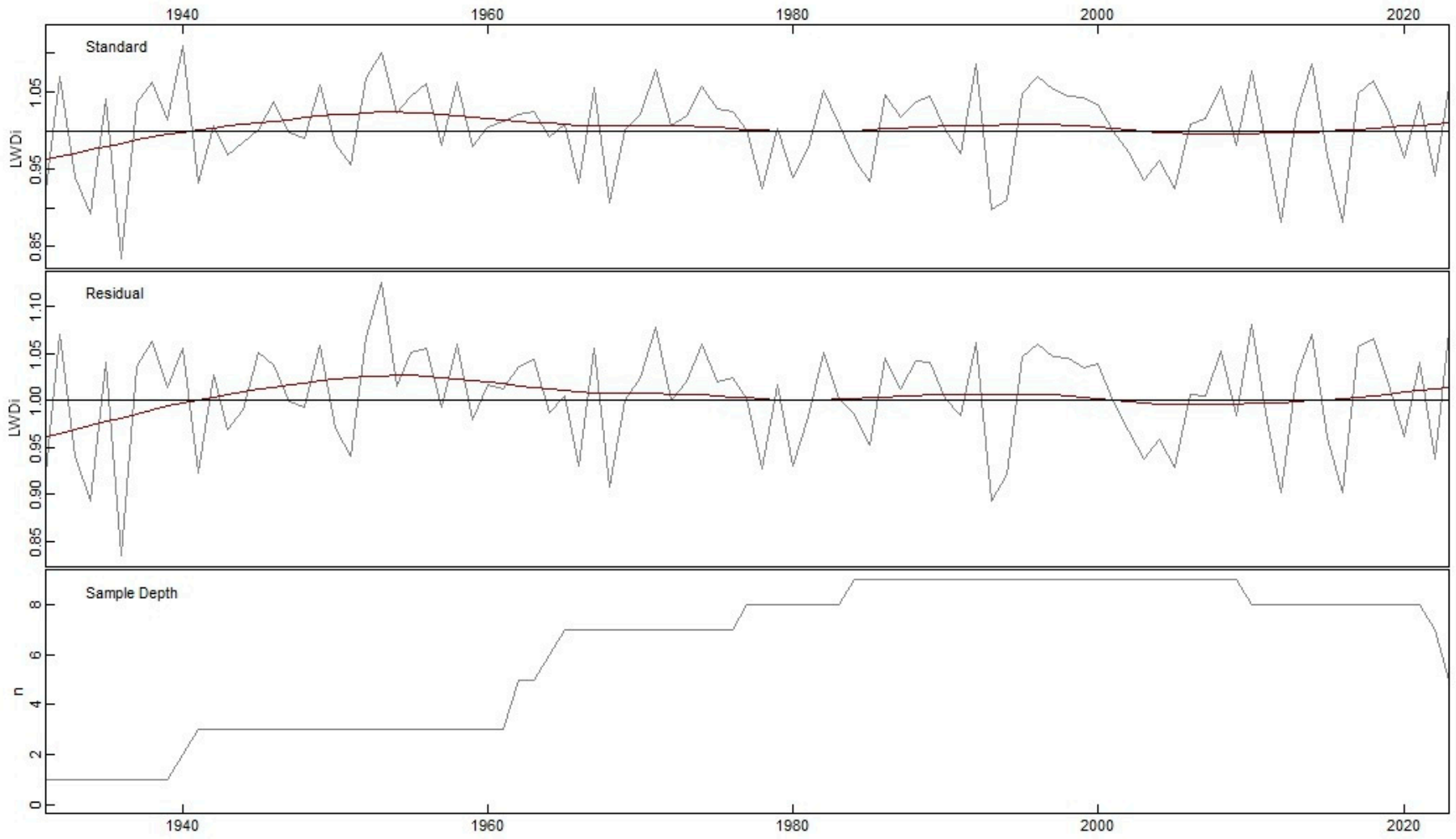

Figure S 14 Latewood density chronology for the Pinus sylvestris (PS) site Villanua (VI) based on standardized Latewood density index (LWDi). The last plot shows the number of measured samples.

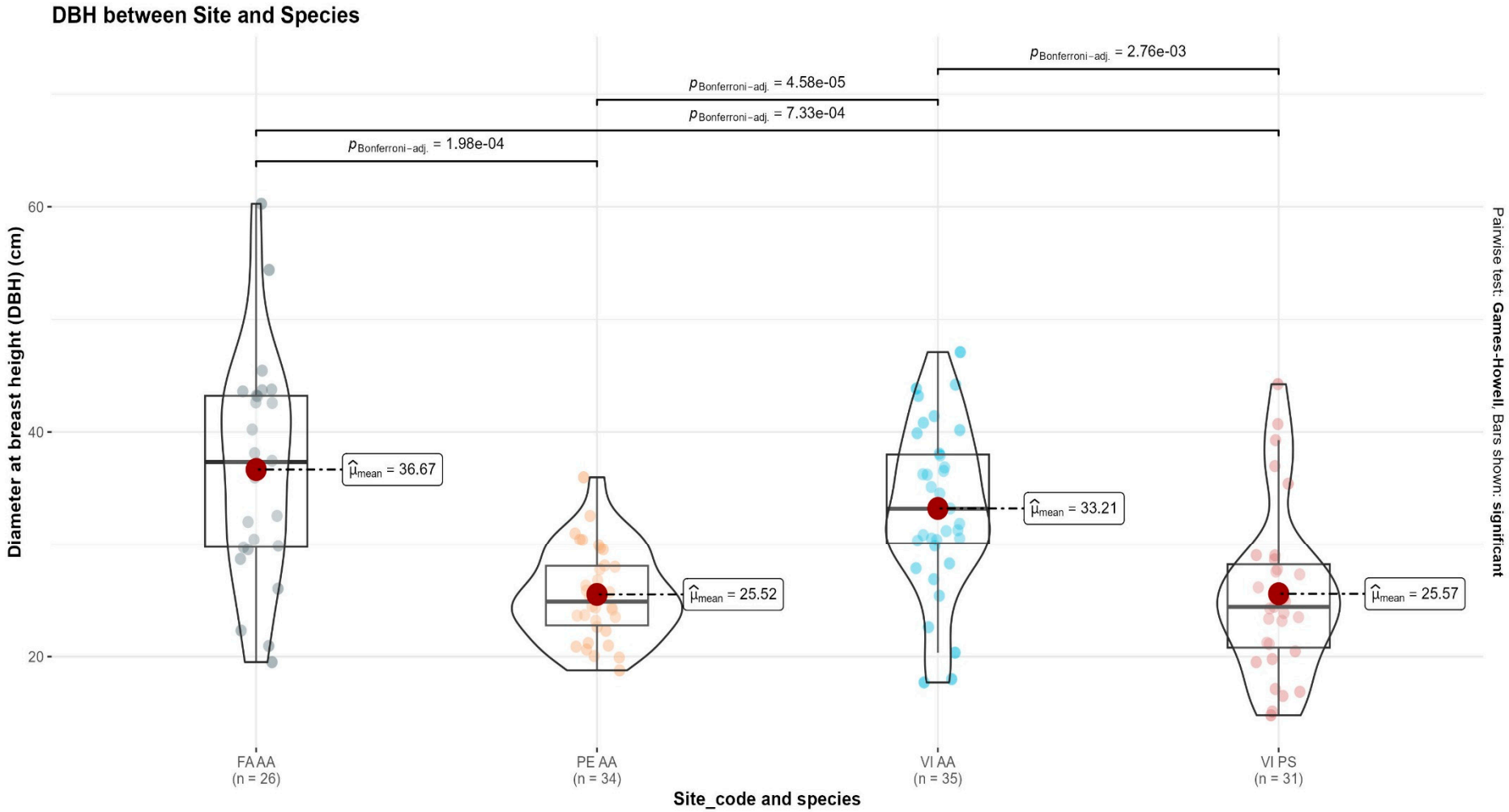

Figure S 15 Diameter at breast height (DBH) of Abies alba (AA) and Pinus sylvestris (PS) across study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa). Violin plots show the distribution of DBH values with means (red dots) and standard error. Statistically significant differences (Bonferroni-adjusted p values) are indicated by horizontal bars based on Games–Howell post hoc tests.

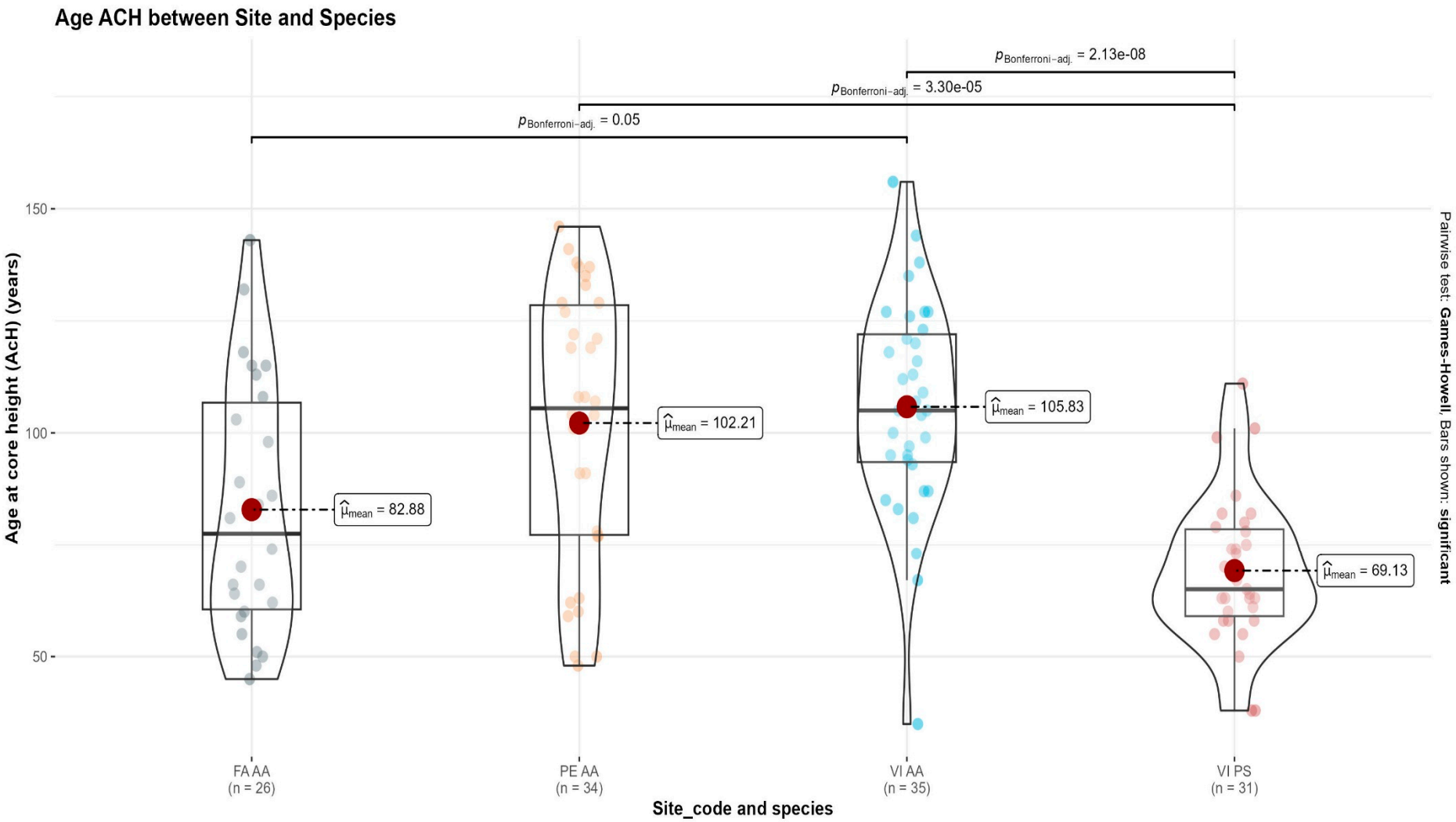

Figure S 16 Age at core height (ACH) of Abies alba (AA) and Pinus sylvestris (PS) across study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa). Violin plots show the distribution of DBH values with means (red dots) and standard error. Statistically significant differences (Bonferroni-adjusted p values) are indicated by horizontal bars based on Games–Howell post hoc tests.

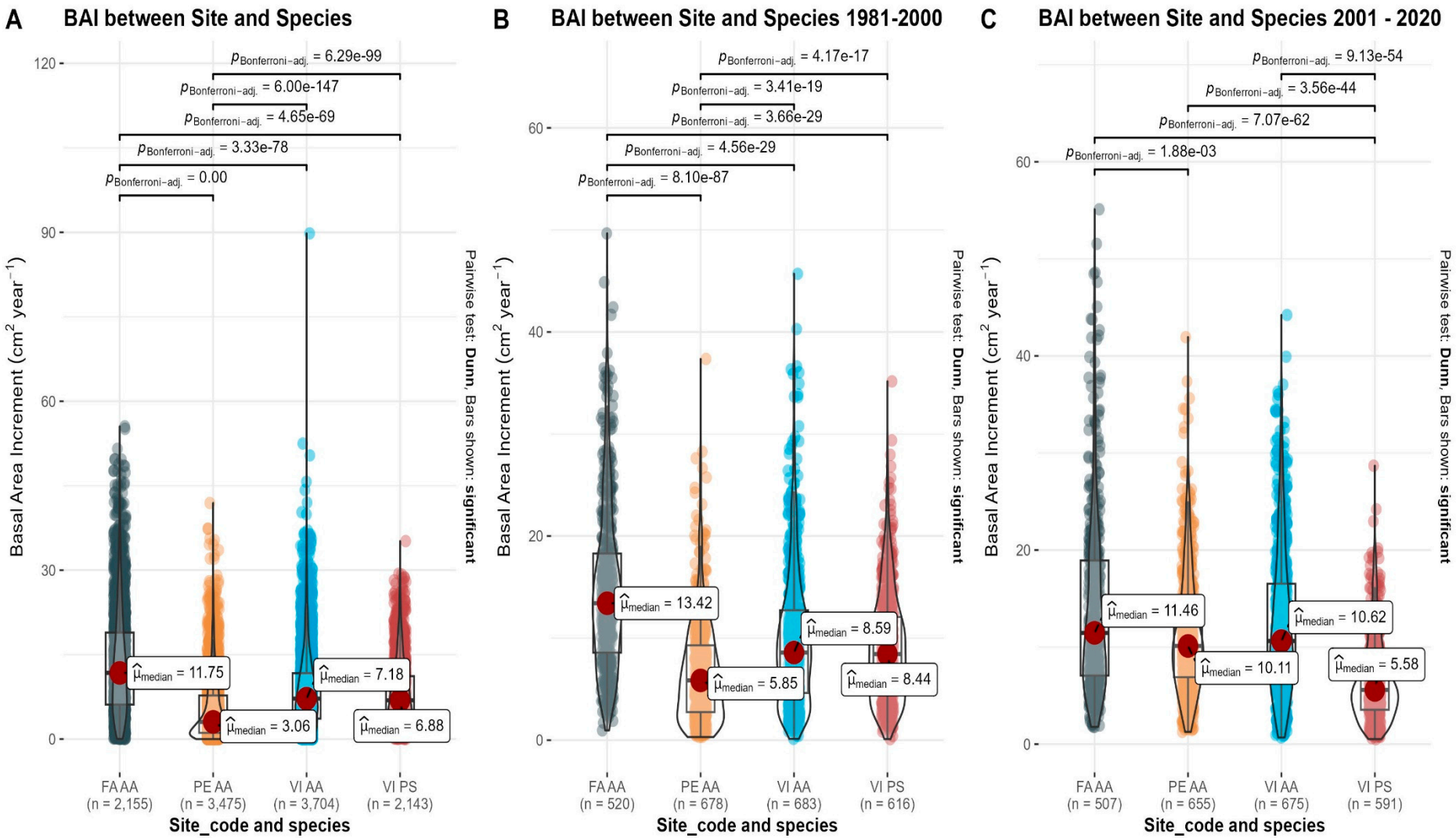

Figure S 17 Basal Area Increment (BAI) of Abies alba (AA) and Pinus sylvestris (PS) trees across study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) in full time series (A), 1981-2000 (B) and 2001-2020 (C) time periods. Violin plots represent the distribution of BAI values with medians (red dots). Statistically significant differences between groups are shown using Bonferroni-adjusted p-values from Dunn's post hoc test.

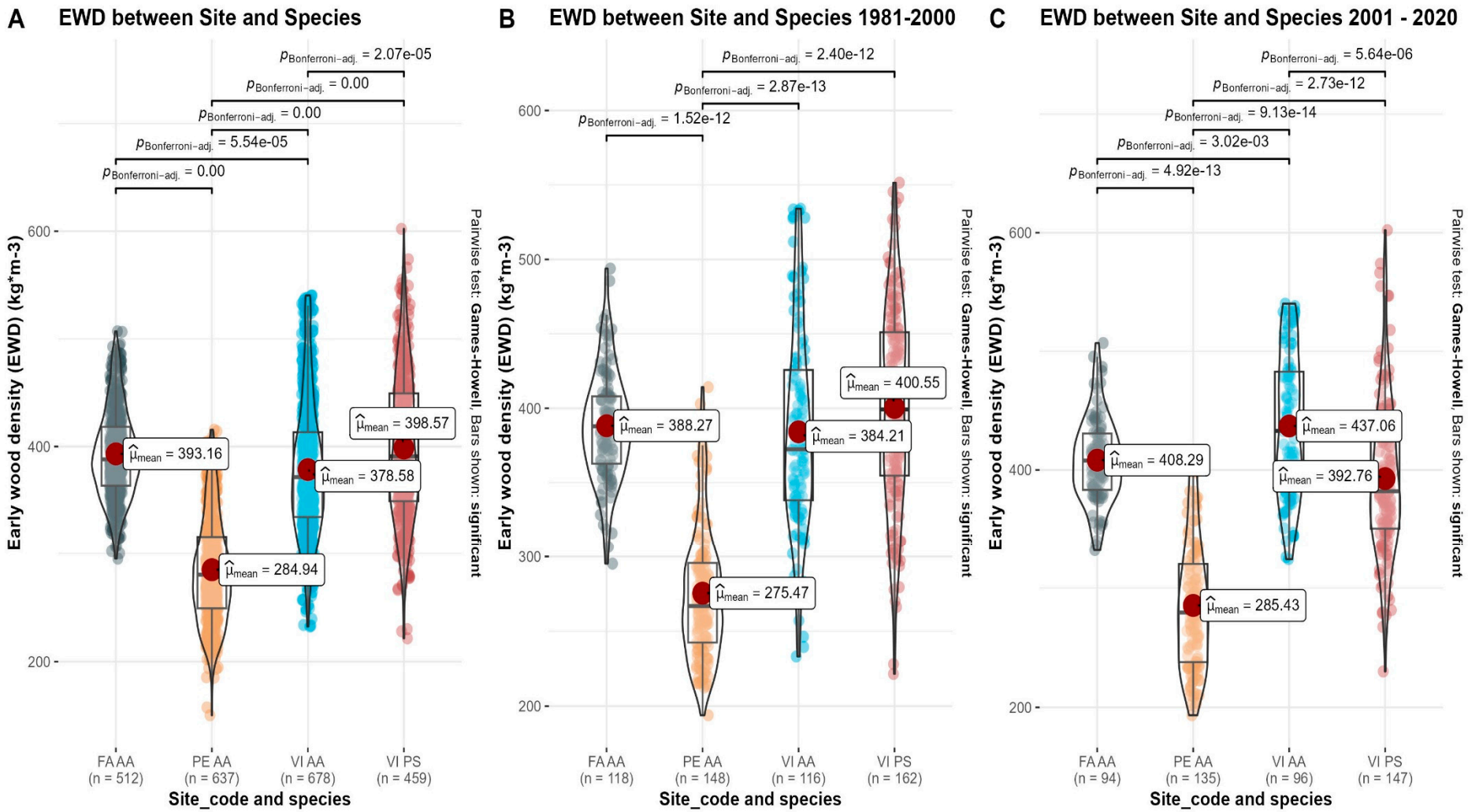

Figure S 18 Earlywood density (EWD) of Abies alba (AA) and Pinus sylvestris (PS) trees across the study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) in full time series (A), 1981-2000 (B) and 2001-2020 (C) time periods. Violin plots represent the distribution of EWD values with means (red dots). Statistically significant differences between groups are marked with Bonferroni-adjusted p-values from Games–Howell post hoc tests.

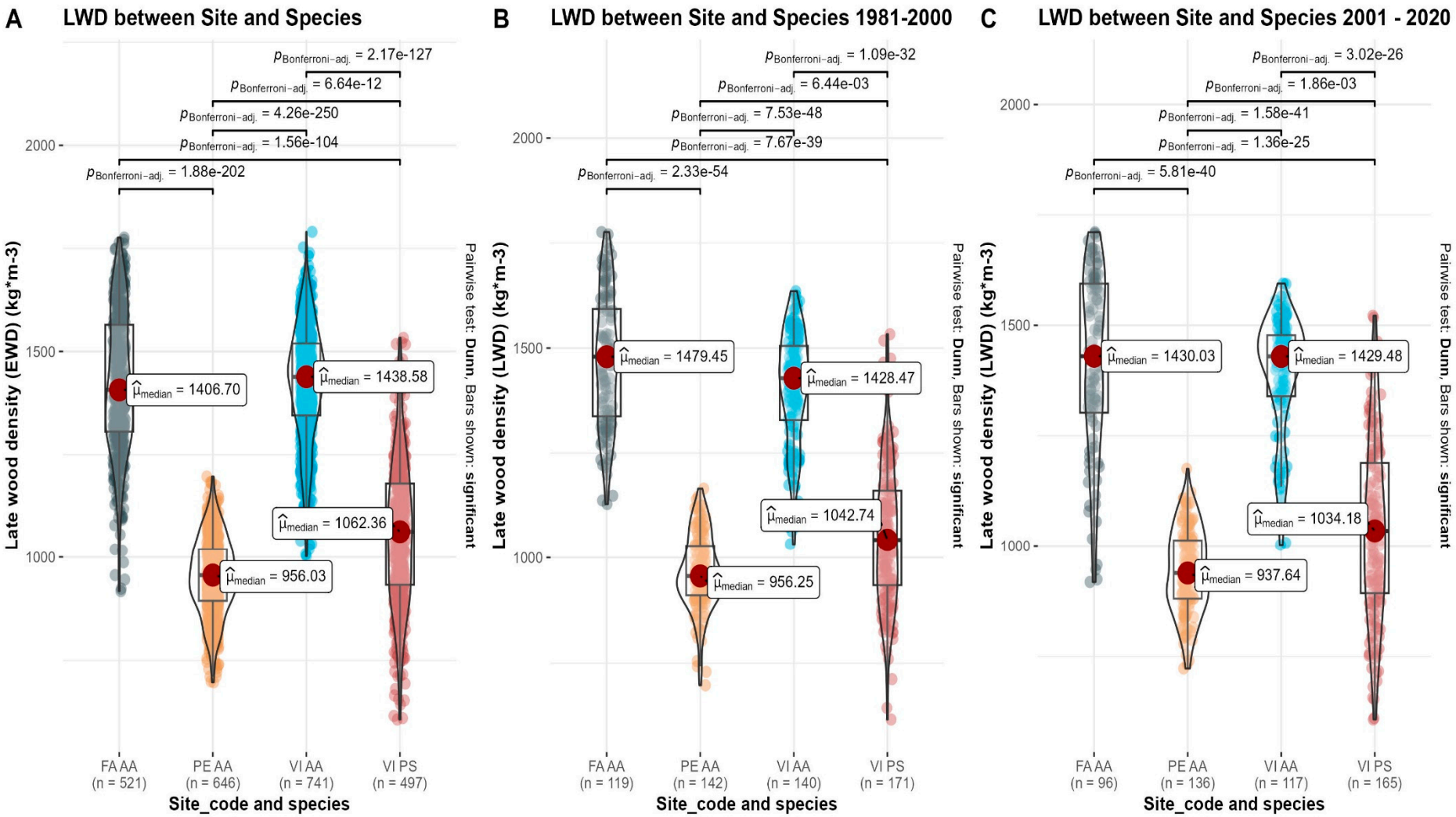

Figure S 19 Latewood density (LWD) of Abies alba (AA) and Pinus sylvestris (PS) trees across the study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) in full time series (A), 1981-2000 (B) and 2001-2020 (C) time periods. Violin plots represent the distribution of EWD values showing the median (red dots). Statistically significant differences between groups are shown using Bonferroni-adjusted p-values from Dunn's post hoc test.

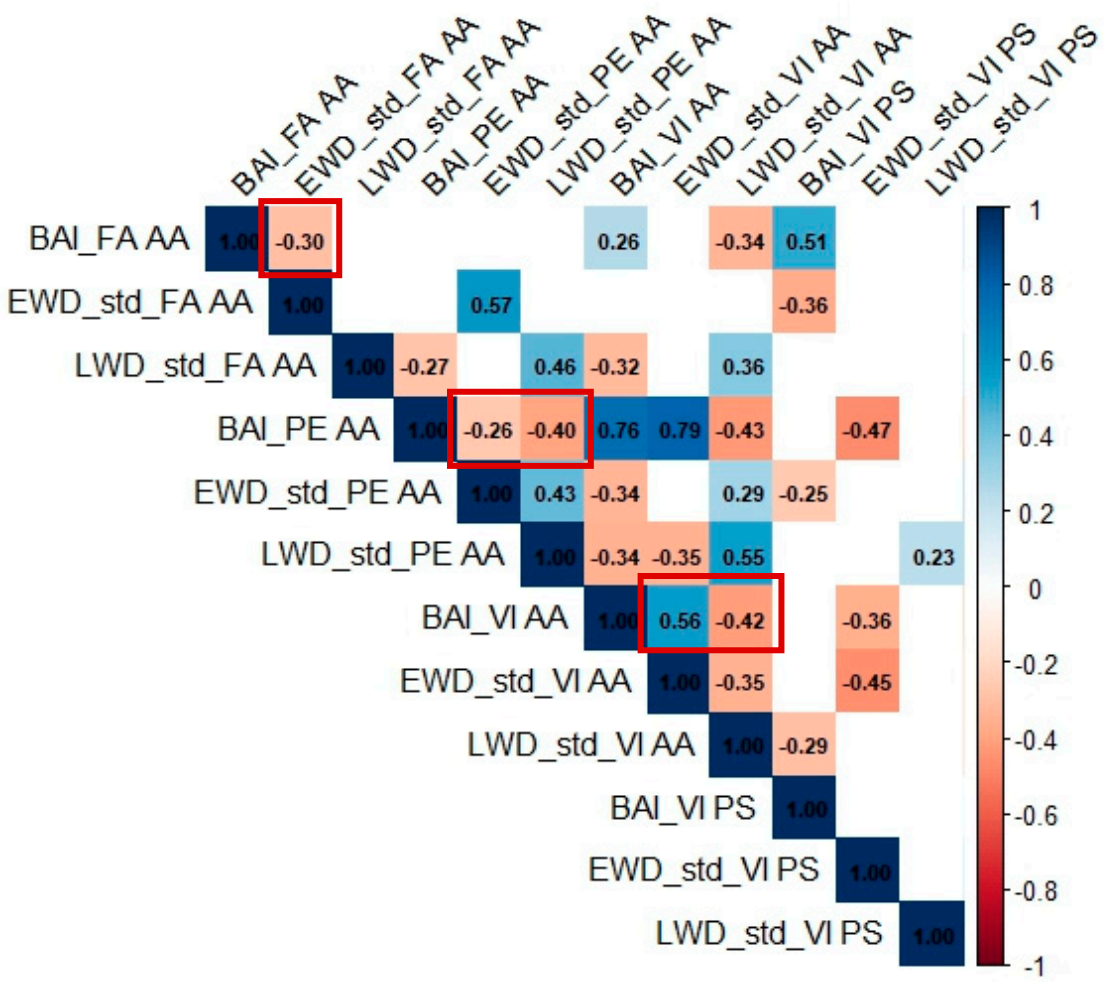

Figure S 20 Pearson correlation matrix between site-species growht (BAI) and standarized wood density (EWD and LWD) series. Site codes are FA (Fago), PE (Paco Ezpela), VI (Villanua). Species codes: Abies alba (AA) and Pinus sylvestris (PS).

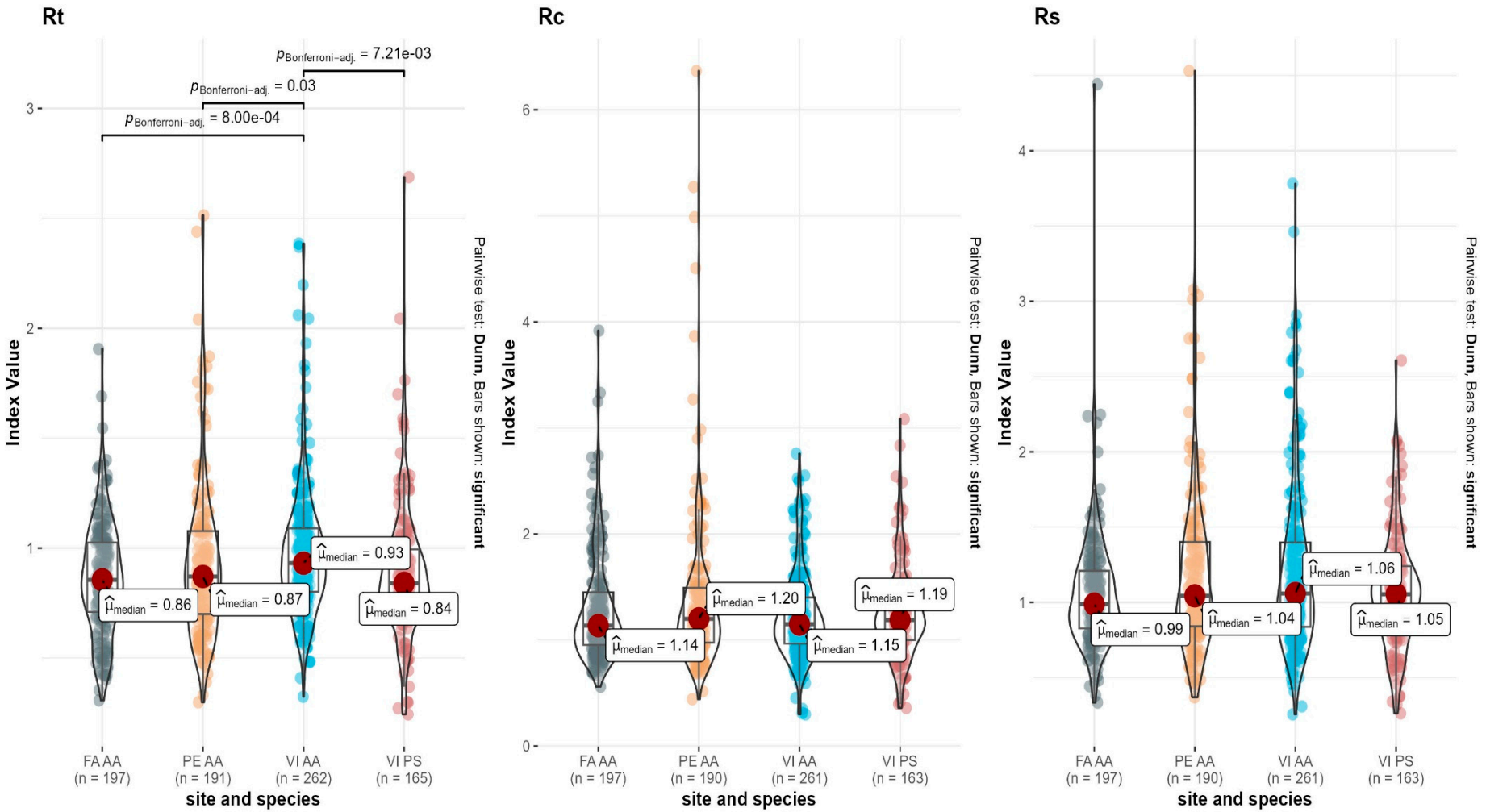

Figure S 21 BAI Resistance (Rt) Recovery (Rc) and Resilience (Rs) indices across the study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) of Abies alba (AA) and Pinus sylvestris (PS) trees. Violin plots represent index values in four pointer years (1986, 1998, 2005, 2012) showing the median (red dots). Statistically significant differences between groups are shown using Bonferroni-adjusted p-values from Dunn's post hoc test.

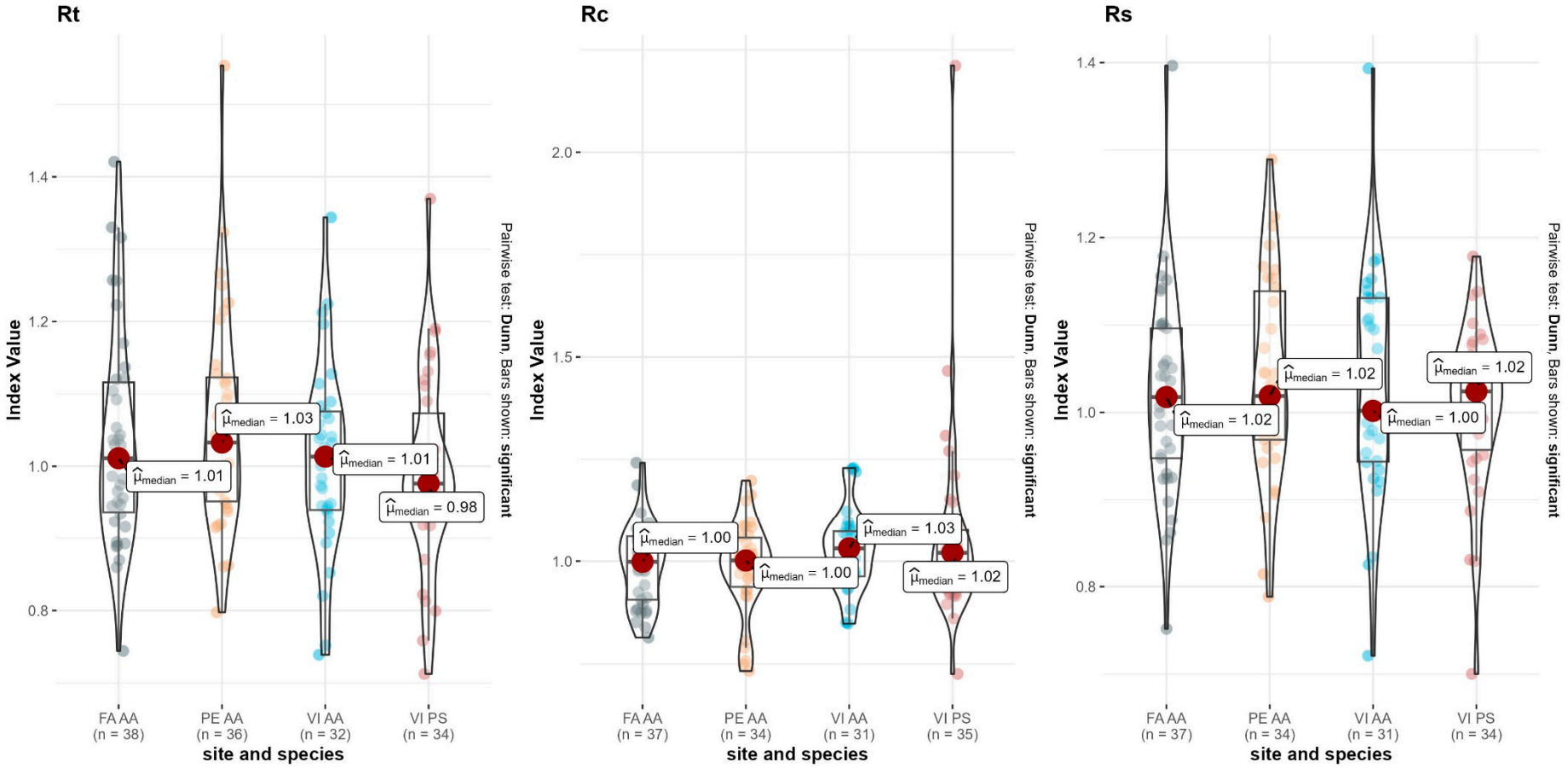

Figure S 22 EWDi Resistance (Rt) Recovery (Rc) and Resilience (Rs) indices across the study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) of Abies alba (AA) and Pinus sylvestris (PS) trees. Violin plots represent index values in four pointer years (1986, 1998, 2005, 2012) showing the median (red dots). Statistically significant differences between groups are shown using Bonferroni-adjusted p-values from Dunn's post hoc test.

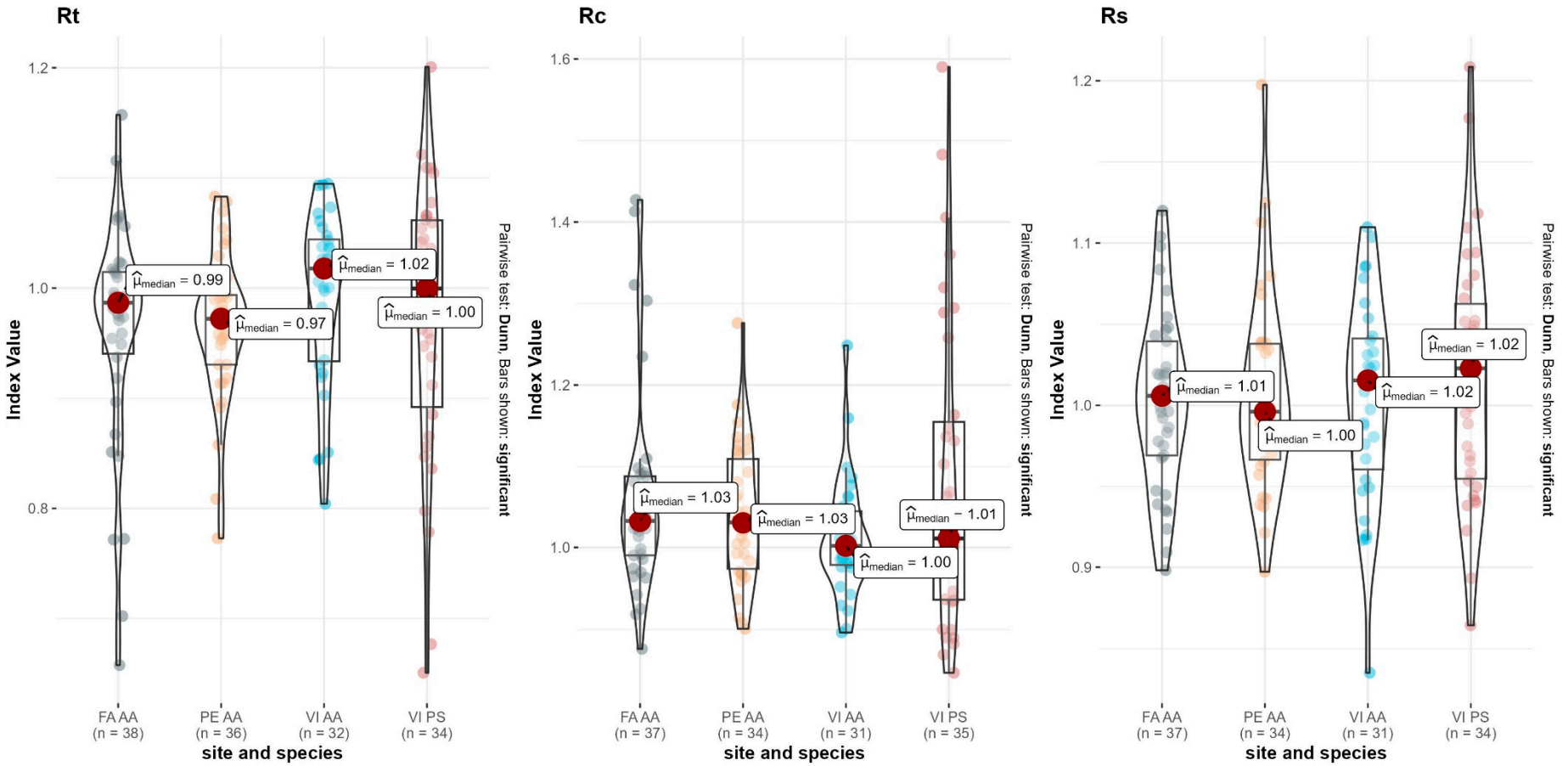

Figure S 23 LWDi Resistance (Rt) Recovery (Rc) and Resilience (Rs) indices across the study sites: FA (Fago), PE (Paco Ezpela), and VI (Villanúa) of Abies alba (AA) and Pinus sylvestris (PS) trees. Violin plots represent index values in four pointer years (1986, 1998, 2005, 2012) showing the median (red dots). Statistically significant differences between groups are shown using Bonferroni-adjusted p-values from Dunn's post hoc test.

Table S3 Independent contributions of Recovery (Rc) and Resistance (Rt) indices explaining resilience (Rs) across wood traits. Data correspond to Abies alba (AA) and Pinus sylvestris (PS) study sites (FA, PE and VI). Abbreviations: BAI, basal area increment; EWD, earlywood density; LWD; latewood density.

Variable	Term	Site_Species	Estimate	Std Error	Statistic	P-Value	r2
BAI	Rc	FA AA	0.402	0.046	8.65	<0.001	0.277
		PE AA	0.437	0.042	10.30	<0.001	0.359
		VI AA	0.889	0.062	14.20	<0.001	0.437
		VI PS	0.329	0.063	5.19	<0.001	0.143
	Rt	FA AA	0.652	0.101	6.48	<0.001	0.177
		PE AA	0.805	0.099	8.10	<0.001	0.259
		VI AA	1.230	0.082	14.90	<0.001	0.460
		VI PS	0.751	0.074	10.10	<0.001	0.390
EWD	Rc	FA AA	0.086	0.183	0.47	0.641	0.006
		PE AA	0.660	0.194	3.41	<0.05	0.266
		VI AA	0.359	0.274	1.31	0.200	0.056
		VI PS	0.165	0.133	1.24	0.223	0.046
	Rt	FA AA	0.543	0.088	6.15	<0.001	0.520
		PE AA	0.743	0.152	4.91	<0.001	0.430
		VI AA	0.764	0.101	7.32	<0.001	0.649
		VI PS	0.409	0.108	3.77	<0.001	0.308
LWD	Rc	FA AA	0.027	0.062	1.44	0.662	0.055
		PE AA	0.454	0.101	4.51	<0.001	0.388
		VI AA	0.608	0.147	4.14	<0.001	0.371
		VI PS	0.268	0.086	3.10	<0.05	0.231
	Rt	FA AA	0.138	0.074	1.87	0.0.73	0.096
		PE AA	0.150	0.183	0.82	0.418	0.020
		VI AA	0.576	0.185	3.11	<0.05	0.250
		VI PS	0.081	0.133	0.61	0.545	0.012