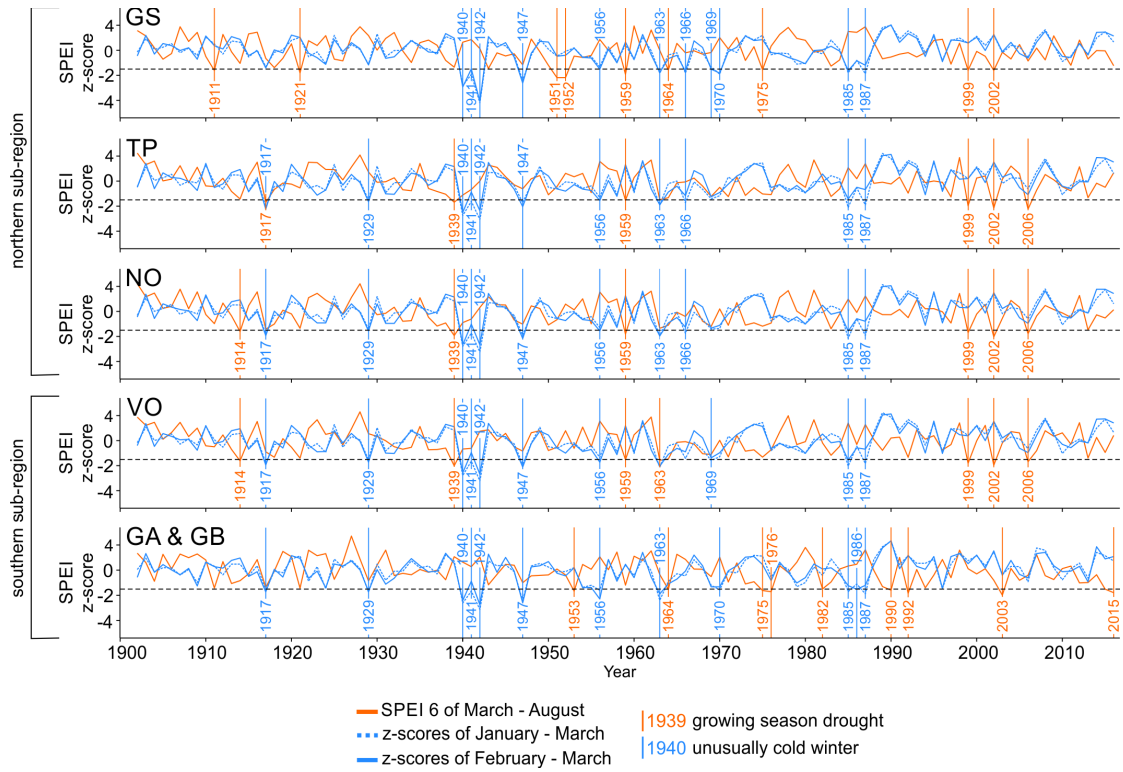
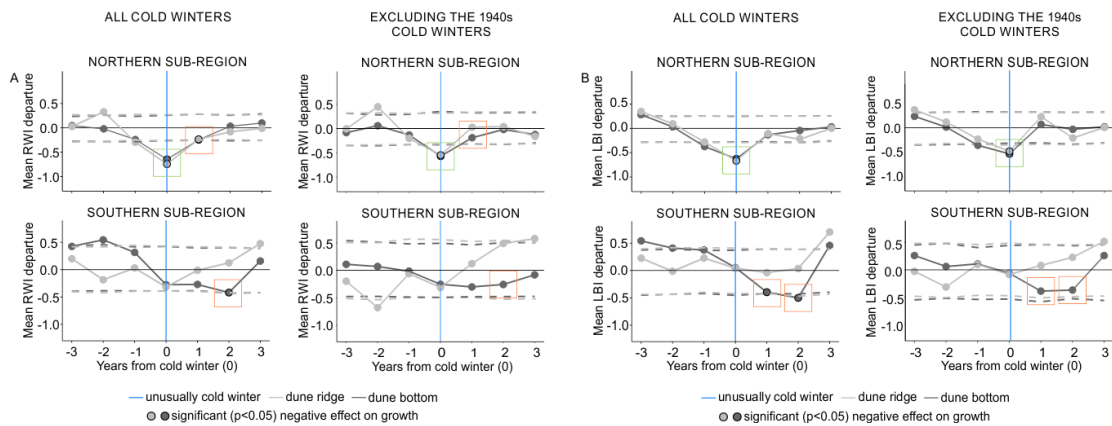


## Supplementary Material



**Figure S1.** SPEI6 integrated over March – August season (orange line) and z-scores of January – March (dashed blue line) and February – March (solid blue line) temperatures as well as individual site-specific growing season droughts (orange vertical lines) and unusually cold winters (blue vertical lines) which exceed a threshold of SPEI and z-score  $\leq -1.5$  (horizontal dashed line). See Table 1 in the article for description of site names and abbreviations.



**Figure S2.** The results of superposed epoch analysis (SEA) conducted to study the robustness of the method. The comparison has been done for the SEA performed for all and selected (all excluding the events in the 1940s) superposed sub-region-specific cold winter events, ring width (A) and

latewood blue intensity (B) datasets. Light and dark gray represent dune ridge and bottom microsites, respectively. Blue line shows an event year (i.e., superposed sub-region-specific cold winters) and circles with black outline present significant negative effect on growth. Horizontal dashed lines represent significance threshold at  $p < 0.05$ . Green rectangle indicates that after excluding the 1940s cold winter events from the SEA, the response stayed significant within a sub-region and a tree-ring parameter. Orange rectangle indicates that after excluding the 1940s cold winter events from the SEA, the response has turned to be insignificant within a sub-region and a tree-ring parameter.

**Table S1.** Descriptive statistics of ring width (RW) and latewood blue intensity (LBI) chronologies per microsite calculated for the 1902-2016 period relevant for Superposed Epoch Analysis.

Region	Microsite	Chronology span (years) N>5		EPS		Rbar		GLK	
		RW	LBI	RW	LBI	RW	LBI	RW	LBI
Estonia	VOR	1816-2016	1816-2016	0.97	0.95	0.44	0.33	0.65	0.63
	VOB	1816-2016	1829-2016	0.97	0.84	0.43	0.15	0.65	0.63
	TPR	1861-2016	1862-2016	0.96	0.94	0.38	0.30	0.66	0.64
	TPB	1875-2016	1875-2016	0.97	0.96	0.40	0.35	0.66	0.68
	NOR	1819-2016	1829-2016	0.97	0.94	0.42	0.21	0.64	0.62
	NOB	1825-2016	1825-2016	0.95	0.92	0.40	0.30	0.64	0.64
Sweden	GSR	1683-2016	1724-2016	0.93	0.90	0.31	0.24	0.61	0.62
	GSB	1804-2016	1808-2016	0.94	0.90	0.45	0.34	0.66	0.63
Poland	GBR	1854-2016	1857-2016	0.95	0.91	0.39	0.27	0.64	0.62
	GBB	1852-2016	1853-2016	0.96	0.92	0.43	0.30	0.67	0.62
	GAR	1859-2016	1859-2016	0.95	0.93	0.39	0.33	0.66	0.62
	GAB	1852-2016	1852-2016	0.94	0.95	0.37	0.38	0.64	0.64

**Table S2.** Results of superposed epoch analysis for all individual growing season droughts, microsite ring-width (RW), and latewood blue intensity (LBI) chronologies. White cells indicate lack of drought detected at a certain site, while orange cells indicate identified drought. The numbers in the orange cells indicate the timing of growth response, for example, 0 means an effect on RW/LBI in the event year, +1, +2, and +3 mean an effect on RW/LBI one, two, and three year(s) after the event. At the same time, these numbers indicate the duration of growth reductions, for example: 1, 2, and 3 in a single orange cell mean that growth reduction lasted three years. A blank orange cell (i.e., with no numerical value) indicates an absence of drought effect on growth although drought was climatically recorded. See Table 1 in the article for description of (micro)site names and abbreviations.

year	ring width											
	GS		TP		NO		VO		GA		GB	
	GSR	GSB	TPR	TPB	NOR	NOB	VOR	VOB	GAR	GAB	GBR	GBB
1911												
1914												
1917												
1921												
1939			+1	+1,2	+1		+1,2,3	+1				
1951												
1952												
1953									+1		+1	
1959												
1963												
1964												

1975									+2			
1976									+1			
1982									+1			
1990												
1992												
1999												
2002				+1,2								
2003												
2006												
2015												

year	latewood blue intensity											
	GS		TP		NO		VO		GA		GB	
	GSR	GSB	TPR	TPB	NOR	NOB	VOR	VOB	GAR	GAB	GBR	GBB
1911												
1914												
1917												
1921												
1939			+1		+1	+1	+1,2,3	+1				
1951												
1952												
1953									+1	+1	+1	
1959	+1,3			+3		+1						
1963												
1964												
1975									+1	+1	+1,2	
1976									0	0	0,+1	
1982									0			
1990												
1992												
1999												
2002			+1	+1	+1		+3					
2003									+3		+3	
2006							0					
2015												

**Table S3.** Results of superposed epoch analysis for all individual unusually cold winter events, microsite ring-width (RW), and latewood blue intensity (LBI) chronologies. White cells indicate lack of cold winter detected at a certain site, while blue cells indicate identified cold winter. The numbers in the blue cells indicate the timing of growth response, for example, 0 means an effect on RW/LBI in the event year, +1, +2, and +3 mean an effect on RW/LBI one, two, and three year(s) after the event. At the same time, these numbers indicate the duration of growth reductions, for example: 1, 2, and 3 in a single blue cell mean that growth reduction lasted three years. A blank blue cell (i.e., with no numerical value) indicates an absence of cold winter effect on growth although winter frost was climatically recorded. See Table 1 in the article for description of (micro)site names and abbreviations.

year	ring width											
	GS		TP		NO		VO		GA		GB	
	GSR	GSB	TPR	TPB	NOR	NOB	VOR	VOB	GAR	GAB	GBR	GBB
1917										+1,2		+2
1929								+1,2				
1940	0,+1,2	0,+1	0	0,+1	0		0,+1,2	0				
1941	0,+1	0		0			+1					
1942	0						0					
1947									+2	+2	+2	+2
1956			0		0		0					
1963												
1966												
1969							+2					
1970												
1985				0								
1986												
1987												

Year	latewood blue intensity											
	GS		TP		NO		VO		GA		GB	
	GSR	GSB	TPR	TPB	NOR	NOB	VOR	VOB	GAR	GAB	GBR	GBB
1917										+2		+2
1929								+2				+1
1940	+1,2	+1	0		0	0	0,+1,2,3	0				
1941	0,+1	0					0,+1,2					
1942	0						0,+1					
1947									+1,2	+1,2	+1,2,3	+1,2
1956					0		0	0				
1963												
1966		+3										
1969		0					+3					
1970												
1985	+2		0	0,+2								
1986												
1987	0			0								