



# Eberswalde University for Sustainable Development

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NE-Germany - A dendroecological and  
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# Climate Sensitivity of Rare Native Tree Species in NE-Germany A Dendroecological and Ecophysiological Approach

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**Project overview** The project aims to **identify suitable tree species to increase the biodiversity in Northeast German forests under changing climate**. The climate projections for this region predict higher temperatures and less precipitation during the growing season and generally more extreme events (Lasch *et al.* 2002; Lindner *et al.* 1997). In particular we assess the **sensitivity of rare native tree species to extreme/prolonged summer drought**. These rare and less frequently studied species include *Taxus baccata* (TB), *Betula pendula* (BP), *Carpinus betulus* (CB), *Prunus avium* (PA), *Acer campestre* (AC), *Malus sylvestris* (MS), *Pyrus pyraeaster* (PP) and *Sorbus torminalis* (ST).

**Methods** In a pot experiment leaf gas exchange, water potential and biomass were assessed on watered and non-watered 3-5 year old trees during the main growing season.

In **mixed forest stands** with occurrence of the rare tree species in specific dimensions, density and vitality and low groundwater table, we collected **stand data and soil parameters** and extracted **increment cores of all eight tree species for dendrochronology and C stable isotope analysis of distinct pointer years**.

## Rare native tree species in their natural habitat

**CLIMATE DIAGNOSIS** Northeast Germany experiences only 75% of the country's annual precipitation which makes it a prime model region to investigate how drought effects vegetation.

**SITE and SPECIES SELECTION** Are rare native species of this area already adapted to the predicted, even more drought-stressed climate situation of the future?

**ANALYSIS of TREE RING GROWTH of RARE NATIVE SPECIES** Dendrochronological analyses show a site chronology synchronisation since the late 1980s, and a growth decrease for all sites in 1989, 1992, 2003 and 2006 (negative pointer years). Comparing the climatic water balance (calculated from radiation, temperature and precipitation) to the tree ring data reveals that drought stress coincides with growth depression.

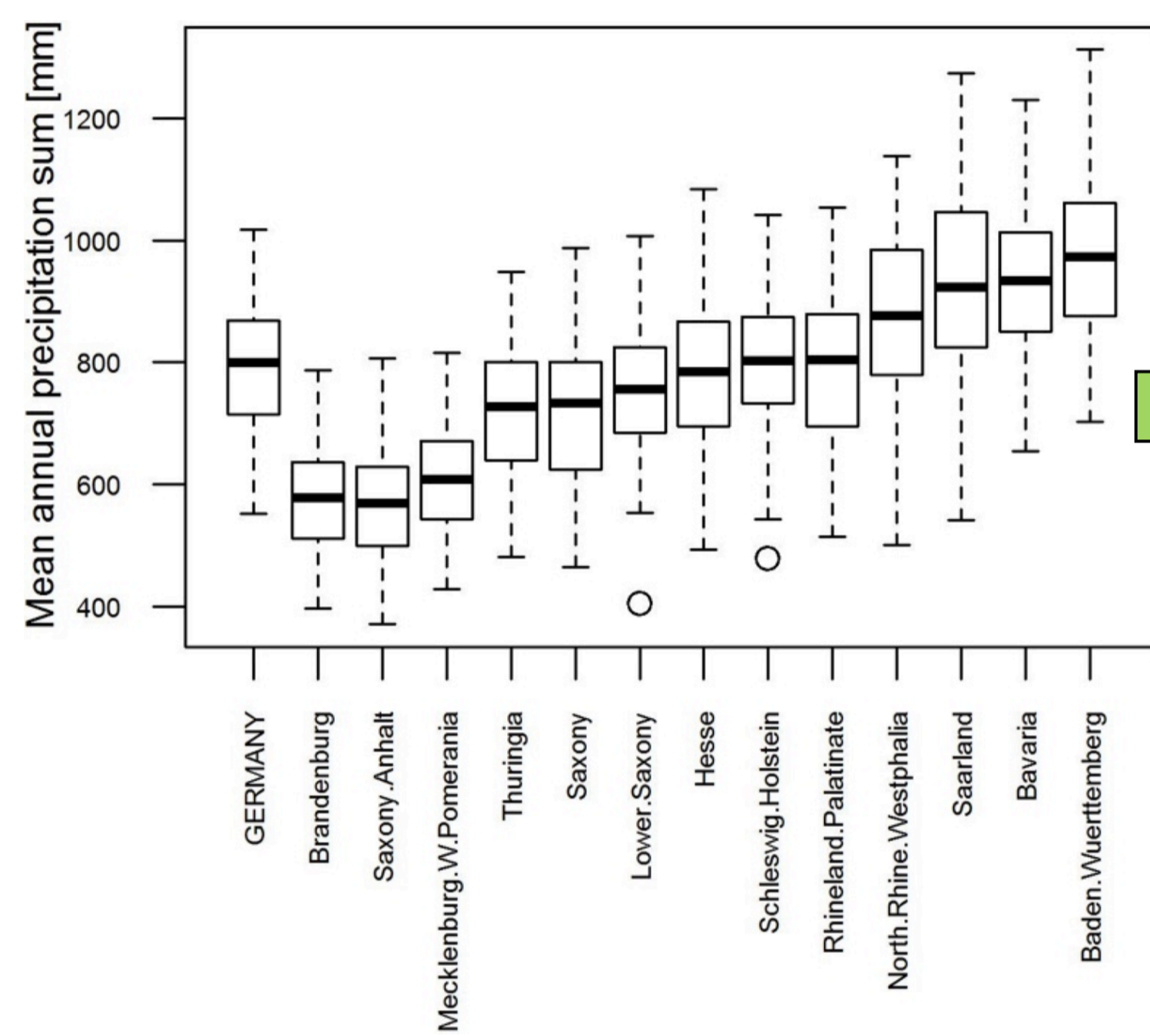


Fig.1: Annual rainfall per German federal state between 1951 and 2016.

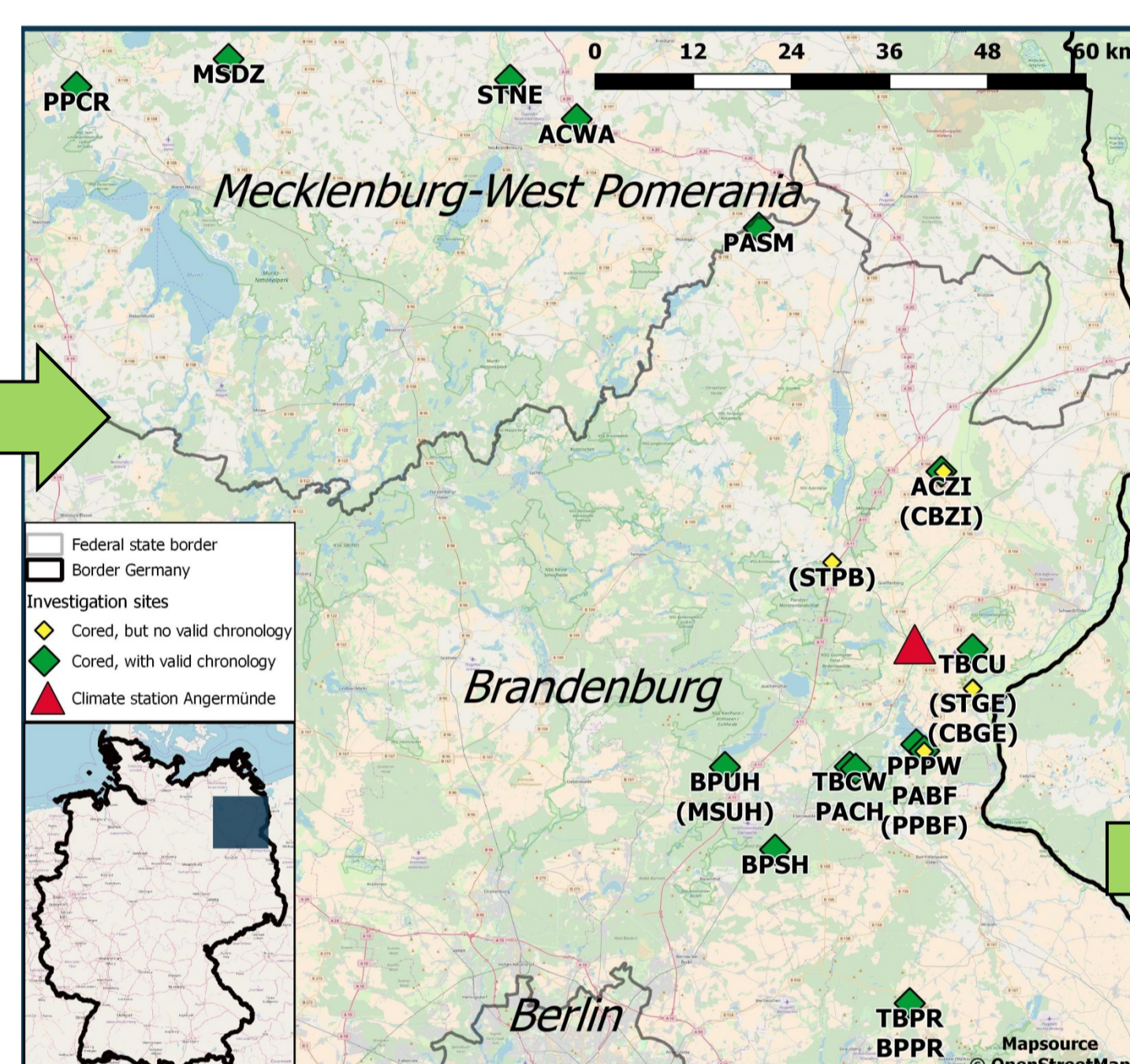


Fig.2: Study area. Site acronyms: "AABB" - species (AA), location (BB).

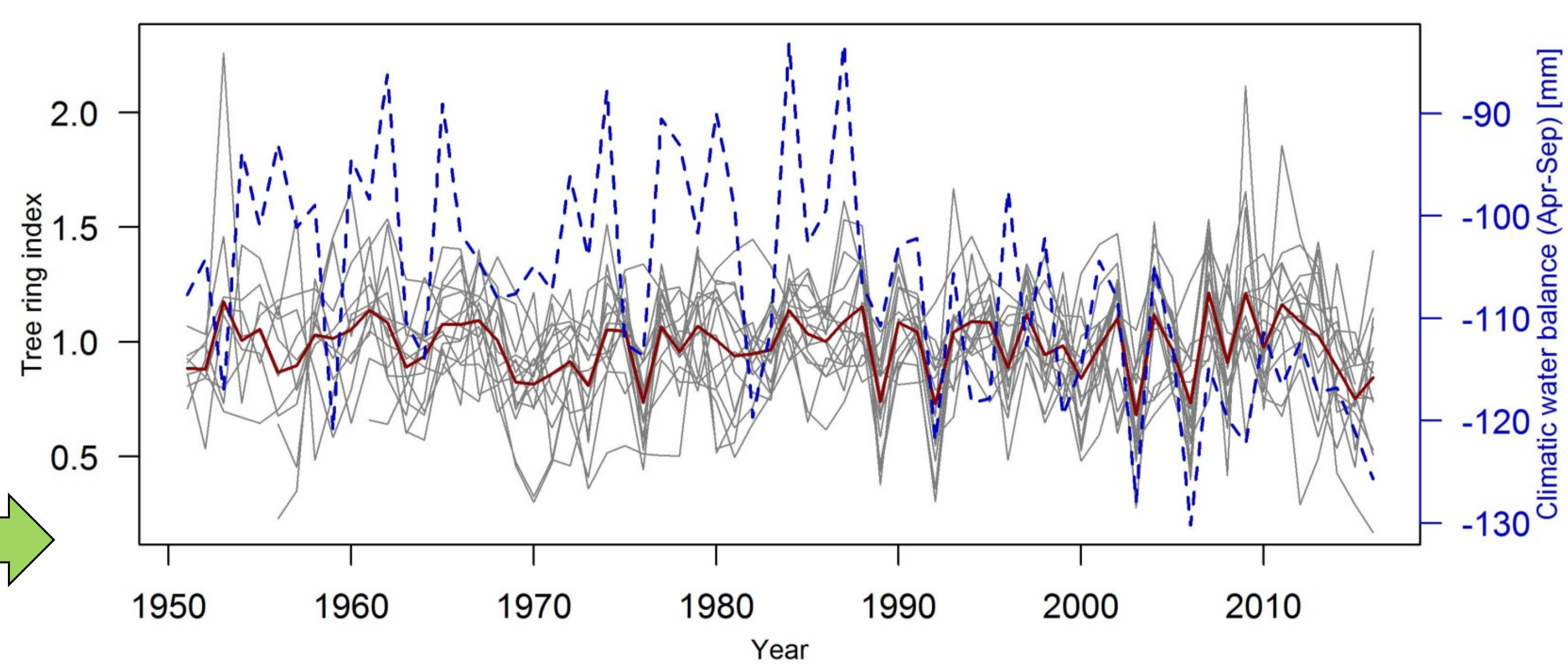


Fig.3: Tree ring chronologies per site (grey curves), Master chronology (red curve) and Climatic water balance of the growing season (dashed blue line).

## Negative pointer years – tree ring measurements and stable isotope analyses ( $\delta^{13}\text{C}$ )

**NEGATIVE POINTER YEARS** In summary the years 1976, 1989, 1992 and 2003 showed to be the most common negative pointer years.

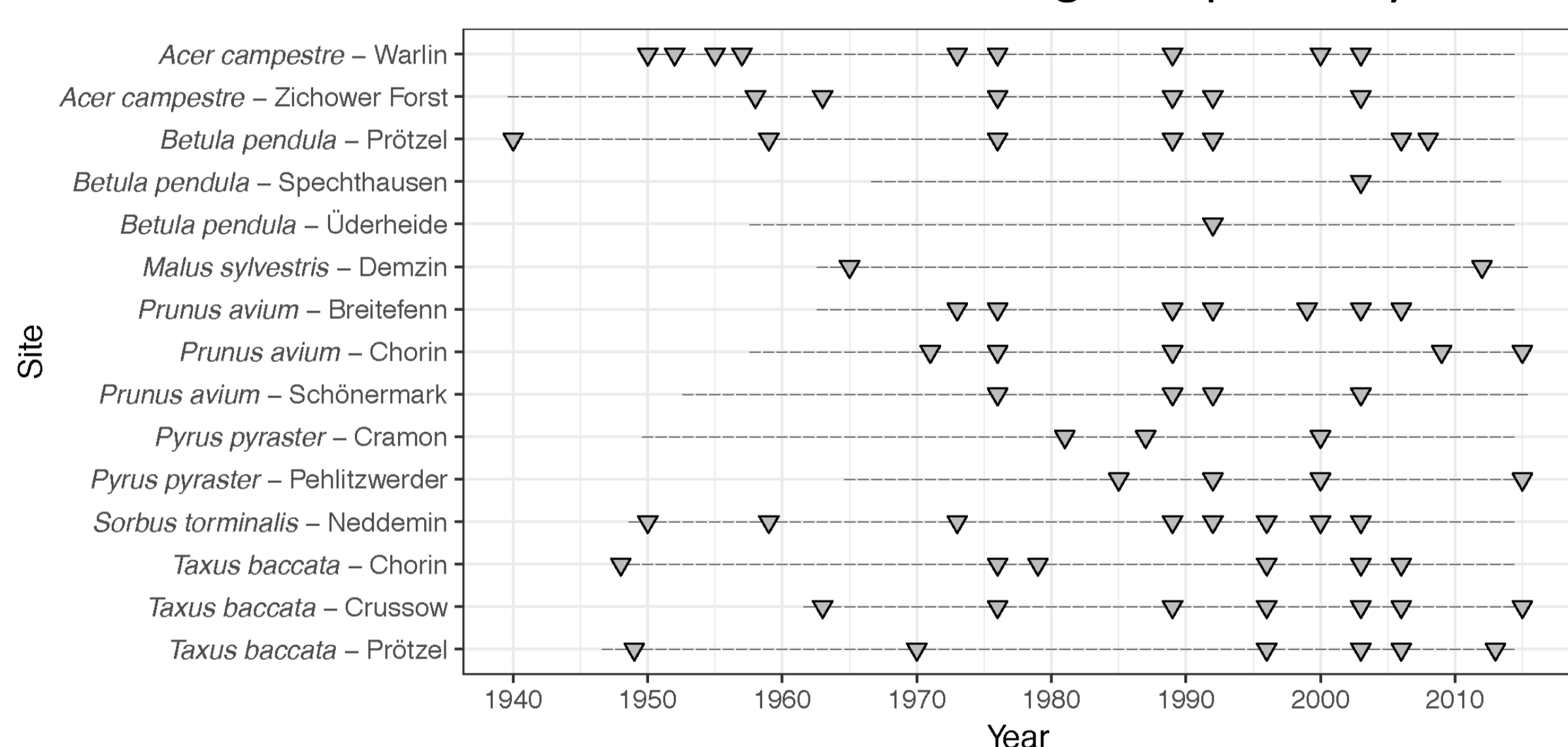


Fig.4: Negative pointer years for all sites. Triangle = negative pointer year according to Cropper with moving window = 5 years, dash = neutral year or positive pointer year (Cropper, 1979; van der Maaten-Theunissen *et al.* 2015).

**STABLE ISOTOPE NATURAL ABUNDANCE ANALYSIS ( $\delta^{13}\text{C}$ )**

Preliminary results of the raw stable carbon isotope data of individual tree rings (1971–1981 and 1998–2017) reveal years of drought stress (= stomata closure) experienced by the individual tree species expressed by less negative  $\delta^{13}\text{C}$  values. These partly overlap with the negative pointer years identified by dendrochronological analyses verifying a growth decrease through drought stress.

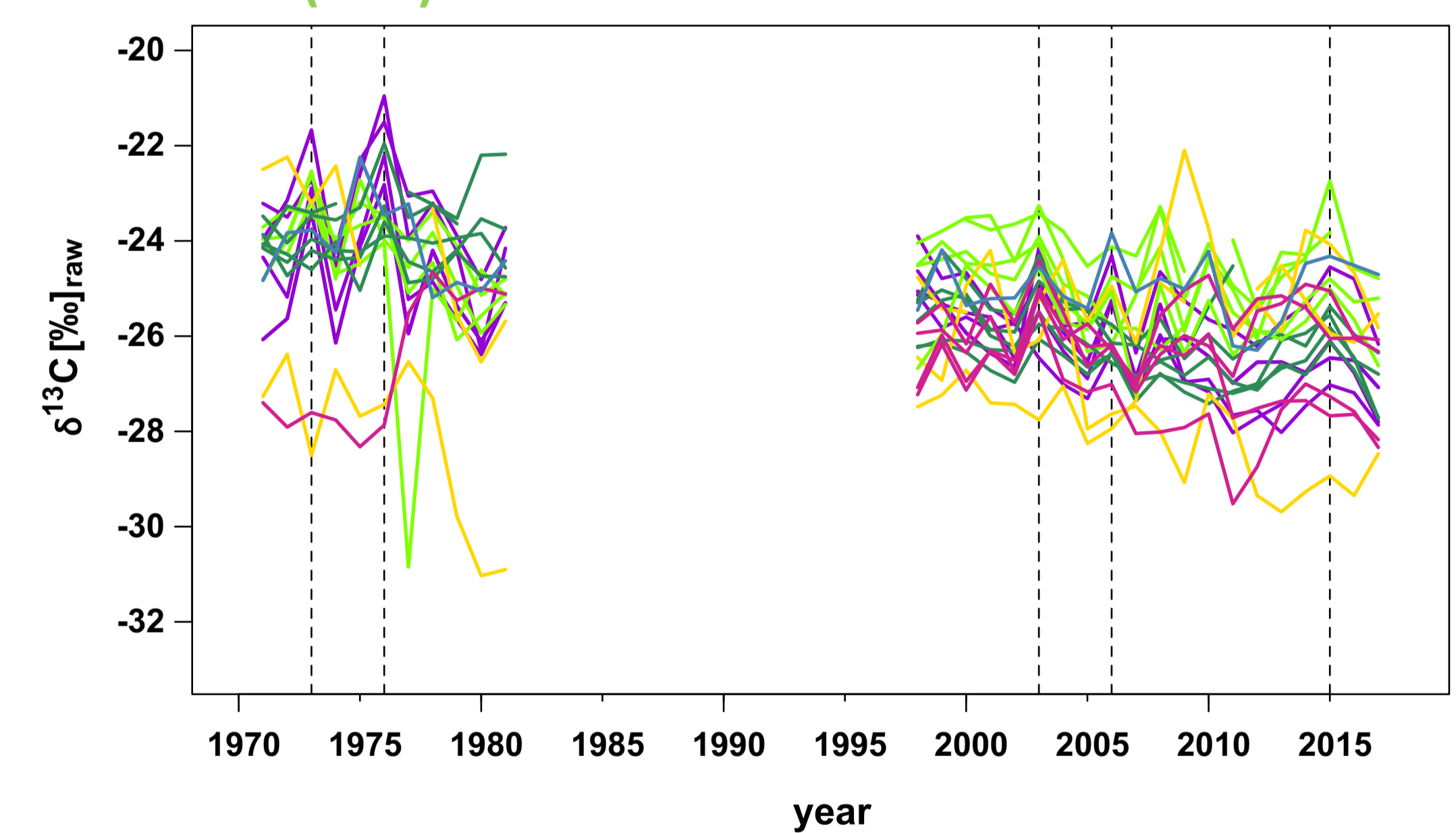


Fig.5: Raw carbon isotope ( $\delta^{13}\text{C}$ ) data of *A. campestre* (yellow;  $n = 3$ ), *B. pendula* (light green;  $n = 5$ ), *P. avium* (violet;  $n = 4$ ), *P. pyraeaster* (blue;  $n = 1$ ), *S. torminalis* (pink;  $n = 4$ ) and *T. baccata* (dark green;  $n = 5$ ). Negative pointer years 1973, 1976, 2003, 2006 and 2015 (dashed lines).

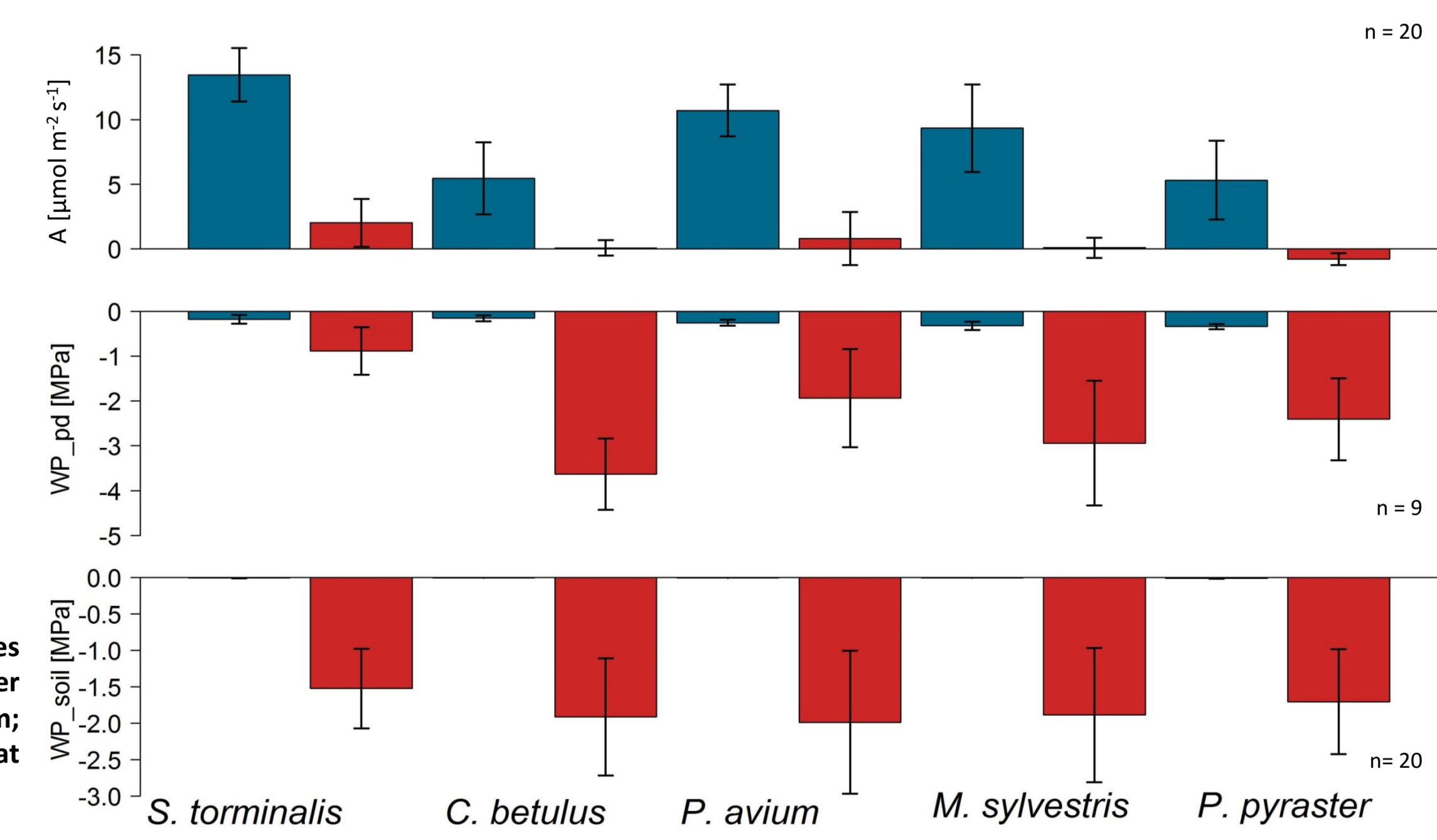
## Artificial drought for rare native tree species

**POT PLANT EXPERIMENT** Preliminary results reveal highest net assimilation rates (A) for *S. torminalis* and lowest for *P. pyraeaster* after prolonged drought (Fig.7). Predawn leaf water potential (WP<sub>pd</sub>) was also least negative in *S. torminalis* and most negative in *C. betulus*, *M. sylvestris* and *P. pyraeaster*. Transpiration rate and stomatal conductance behaved correspondingly (data not shown). *S. torminalis* so far appears to be the most isohydric of the studied species. Data from the 2018 campaign will be used to further refine the analyses.



Fig.6: (above) Experimental setup in the rainout shelter. Control trees (left and right double row) and drought trees (middle double rows) at the end of the drought 2018.

Fig.7 (right): Results for the 2017 campaign. Mean values ( $\pm 1\text{sd}$ ) of net assimilation rate (top), predawn leaf water potential (middle) and soil water potential (bottom; derived from soil water content and specific pF-curve) at the end of the drought treatment (45–56 days). Blue bars = control, red bars = drought treatment.



**Synthesis and Results** A multiproxy approach (ecophysiological measurements, dendrochronology and isotope analyses) was used to **pin-point specific reaction patterns to summer drought** and to characterize these rare native tree species in more detail concerning their adaptations to drought stress. Merged

results will be used to **assess their relative drought sensitivity**. The conclusions of this study can be used to shape silvicultural decision making to **increase tree species richness and biodiversity in a changing climate** and to better understand the **drought reactions of less studied tree species** in Northeast Germany.