

# BUG OR CLIMATE: DECOUPLING EFFECTS OF OAK LACE BUG INFESTATION AND CLIMATE CHANGE ON PEDUNCULATE OAK TREE GROWTH IN CROATIA

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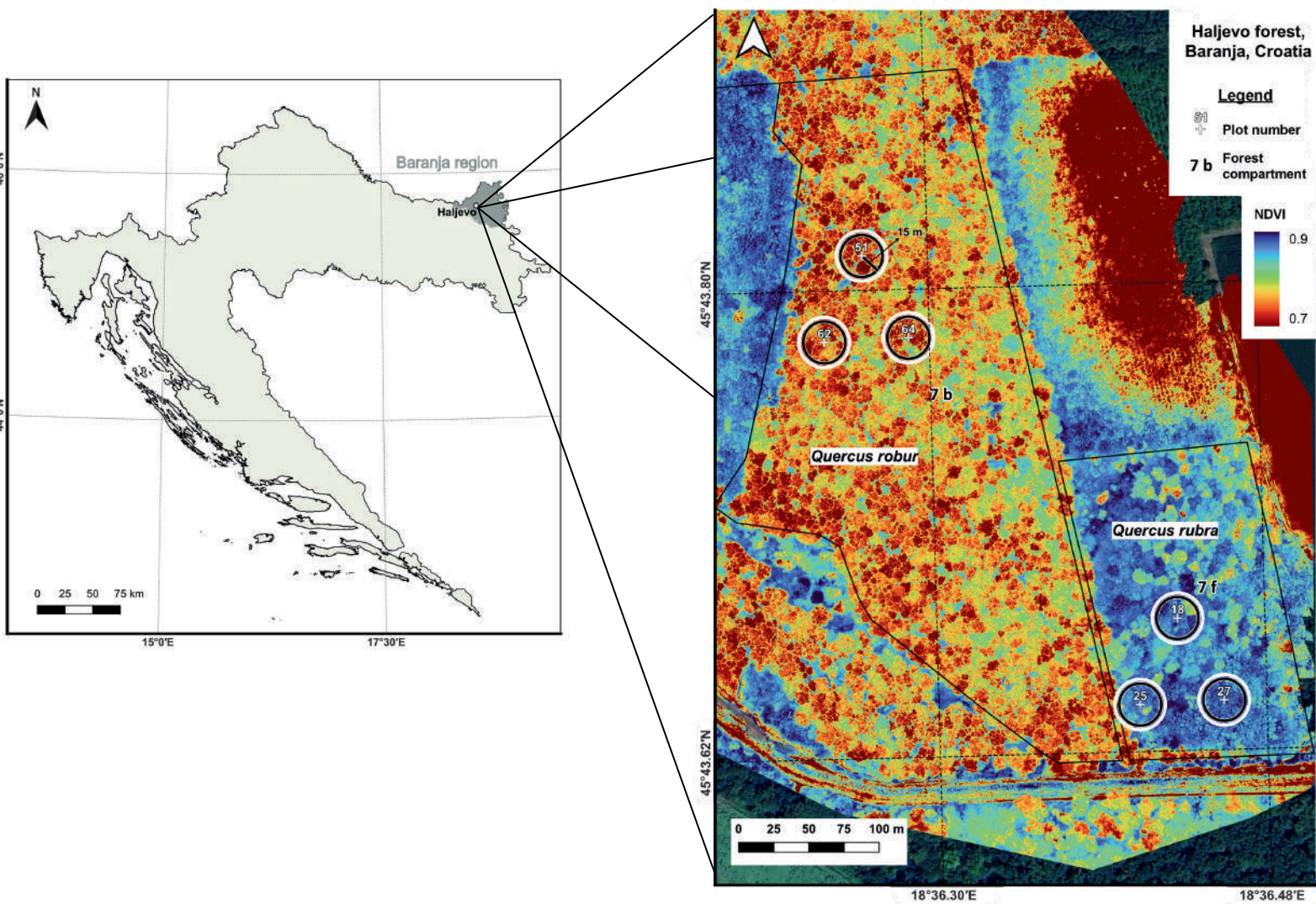
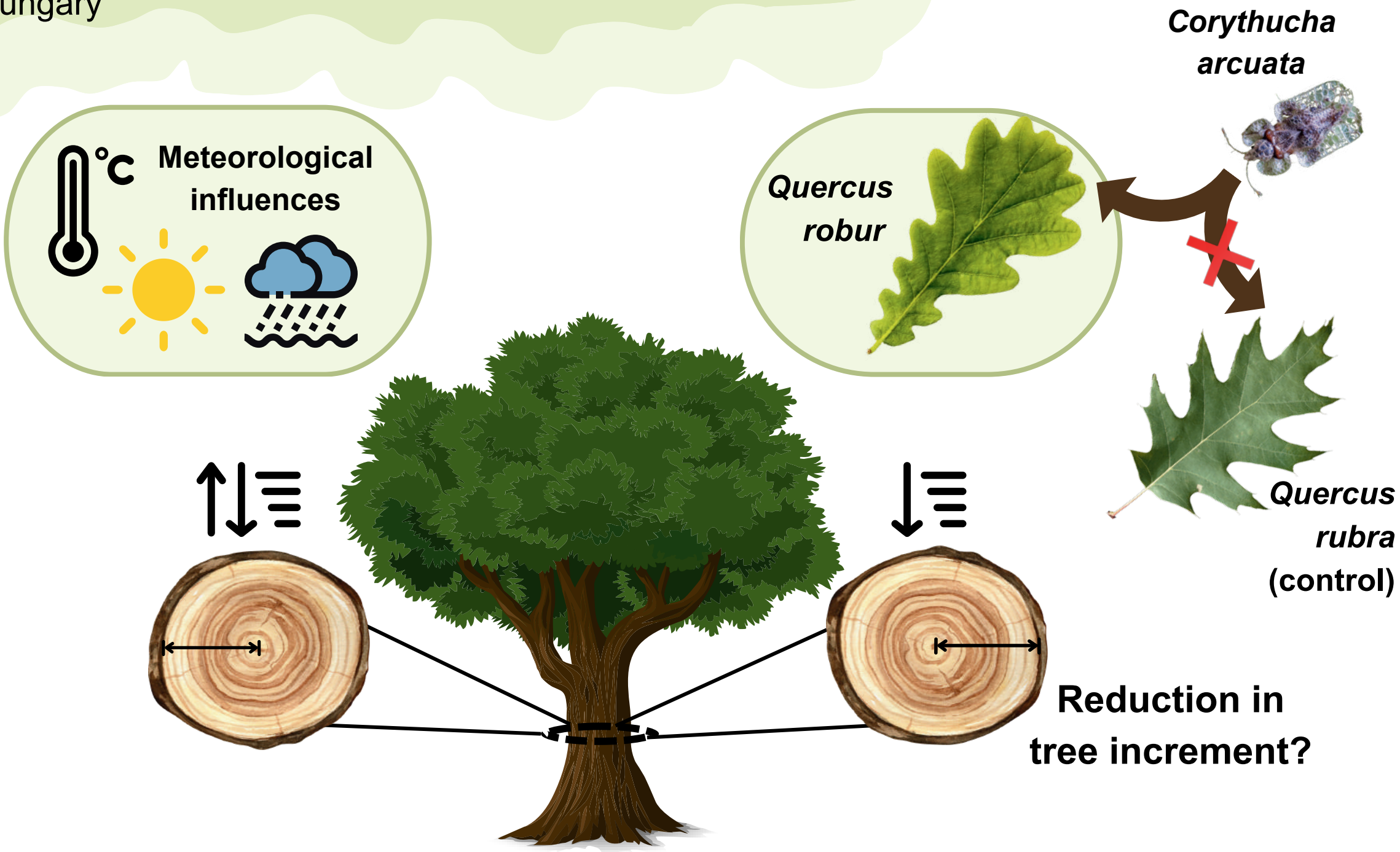
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## INTRODUCTION

The net increment of forest biomass is a critical mechanism for removing CO<sub>2</sub> from the atmosphere. Climate change and pest outbreaks negatively affect tree growth, thereby threatening carbon storage in forests. One such invasive forest pest, Oak lace bug (*Corythucha arcuata*, Say), has spread rapidly in oak forests in Croatia since 2013. It poses great concern because its infestation does not significantly diminish over time. The aim of this study is to estimate the impact of the oak lace bug on tree growth.

## MATERIALS & METHODS

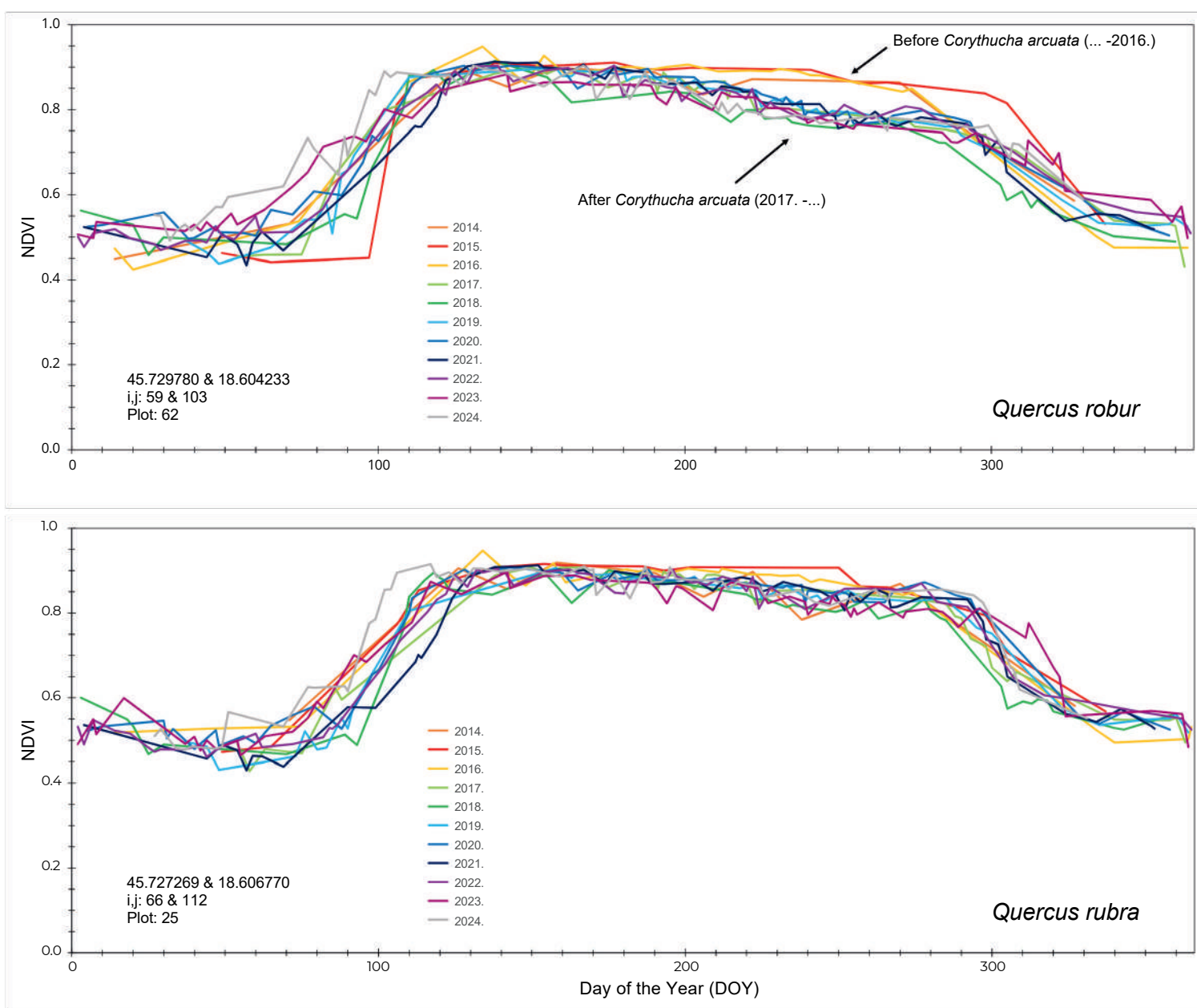
In the Baranja region (northeastern Croatia), six permanent plots were established and tree core samples were collected in 2024. Tree core samples were prepared with a microtome for long cores (WSL), scanned with a scanner, and their growth increments were measured using Coorecorder. Differences in growth dynamics between pedunculate oak (*Quercus robur* L.) and control species, red oak (*Quercus rubra* L.), were analysed for two periods, before and after pest arrived to the location (year 2016). Additionally, isotope  $\delta^{13}\text{C}$  analysis with laser ablation method for a subset of the tree core samples is being analysed to elucidate the mechanisms of impact of the oak lace bug (OLB).



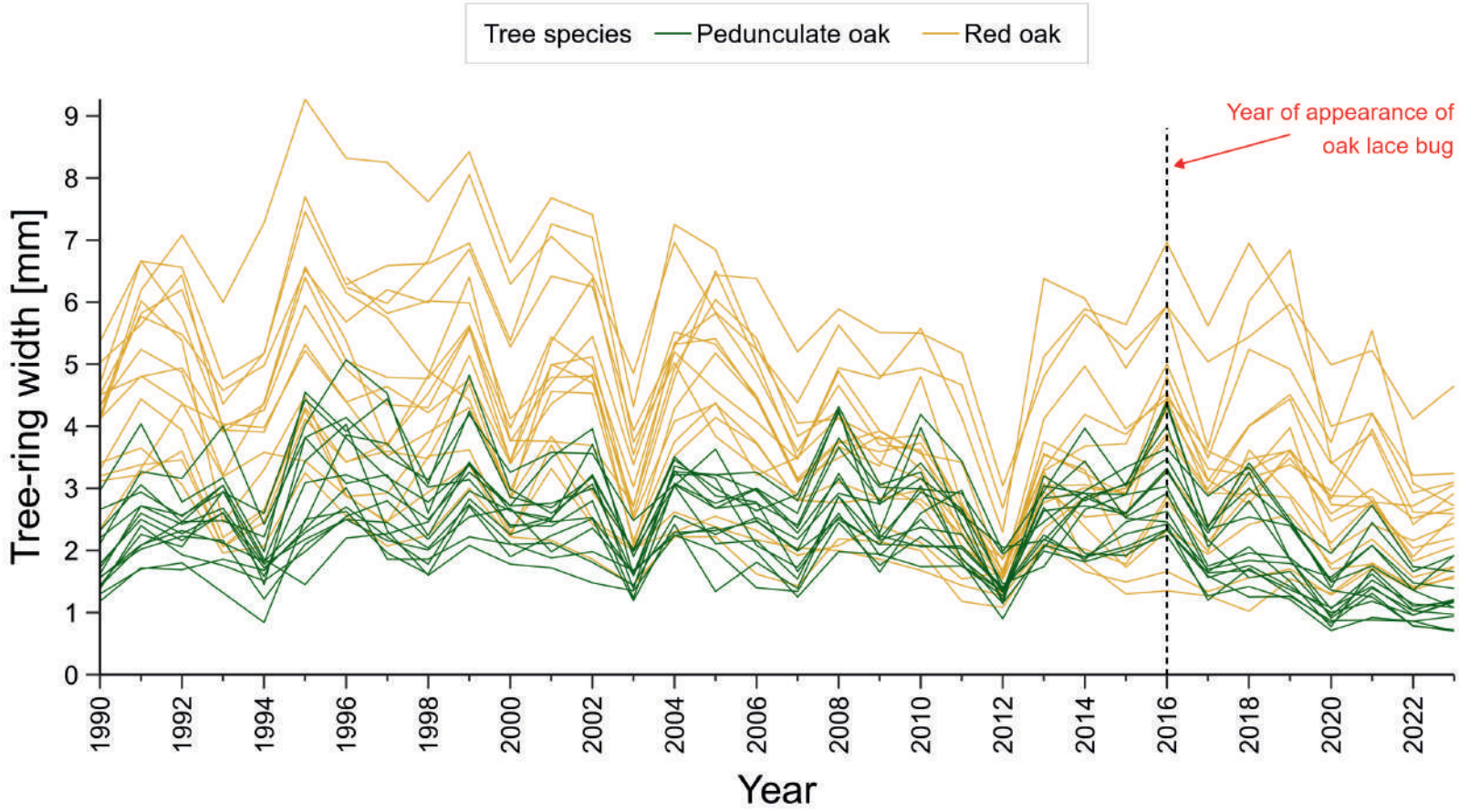
**Figure 1.** Geographical location of the research site (left) with positions of the experimental plots (white circles) within the management unit Haljevo-Kozaračke šume and forest compartments (right). Colors indicate NDVI derived from red and near-infrared spectral channels obtained with camera mounted on UAV.

**Figure 2.** Phenological NDVI curves derived from Harmonized Landsat Sentinel-2 (HLS) data for the period 2014–2024 for *Q. robur* and *Q. rubra* plots.

As the vegetation season progresses, a significant decline in NDVI is noticeable in pedunculate oak stands from 2017 onwards (top), indicating that the damage caused by the OLB became substantial during that time. In the red oak stands (bottom), no such decline is observed, as this species is not affected by the OLB (Fig. 2).



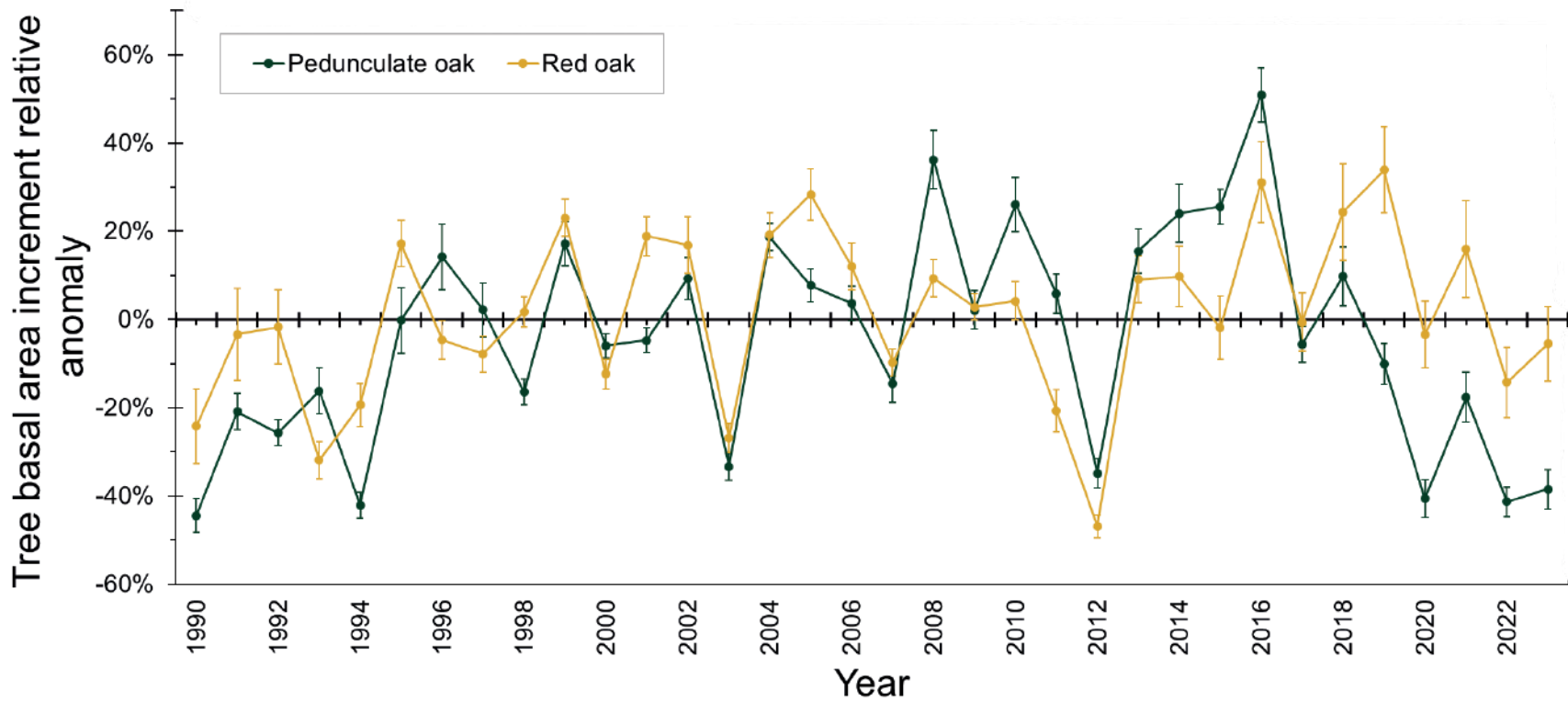
## RESULTS



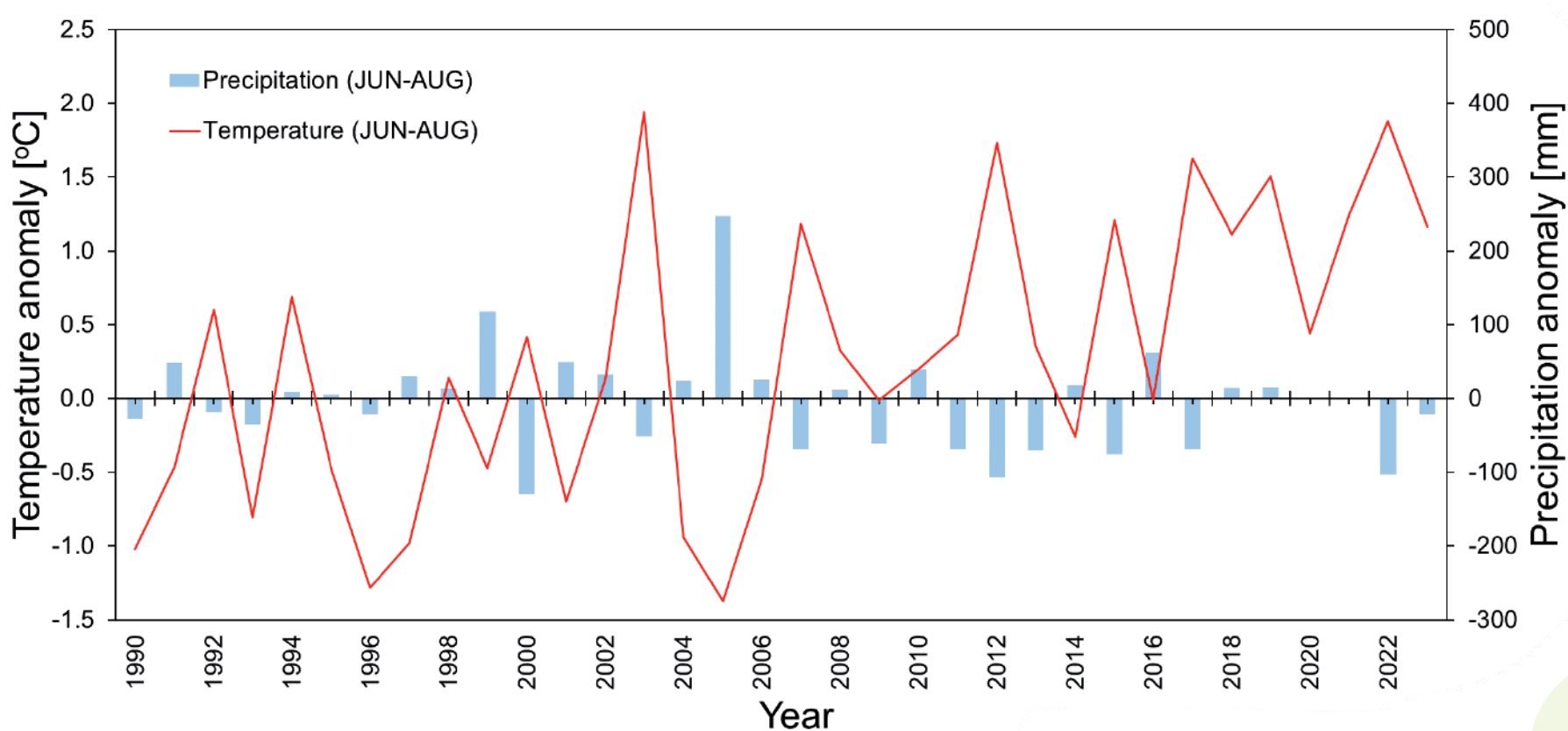
**Figure 3.** Crossdated tree-ring widths by years for pedunculate oak and red oak tree cores. The number of tree cores per tree species is 15 and 17 for pedunculate oak and red oak, respectively.

**Table 1.** Tree-ring widths (mean  $\pm$  s.e.) from all tree core samples, grouped by tree species and by 6-year periods, before (2009-2015) and after (2017-2023) OLB appeared. Different lowercase letters indicate statistically significant difference ( $p < 0.05$ ) in tree ring widths between different periods and different tree species.

Tree Species	N	Tree-ring width [mm]	
		2009-2015	2017-2023
Pedunculate oak	105	2.376 $\pm$ 0.06 <sup>a</sup>	1.581 $\pm$ 0.06 <sup>b</sup>
Red oak	119	3.078 $\pm$ 0.12 <sup>c</sup>	3.027 $\pm$ 0.11 <sup>c</sup>



**Figure 4.** Relative anomaly of tree basal area increment (mean  $\pm$  s.e.) for pedunculate oak and red oak from the 1990-2016 mean .



**Figure 5.** Mean temperature and cumulative precipitation anomalies (from June to August) for 1990-2023, relative to the 1990-2016 reference period (data source: FORESEE database).

Decoupling between pedunculate oak and red oak in basal area increment relative anomalies after 2019 is observable, indicating increment reduction of pedunculate oak due to the OLB outbreak (Fig. 4).

**Preliminary results indicate reduced tree growth of pedunculate oak after the oak lace bug outbreak, confirming a negative impact of the pest on tree increment ...**



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