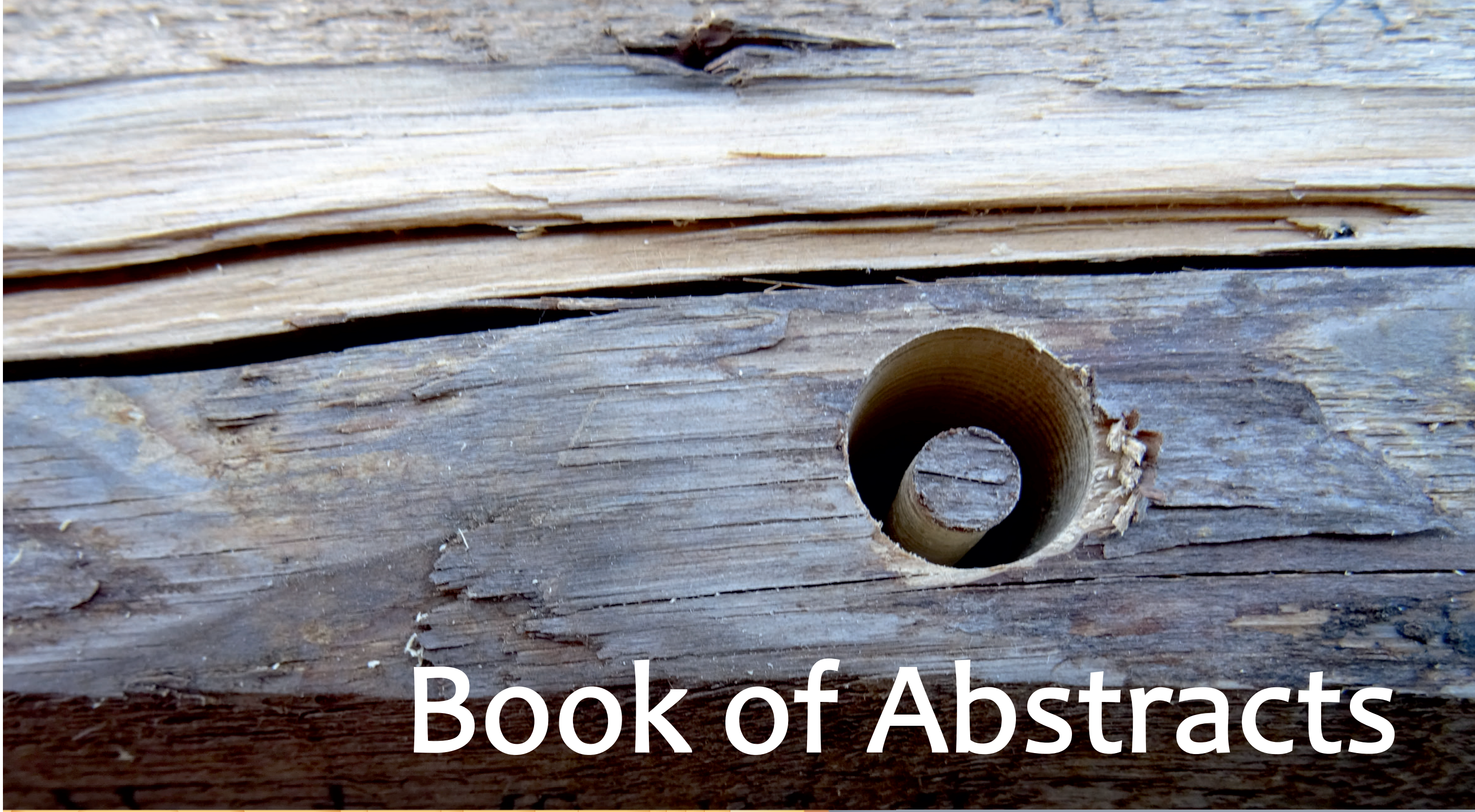


Book of Abstracts

2010 • Kolka, Latvia

2012 • Šventoji, Lithuania

2014 • Järvselja, Estonia

2016 • Annas Tree School, Latvia

2018 • Liškiava, Lithuania

•BaltDendro 2023

6th International Conference of Baltic Countries' Dendrochronologists

Saaremaa, Estonia

14–18 August 2023

BaltDendro 2023

6th International Conference of
Baltic Countries' Dendrochronologists

14–18 August 2023, Saaremaa, Estonia

Book of Abstracts

Tartu 2023

This publication contains abstracts submitted for the BaltDendro 2023 conference.

Editor: Kristina Sohar

Cover photo: Alar Läänelaid

Recommended citation:
Sohar K (ed.) (2023) Book of Abstracts. BaltDendro Conference 2023, 14–18 August, 2023, Saaremaa, Estonia. 29 p.

Citation example for individual abstract:
Klisz M, Pilch K, Wrzesiński P, Zin E (2023) Upscaling from local to regional scales, new avenues for dendroecological research to assess tree adaptation to the changing climate of the Baltic region. In: Sohar K (ed.) Book of Abstracts. BaltDendro Conference 2023, 14–18 August, 2023, Saaremaa, Estonia. p. 7.

This publication will be available at https://sisu.ut.ee/baltdendro2023/abstract

Contents

Organizers 4

Programme 5

Marcin Klisz Upscaling from local to regional scales, new avenues for dendroecological research to assess tree adaptation to the changing climate of the Baltic region 7

Alan Crivellaro Beyond wood anatomy research 8

Roberts Matisons How plastic is the eastern Baltic Scots pine? 9

Darius Valūnas High resolution environmental imprints in stable carbon isotope tree-ring records 10

Kärt Erikson Effect of water level change and weather on radial increment of Scots pine (*Pinus sylvestris* L.) in Lehtmetsa Bog 11

Aleksei Potapov Modelling tree growth under changing site conditions: forest drainage in peatlands 12

Rūtilė Pukienė Connection between (intra-)annual raised bog pines increment and meteorological conditions 13

Maris Hordo Thinning and drought response to tree growth on shelterwood cutting area 14

Virkeli Viiberg Drought effects on radial growth of Norway spruce (*Picea abies*) and silver birch (*Betula pendula*) in pure and mixed stands in Estonia 15

Sandra Metslaid Climate and drought effects on annual growth variation in Norway spruce provenances 16

Toomas Tarmu Practicality of sonic tomography (PiCUS 3 Sonic Tomograph) to detect to hidden wood decay in Estonian spruce stands 17

Vineta Vērpēja Analysis of yarrow *Achillea millefolium* and dropwort *Filipendula vulgaris* growth rings in variously aged meadows 18

Alar Läänelaid Activities at dendro-lab of the University of Tartu since 2018 19

Māris Zunde The latest results of dendrochronological dating in Latvia 20

Rūtilė Pukienė Historical versus dendrochronological dating of the rise of a city: the case of Vilnius 21

WORKSHOP I Roberts Matisons How can R help in dendrochronology: moving forward and beyond 22

WORKSHOP II Alan Crivellaro, Aleksei Potapov Blue rings 23

Excursion 24

List of participants 29

Organizers

Maris Hordo – Estonian University of Life Sciences
Sandra Metslaid – Estonian University of Life Sciences
Aleksei Potapov – Estonian University of Life Sciences
Kristina Sohar – University of Tartu
Alar Läänelaid – University of Tartu

This event is organised by the Doctoral School of Earth Sciences and Ecology, supported by the European Union, European Regional Development Fund (Estonian University of Life Sciences ASTRA project „Value-chain based bio-economy").

European Union
European Regional
Development Fund

Investing
in your future

www.emu.ee
Eesti Maaülikool
Estonian University of Life Sciences

UNIVERSITY OF TARTU

Programme

Monday, 14.08.2023

18:00 Arrival

20:00 DINNER and ICE-BREAKER

Tuesday, 15.08.2023

08:00 BREAKFAST

09:00 *Opening*

Prof. Ahto Kangur, Estonian University of Life Sciences

Kristina Sohar, University of Tartu

09:15 **Invited speaker: Marcin Klisz**, Kamil Pilch, Piotr Wrzesiński, Ewa Zin

Upscaling from local to regional scales, new avenues for dendroecological research to assess tree adaptation to the changing climate of the Baltic region

10:00 **Alan Crivellaro**

Beyond wood anatomy research

10:20 **Roberts Matisons**, Diāna Jansone, Oskars Krišāns, Āris Jansons

How plastic is the eastern Baltic Scots pine?

10:40 COFFEE BREAK

11:00 **Darius Valūnas**, Jonas Mažeika, Rūtilė Pukienė, Miglė Stančikaitė, Žana Skuratovič

High resolution environmental imprints in stable carbon isotope tree-ring records

11:20 **Kärt Erikson**, Ain Kull, Alar Läänelaid, Kristina Sohar

Effect of water level change and weather on radial increment of Scots pine (Pinus sylvestris *L.*) *in Lehtmetsa Bog*

11:40 **Aleksei Potapov**, Lauri Mehtätalo, Sandra Metslaid, Maris Hordo

Modelling tree growth under changing site conditions: forest drainage in peatlands

12:00 **Rūtilė Pukienė**, Marija Žukovskienė, Julius Taminskas, Ieva Baužienė

Connection between (intra-)annual raised bog pines increment and meteorological conditions

12:20 LUNCH

13:00 **Maris Hordo**, Reeno Sopp, Martin Tishler, Reimo Lutter, Hardi Tullus

Thinning and drought response to tree growth on shelterwood cutting area

13:20 **Virkeli Viiberg**, Sandra Metslaid, Maris Hordo

Drought effects on radial growth of Norway spruce (Picea abies) *and silver birch* (Betula pendula) *in pure and mixed stands in Estonia*

13:40 **Sandra Metslaid**, Vivika Kängsepp, Aleksei Potapov

Climate and drought effects on annual growth variation in Norway spruce provenances

14:00 **Toomas Tarmu**, Andres Kiviste, Diana Laarmann

Practicality of sonic tomography (PiCUS 3 Sonic Tomograph) to detect to hidden wood decay in Estonian spruce stands

14:20 COFFEE BREAK

14:30 **Vineta Vērpēja**, Iluta Dauškane

Analysis of yarrow Achillea millefolium *and dropwort* Filipendula vulgaris *growth rings in variously aged meadows*

14:50 **Alar Läänelaid**, Kristina Sohar

Activities at dendro-lab of the University of Tartu since 2018

15:10 **Māris Zunde**
The latest results of dendrochronological dating in Latvia

15:30 **Rūtilė Pukienė**
Historical versus dendrochronological dating of the rise of a city: the case of Vilnius

16:00 Departure to Kuressaare

16:30 Excursion in Kuressaare Castle

18:00 Walk in Kuressaare

20:00 DINNER

Wednesday, 16.08.2023

08:00 BREAKFAST

09:00 **Roberts Matisons**
Workshop I *How can R help in dendrochronology: moving forward and beyond*

11:00 COFFEE BREAK

11:20 **Workshop I** *continues*

13:00 LUNCH

14:00 **Alan Crivellaro and Aleksei Potapov**
Workshop II *Blue rings*

16:00 COFFEE BREAK

16:20 **Workshop II** *continues*

19:00 DINNER

20:00 Free time

Thursday, 17.08.2023

08:00 BREAKFAST

09:00 Excursion

14:00 LUNCH in Lümanda

14:45 Excursion

19:00 FINAL DINNER AND CLOSING WORDS

Friday, 18.08.2023

08:00 BREAKFAST

09:00 Departure

Upscaling from local to regional scales, new avenues for dendroecological research to assess tree adaptation to the changing climate of the Baltic region

Marcin Klisz[1*], Kamil Pilch[2], Piotr Wrzesiński[1], Ewa Zin[2, 3]

[1] *Dendrolab IBL, Department of Silviculture and Forest Tree Genetics, Forest Research Institute (IBL), Sękocin Stary, Poland*

[2] *Dendrolab IBL, Department of Natural Forests, Forest Research Institute (IBL), Białowieża, Poland*

[3] *Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences (SLU), Alnarp, Sweden*

* *Correspondence: m.klisz@ibles.waw.pl*

KEY WORDS: Dendrolab IBL, climate adaptation, fire reconstruction, bog pine

Dendrolab IBL is a spontaneous initiative of dendrochronologists from the Forest Research Institute working in two departments of the Institute in Sękocin and Białowieża. In Białowieża, we focus on dendroclimatology, fire ecology (including tree ring fire history reconstruction and prescribed fire), long-term tree demography, and various factors affecting stem circumference changes (Salomón et al. 2018, Zin et al. 2022). We work mainly in temperate Europe, with numerous studies in one of the best preserved old-growth woodlands of this region - Białowieża Forest (Jaroszewicz et al. 2019). Currently, we are studying the effects of weather conditions and hydrology on radial growth of Scots pine in bog forests, fire history of mixed deciduous oak-dominated forests, and current tree growth there. At Sękocin, on the other hand, we mainly study the adaptation of native and introduced tree species to climate change, both at the inter- and intra-species level, as well as on the population and individual level (Klisz et al. 2022, 2023). These studies aim to understand both the spatial and temporal variability of tree adaptation processes in Central and Eastern Europe, considering the modelling of the tree growth response to expected climate change. In collaboration with dendrochronologists from Central Europe, we investigate the climate sensitivity of *Quercus robur* considering climate change scenarios. Preliminary results demonstrated that results obtained for local sites can be transferred to regions representative of the species' climate envelope.

Jaroszewicz B, Cholewińska O, Gutowski JM, Samojlik T, Zimny M, Latałowa M (2019.) Białowieża Forest – A Relic of the High Naturalness of European Forests. Forests 10: 849. DOI: 10.3390/f10100849

Klisz M, Jevšenak J, Prokopuk Y, Gil W, Mohytych V, Puchałka R (2022) Coping with Central European climate – xylem adjustment in seven non-native conifer tree species. Dendrobiology 88: 105–123. DOI:10.12657/denbio.088.008

Klisz M, Chakraborty D, Cvjetkovic B, Grabner M, Lintunen A, Mayer K, George JP, Rossi S (2023) Functional traits of boreal species and adaptation to local conditions. In: Girona M, Morin H, Gauthier S, Bergeron Y (Eds.), Boreal Forests in the Face of Climate Change - Sustainable Management. Springer Nature Switzerland AG, pp. 323–355.

Salomón RL et al. (2022) The 2018 European heatwave led to stem dehydration but not to consistent growth reductions in forests. Nature Communication 13: 1–12. DOI: 10.1038/s41467-021-27579-9

Zin E, Kuberski Ł, Drobyshev I, Niklasson M (2022) First Spatial Reconstruction of Past Fires in Temperate Europe Suggests Large Variability of Fire Sizes and an Important Role of Human-Related Ignitions. Frontiers in Ecology and Evolution 10: 1–14. DOI: 10.3389/fevo.2022.768464

Beyond wood anatomy research

Alan Crivellaro[1]

[1] *Forest Biometrics Laboratory, Faculty of Forestry, "Stefan cel Mare" University of Suceava, Str. Universitatii 13, 720229 Suceava, Romania*

* *Correspondence: alancrivellaro@gmail.com*

KEY WORDS: plant cell walls, lignification, blue ring, plant anatomy, wood identification

The study of wood anatomy and its application in dendrochronology is moving from qualitative descriptions of anatomical structures to a quantitative approach. However, qualitative wood anatomy remains fundamental for interpreting and quantifying wood anatomical traits and needs to be fully explored. In this talk, I will present some recent studies that apply wood anatomical observations, unrevealing a reduced ability of plants to lignify their secondary cell walls under extremely cold growing season temperatures. I'll also explore the boundary and wood anatomical knowledge presenting a comprehensive analysis of global wood anatomy datasets. My talk will touch the frontiers of wood anatomy research and will highlight possible of wood anatomy endeavours.

How plastic is the eastern Baltic Scots pine?

Roberts Matisons[1], Diāna Jansone[1], Oskars Krišāns[1], Āris Jansons[1]

[1] *LSFRI Silava, Rigas str. 111, Salaspils, Latvia*

* *Correspondence: robism@inbox.lv*

KEY WORDS: provenance trial, tree-ring network, local adaptation, regional climatic signals

In the light of accelerating climatic changes and shifting species distribution, adaptability of local tree populations is becoming paramount for sustainability of forests and their ecological services. Though the populations of wide spread species can be genetically adapted to local conditions, thus determining their ecological plasticity, which burdens predictions. On the other hand, local genetic adaptation is a precondition for breeding of more sustainable genotypes. Accordingly, information on the plasticity and hence adaptability of weather-growth responses across the climatic gradient is crucial for improving the accuracy of projection of tree growth and supplementation of breeding populations.

Regional weather-growth responses were estimated for local populations in situ based on increment cores collected in commercial stands along a latitudinal transect stretching from southern Finland to northern Germany. To estimate the effect of local genetic adaptation on weather sensitivity of growth and productivity, five provenances with contrasting productivity were tested in five trials *ex situ* as well as *in situ*. Tree ring widths were measured, the time series were crossdated and detrended. Considering extended climatic gradient, the relationships between chronologies and local climatic data were estimated using generalized additive models (multiple regression), which allow estimation of nonlinear (spline) responses.

Considering that studied stands grew under temperate climate, the weather-growth relationships were complex and radial increment was affected by temperature during the dormancy period as well as the meteorological conditions determining water availability in summer. Carryover effects of conditions in summer preceding growth were also estimated. Most of the regional weather drivers of growth were estimated with nonlinear responses (bell shaped and threshold) implying better scalability compared to the linear ones. The analysis of provenances indicated productivity-sensitivity relationships, with more productive genotypes being more plastic in terms of responses to weather fluctuation.

High resolution environmental imprints in stable carbon isotope tree-ring records

Darius Valūnas[1*], Jonas Mažeika[1], Rūtilė Pukienė[1], Miglė Stančikaitė[1], Žana Skuratovič[1]

[1] *Nature Research Centre, Vilnius, Lithuania*

* *Correspondence: darius.valunas@gamtc.lt*

KEY WORDS: tree ring, delta notation, whole wood, isotopic composition, climatic variations

Annual tree ring growth increments correlate with a variety of factors, such as air temperature, cloudiness, summer and winter precipitation and availability to soil water. Hence, tree ring width and density measurements have been used for reconstructing past climates, as well as for recovery of trends of climatic variations. Another widely used proxy that reflects tree growth response to environmental factors is carbon isotope ratios in tree ring cellulose, typically expressed as delta notation $\delta^{13}C$. As an index of water use efficiency, $\delta^{13}C$ records allow a more accurate interpretation of environmental factors affecting the tree growth.

We assume that changes in the air temperature and precipitation during the growth season will result in corresponding changes in the isotopic composition of the tree ring. The assumption is based on the dependence of and the rate of carbon assimilation on the stomatal conductance preconditioned by the temperature, humidity, the amount of sunlight and availability of moisture sources. $\delta^{13}C$ values are expected to corelate with the air temperature and precipitation whereas visible digressions from the regular pattern are likely to testify climatic stress experienced by the tree.

We investigated tree rings of *Pinus sylvestris* L. collected in north-eastern Lithuania, Zarasai region. The site is not directly exposed to anthropogenic impact. The tree rings were split into 13 segments each to yield a total of 169 samples. $\delta^{13}C$ measurements were made in homogenized whole wood of the 13 samples by means of a laser absorption spectrometer. The obtained chronologies were compared with meteorological data to identify correlations with the temperature and precipitation as the key factors affecting tree growth in the site.

Effect of water level change and weather on radial increment of Scots pine (*Pinus sylvestris* L.) in Lehtmetsa Bog

Kärt Erikson[1*], Ain Kull[1], Alar Läänelaid[1], Kristina Sohar[1]

[1] *Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Estonia*

* *Correspondence: kart.erikson@ut.ee*

KEY WORDS: Scots pine, *Pinus sylvestris* L., dendrochronology, dendroclimatology, bog

It is estimated that about 22.3% of Estonia is covered with peatlands (Orru and Orru 2008). Around 70% of Estonian peatlands have been significantly influenced by drainage or other activities (Vasander et al. 2003, Paal and Leibak 2011). The aim of this study was to create tree-ring chronologies of Scots pine from Lehtmetsa Bog and to analyse the influence of changes in water level and climatic variables on tree-ring growth.

The Lehtmetsa Bog is located in central Estonia. An old peat extraction site (active from 1969 to 1996) lies at the northern border of the study area. On the southern border is Lake Kivijärv, which has had its water level lowered twice. In this study, tree-ring samples of pine trees were collected from five different study sites along a gradient of water table.

The results from this study confirmed that growth of pines in spatially close sites differed significantly. One site out of five behaved like a natural area, two were influenced by both climate and anthropogenic changes in water level in the nearby peat extraction site or the lake. Two sites were mostly influenced by the changes in water level in the nearby peat extraction site. Comparing the study site chronologies, a noticeable correlation between the chronologies of two study areas was seen until 1970. After that the chronologies start to differ significantly due to changes in the water level in the nearby peat extraction site. There were some analogies with previous works (Dauškane et al. 2011) but also a lot of differences that can be explained by peatlands' strong hydrological conditions and anthropogenic changes in water level on tree-ring growth. The climatic analysis showed that one study site was mostly influenced by precipitation and the other two by both precipitations and temperature. Correlations between tree growth and climatic variables varied greatly by study site. Overall, the results indicate that peatland pines have a faster response to the lowering of water level than to the rise.

Dauškane I, Brumelis G, Elferts D (2011) Effect of climate on extreme radial growth of Scots pine growing on bogs in Latvia. Estonian Journal of Ecology 60: 236–248. DOI:10.3176/eco.2011.3.06

Orru M, Orru H (2008) Sustainable use of Estonian peat reserves and environmental challenges. Estonian Journal of Earth Sciences 57(2): 87–93. DOI:10.3176/earth.2008.2.04

Paal J, Leibak E (2011) Estonian mires: inventory of habitats. Regio Ltd, Tartu: 173 p. https://issuu.com/elfond/docs/estonian_mires_inventory

Vasander H, Tuittila E-S, Lode E, Lundin L, Ilomets M, Sallantaus T, Heikkilä R, Pitkänen M-L, Laine J (2003) Status and restoration of peatlands in Northern Europe. Wetlands Ecology and Management 11: 51–63. DOI: 10.1023/A:1022061622602

Modelling tree growth under changing site conditions: forest drainage in peatlands

Aleksei Potapov[1*], Lauri Mehtätalo[2], Sandra Metslaid[1], Maris Hordo[1]

[1] *Chair of Forest and Land Management and Wood Processing Technologies, Estonian University of Life Sciences, Kreutzwaldi 5, 51006, Tartu, Estonia*

[2] *Natural Resources Institute Finland (Luke), Yliopistokatu 6 B, 80100 Joensuu, Finland*

* *Correspondence: aleksei.potapov@emu.ee*

KEY WORDS: peatland, forest drainage, *Pinus sylvestris*, growth response

Peatland forestry is often associated with the management of site hydrology aimed to adjust soil moisture status and improve stand growth. The effect of ditching activities on forest growth dynamics varies greatly among diverse peatland sites and modelling post-treatment growth can be challenging also because of growth release events associated with shifts in site hydrology governed by regional climate dynamics. Understanding the effects of hydroclimatic factors and silvicultural operations on the growth trends of peatland forests is of great importance since peatland ecosystems are key players in the global carbon cycle.

We developed two tree-level mixed-effect models to estimate *Pinus sylvestris* basal area growth response to initial ditching and ditch network maintenance (DNM) based on ring-width data collected from peatland stands across Estonia. The results indicated that initial ditching induced an additional increment up to around 800 mm^2 $year^{-1}$ on average, the maximum response value was reached 16 years after the treatment. Response to DNM was smaller (varied up to 500 mm^2 $year^{-1}$), but the maximum value was reached faster (after 10 years on average). Smaller trees experienced greater growth response, however, larger trees responded faster than smaller ones. The models suggest that growth response to ditching and DNM was more pronounced in stands with lower growing stock (most likely because in highly-stocked stands groundwater level was sufficiently deep already before the treatment due to biological drainage) and in more productive sites. Trees closer to the drainage ditch responded slightly more intensively to changes in site conditions after initial ditching, however, contrary to previous research, this relationship was significant only in the case of one of the ditches surrounding a forest stand (reference ditch selected according to the topography of the landscape) but not the nearest one.

Connection between (intra-)annual raised bog pines increment and meteorological conditions

Marija Žukovskienė[1*], Julius Taminskas[1], Ieva Baužienė[1], Rūtilė Pukienė[1,2]

[1] *Nature Research Centre, Akademijos str. 2, LT–08412 Vilnius, Lithuania*

[2] *National Museum Palace of Grand Dukes of Lithuania*

* *Correspondence: marija.zukovskiene@gamtc.lt*

KEY WORDS: raised bog, tree rings, EW (earlywood), LW (latewood)

Globally peatlands are indicators and regulators of climate change processes. In previous studies the peatland trees were used as proxies for various environmental variables (Läänelaid 1982, Linderholm et al. 2002, Linderholm and Leine 2004, Dauskane et al. 2011, Moir 2012). Based on dendro-climatological studies of the Scots pine it was determined that tree rings are negatively affected by cold winters and summer droughts in Lithuania (Vitas and Erlickytė 2008, Edvardsson et al. 2015). The pre-season temperature (Feb-March-April) was the most important factor for the mineral soil pines, whereas it was difficult to find a common significant factor for the peatland pines in Lithuania (Edvardsson et al. 2015).

Tree sensitivity to climatic conditions depends not only on the biological properties or hydrological regime, but also on the time period, when wood of separate tree-ring parts is formed. However, not so many studies on the response of the increment of separate tree rings parts to climate have been performed.

An assessment of temperature impact on annual rings growth of raised bog pines showed that the strongest negative impact was exerted by January temperature extremes of the current year. A positive impact on ring formation was exerted by the May temperature of the previous year. Positive influence of the precipitation on the annual tree-ring growth has been observed during April and May. Our study shows that variation in earlywood is more sensitive measure of environmental changes than latewood. Moreover, the study shows that the amount of summer precipitation has a negative impact on the formation of tree rings not only during the ongoing growth season, but also a negative influence over the three next coming years. The reason for that prolonged effect could be lagging hydrological responses in peatlands and negative influence of too high groundwater level.

Dauskane I, Brūmelis G, Elferts D (2011) Effect of climate on extreme radial growth of Scots pine growing on bogs in Latvia. Estonian Journal of Ecology 60(3): 236–248. DOI:10.3176/eco.2011.3.06

Edvardsson J, Rimkus E, Corona C, Simanauskiene R, Kazys J, Stoffel M (2015) Exploring the impact of regional climate and local hydrology on *Pinus sylvestris* L. growth variability – A comparison between pine populations growing at peat soils and mineral soils in Lithuania. Plant Soil 392: 345–356. DOI: 10.1007/s11104-015-2466-9

Läänelaid A (1982) Radial increment of bog pines and climatic changes. International Biological Programme 9: 135–146.

Linderholm HW, Leine M (2004) An assessment of twentieth century tree-cover changes on a southern Swedish peatland combining dendrochronoloy and aerial photograph analysis. Wetlands 24(2): 357–363. DOI: 10.1672/0277-5212(2004)024[0357:AAOTCT]2.0.CO;2

Linderholm HW, Moberg A, Grudd H (2002) Peatland pines as climate indicators? A regional comparison of the climatic influence on Scots pine growth in Sweden. Canadian Journal of Forest Research 32(8): 1400–1410. DOI: 10.1139/x02-071

Moir A (2012) Development of a Neolithic pine tree-ring chronology for northern Scotland. Journal of Quaternary Science 27(5): 503–508. DOI: 10.1002/jqs.2539

Vitas A, Erlickytė R (2008) Influence of droughts to the radial growth of Scots pine (*Pinus sylvestris* L.). Ekologia (Bratislava) 27(4): 367–378.

Thinning and drought response to tree growth on shelterwood cutting area

Maris Hordo[1*], Reeno Sopp[2], Martin Tishler[2], Reimo Lutter[2], Hardi Tullus[2]

[1] *Chair of Forest and Land Management and Wood Processing Technologies, Institute of Forestry and Engineering, Estonian University of Life Sciences, Fr.R. Kreutzwaldi 5, 51006, Tartu, Estonia*

[2] *Chair of Silviculture and Forest Ecology, Institute of Forestry and Engineering, Estonian University of Life Sciences, Fr.R. Kreutzwaldi 5, 51006, Tartu, Estonia*

* *Correspondence: maris.hordo@emu.ee*

KEY WORDS: thinning, drought, growth, *Pinus sylvestris*

The current trends in forest management are highlighting the need to find alternative forest regeneration systems to clear-cut based forestry. Shelterwood methods are considered a good alternative to clear-felling. Estimating the response to the extreme weather events is important for developing climate-smart management system. However, we still lack long-term assessments on how lasting are different cutting treatments effects and to what extent they contribute to pine growth recovery after drought. In this study, we aim to assess the impact of thinning after different shelterwood methods and to determine if cutting represents suitable options to increase growth resistance to drought and post-drought growth recovery.

We analyzed basal area increment (BAI) trends (period 1960-2020) from the shelterwood experimental sites. Shelterwood uniform method (SC), group selective (GC) and shelterwood strip (EC) cuttings sites were thinned in 2011 at Järvselja Study and Experimental Station in Estonia (Tishler et al. 2020). Increment core data from pine trees were collected in 2021. Growth of thinned plots were compared with unthinned (CT) plot. The Standardized Precipitation Evapotranspiration Index (SPEI) was used to estimate the severity of droughts and to assess the climate-growth relationships.

The mean annual diameter increment of all trees was the lowest (1.60 mm) on the CT plots after thinning. Growth increased 3-4 years after thinning treatments, but was stable on CT plot. The analysis showed, that mean BAI of shelter trees growing next to EC plot improved significantly ($p<0.05$) after treatment. Pine trees at shelterwood plots were less sensitive were less sensitive to drought than on CT plot. Growth resistance, recovery and resilience varied among the treatments and years, but overall growth resistance to water shortage stress was low in the studied plots. The growth recovery index depended on the calendar year and plot and was low for the two event years (1999, 2002), when meteorological droughts occurred early in the growing season.

Tishler M, Tullus T, Tullus A, Järats A, Lutter R, Lundmark T, Tullus H (2020) Effects of shelterwood method and plant stock type on the early growth and survival of pine seedlings in regeneration stands under hemiboreal conditions. Scandinavian Journal of Forest Research 35(1-2): 85-95. DOI: 10.1080/02827581.2019.1707273

Drought effects on radial growth of Norway spruce (*Picea abies*) and silver birch (*Betula pendula*) in pure and mixed stands in Estonia

Virkeli Viiberg[1], Sandra Metslaid[1*], Maris Hordo[1]

[1] *Chair of Forest and Land Management and Wood Processing Technologies, Estonian University of Life Sciences, Fr.R. Kreutzwaldi 5, 51006, Tartu, Estonia*

* *Correspondence: sandra.metslaid@emu.ee*

KEY WORDS: pure stand, mixed forest, drought, growth reaction, Norway spruce, silver birch

Due to global warming, severe droughts are nowadays occurring more frequently, affecting the tree's increment growth. Economically important species such as Norway spruce and silver birch are particularly affected. The aim of this work is to find out how the growth of Norway spruce (*Picea abies*) and silver birch (*Betula pendula*) differs during drought in pure and mixed stands and how important are the surrounding competition and species diversity for drought resistance. In the course of the study, 180 tree core samples were collected from nine stands: three pure birch, three pure spruce and three mixed stands. From each stand, 15 subject trees and their four neighbouring trees were measured. Drought years were identified using data from the Tartu-Tõravere Weather Station and six drought years were chosen for observation: 1992, 1999, 2002, 2006, 2011, 2018. Based on the information obtained and the measured parameters, basal area increment, competition and diversity indices of the stands were calculated. The results showed that birches are more affected by drought than spruces. Comparing pure and mixed stands, the drought impact on species growing in mixed stands is milder than in pure stands. The effects of competition from neighbouring trees and surrounding species diversity can be both positive and negative.

Climate and drought effects on annual growth variation in Norway spruce provenances

Sandra Metslaid[1*], Vivika Kängsepp[1], Aleksei Potapov[1]

[1] *Chair of Forest and Land Management and Wood Processing Technologies, Estonian University of Life Sciences, Fr.R. Kreutzwaldi 5, 51006, Tartu, Estonia*

* *Correspondence: sandra.metslaid@emu.ee*

KEY WORDS: tree rings, water deficit, Estonia, drought resilience indices, climate change mitigation

Drought stress has emerged as a significant concern for Norway spruce (*Picea abies* (L.) Karst.) populations, even in regions characterized by cool and humid climates. However, in such environments, adaptation to drought has received less attention compared to areas prone to arid conditions. This study aims to assess the differences in radial growth sensitivity to climate and drought response among selected Norway spruce provenances from Norway spruce provenance trails in Estonia. The assessment is based on tree-ring analysis, which allows for reconstructing past growth patterns. The mean monthly temperature, precipitation and the Standardized Precipitation Evapotranspiration Index (SPEI) were tested in the analysis to assess climate-growth relationships. In addition to climate-growth relationships, we evaluate the drought resilience of the selected provenances. The indices developed by Lloret et al. (2011) were applied, and growth reduction during drought periods and recovery capacity after drought events were evaluated, enabling us to assess the ability of studied provenance to withstand and recover from drought stress. This research provides valuable insights into the adaptive capacity of Estonian Norway spruce provenances to changing climatic conditions. It enables identifying the provenances with higher drought resilience, which is crucial for sustainable management and climate-smart forestry implementation in the region.

Lloret F, Keeling EG, Sala A (2011) Components of tree resilience: effects of successive low-growth episodes in old ponderosa pine forests. Oikos 120(12): 1909–1920. DOI: 10.1111/j.1600-0706.2011.19372.x

Practicality of sonic tomography (PiCUS 3 Sonic Tomograph) to detect to hidden wood decay in Estonian spruce stands

Toomas Tarmu[1*], Andres Kiviste[1], Diana Laarmann[1]

[1] *Chair of Forest and Land Management and Wood Processing Technologies, Institute of Forestry and Engineering, Estonian University of Life Sciences, Kreutzwaldi 5, 51006 Tartu, Estonia*

* *Correspondence: toomas.tarmu@emu.ee*

KEY WORDS: mortality, sonic tomography, decay, rot, *Picea abies*

Tree mortality is a critical factor influencing forest development and functioning, yet its understanding, particularly in the context of growth and yield estimation, remains limited. *Heterobasidion sp.* and *Armillaria sp.* are common pathogens causing significant economic damage in Estonia. The risk of infection is amplified in managed forests due to exposed surfaces and stumps. Solely relying on external signs of fungal infection often leads to inadequate assessment of stand vitality. Consequently, there is a need for a more precise method to evaluate stand health in Estonia. In our reseach, we have aimed to assess the feasibility of using sound tomography as a tool for evaluating stand health. Specifically, our focus was on Norway spruce stands as in Estonia, second and older generation Norway spruce (*Picea abies* (L.) Karst.) stands on lime-rich soils are highly susceptible to fungal infections. Our investigations yielded significant findings indicating a relationship between tomograph assessment and stump assessment when major decay damage is present. However, no such relationship has been observed between visual assessment and stump assessment, indicating that relying on external signs alone is unreliable for evaluating decay. Furthermore, our data highlights the inability of the tomograph to detect early stages of decay, such as discoloration, as these do not have a substantial impact on wood structure.

Analysis of yarrow *Achillea millefolium* and dropwort *Filipendula vulgaris* growth rings in variously aged meadows

Vineta Vērpēja[1*], Iluta Dauškane[1]

[1] *Department of Botany and Ecology, University of Latvia*

* *Correspondence: vinetaverpeja@gmail.com*

KEY WORDS: dry grasslands, annual growth rings, perennial herbs, herb dating methods, age structure

Only 0,7% of the territory of Latvia consists of natural grasslands and their numbers are declining because of unsuitable or absent management. Perennial herb growth ring research can help discover plant population dynamics, climate impact and gain the necessary information to improve existing grassland management systems. The main goal was to determine the possibility of using *Achillea millefolium* and *Filipendula vulgaris* rhizome growth ring research regarding grassland longevity and management methods. *Achillea millefolium* and *Filipendula vulgaris* could be used for growth ring analysis but further anatomical research and sample quality adjustments are needed to identify the growth ring borders more accurately. Results showed that grassland age does not impact *Achillea millefolium* and *Filipendula vulgaris* age structure and growth ring width as much as some other environmental aspects could.

Activities at dendro-lab of the University of Tartu since 2018

Alar Läänelaid[1*], Kristina Sohar[1]

[1] *Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Estonia*

* *Correspondence: alar.laanelaid@ut.ee*

KEY WORDS: dendro-dating, doors, wrecks, disturbances

The dendrochronological laboratory at the University of Tartu deals with tree-ring dating as well as dendroclimatological and -ecological questions. Here we present some topics we have worked on since the last BaltDendro 2018.

Doors as new dating objects have been under the scope recently. The door of King's Chapel in Tallinn Dome has dated – pine door 1291 *tpq*, oak planking 1381 *tpq*. Adjusting lath refers to re-use of the door. Another door from Tallinn Old Town, closing the entrance to town prison, was dated to 1392 *tpq*. This door has served at the same place during six hundred years. A challenging door was found in a family chapel in Velise, western Estonia. The chapel was built in the 1880ies, but the door appeared to originate from 1524 *tpq*. The question remains: where spent the door three and a half centuries?

In the course of restoration work we dendro-dated the covers of a manuscript, the Code of Türi, preserved in the Tallinn Archive. Surprisingly, one oak board appeared nearly 80 years earlier than another. Re-usage is confirmed by a hole in that board, filled with a wooden nog.

The renowned master Bernt Notke worked in several countries around the Baltic Sea. Among his most prominent works preserved are the altarpieces in Tallinn (1483) and Aarhus, and the triumphal cross in Lübeck. Tree-ring measurements from these were in our possession and we could check the origin of the oak wood Notke used for sculptures and constructional frameworks.

Several violins have been dated at our dendro-lab. Moreover, a double bass was opened for restoration and inside wood surfaces photographed. Similarity with tree-ring chronologies revealed the tree species – fir, dated 1847 *tpq*.

A wreck lies on the seabed near Naissaar Island. Divers brought up six wood samples from the wreck. Three of them were dated (1526). The wreck timbers probably originate from Uppland, Sweden.

An investigation of a city forest in Helsinki is going on, to find out human-caused disturbances in tree growth.

The latest results of dendrochronological dating in Latvia

Māris Zunde[1*]

[1] *Institute of Latvian History, University of Latvia*

* *Correspondence: maris.zunde@lu.lv*

KEY WORDS: Latvia, dendrochronological dating, tree-ring chronologies, historical wood structures

The Dendrochronological Laboratory of the Institute of Latvian History, University of Latvia, is currently the only unit in Latvia specializing in absolute dating of historical timbers and compilation of long tree-ring chronologies. The laboratory analyses tree-ring data of Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) H. Karst.) and pedunculate oak (*Quercus robur* L.).

The Dendrochronological Laboratory at the Institute of Latvian History has been in existence since 2004, although the work of dendro-dating historical timber commenced at the institute already in the early 1990s. Absolute dates have been obtained for almost 200 timber structures from 72 historical sites in Latvia. The largest share of the work has been performed approximately during the last ten years (2013–2023). In this time, a total of 163 timber structures or parts of structures from 53 historical sites have been dendro-dated, in addition to which the patterns of change in the radial growth of pine trunks in various pine stands at the coast of the Baltic Sea have been studied.

The absolute tree-ring chronologies for pine compiled in this period together cover the period from the 10th to the 20th century AD. The chronologies for spruce span the 16th – 19th century, and those for oak the 10th – 18th century. Special mention should be made of those tree-ring chronologies relating to historical timber structures in the old town of Riga. These were built not only of locally sourced timber, but also of timber brought from far afield along the Daugava waterway.

Historical versus dendrochronological dating of the rise of a city: the case of Vilnius

Rūtilė Pukienė[1,2*]

[1] *National Museum Palace of Grand Dukes of Lithuania*
[2] *Nature Research Centre, Lithuania*

* *Correspondence: bsrupu@gmail.com*

KEY WORDS: dendro-archaeology, wooden constructions, historical sources, 13th century

This year Vilnius, the capital city of Lithuania, celebrates its 700th anniversary. Counting the age of a populated place from the first mention of its name in written sources is a common practice generally accepted by historians. Therefore, the official beginning of the city is the year 1323, when the ‘royal city’ of Vilnius was first mentioned in the letters by Gediminas, the monarch of Lithuania in 1316–1341.

However, the letters are not the official documents of foundation. They only testify an invitation for merchants and artisans to arrive and settle down in the already organised settlement that had attributes of a ‘royal city’. Dendrochronological studies, capable of producing high precision dating results, may be used to establish a more accurate date.

Archaeological artefacts show that a permanent settlement in the Vilnius Castle’s territory dates back to the onset of the first millennium AD. Moreover, Stone Age tools have been found in the location as well. Dendrochronological dating of the oldest wooden constructions still found at the bottom of the cultural layer has revealed that in the second half of the 13th century, especially from 1270, intense building works commenced on the foothill of Upper Castle Hill. On the western cape of the hill, under the present-day Palace of the Grand Dukes, construction of the first brick castle began on the site of the former wooden buildings at the end of the 13th century.

The earliest intensive building phase established by dendrochronological investigation of the oldest wooden constructions predated the historical “birthday” of Vilnius city by more than half a century. However, dendrochronological dates have not yet acquired proper recognition by historians, even though the word ‘history’ derives from Greek and means the ‘knowledge acquired by investigation’. Thus, documentary evidence produces certain inaccuracy and find most of our settlements much younger than they actually are.

WORKSHOP I

How can R help in dendrochronology: moving forward and beyond

Roberts Matisons[1*]

[1] *Latvian State Forest Research Institute Silava*

* *Correspondence: robism@inbox.lv*

KEY WORDS: data analysis, visualization, R

Data curation, analysis, and visualization are paramount for a successful scientific effort. Usually for such efforts, different platforms and software (programmes) are used, which burden the process and render its repeatability, particularly in case of time-limited revisions, troublesome. Murphy's laws also govern the universe. Accordingly, application of a single platform/software for the above-mentioned tasks can facilitate/improve the scientist's day, particularly in the long run. Among the freeware, R is one of the most promising programs in many sciences, including dendrochronology.

In the workshop, R, its principles, ideas, and merits will be presented in a practical manner aiming to meet needs of dendrochronological research. Topics from data preparation, import, standardisation, evaluation, and analysis will be demonstrated and furnished with some theoretical aspects. Several statistical concepts and methods for the extraction of environmental signals stored in tree ring data will be assessed. Basics of visualization of the acquired results will be presented.

For the workshop, it is highly recommended that participants take their laptops with them. If there is an option, MS is preferable over Mac, though both systems are compatible with R.

It is also advantageous if the latest version of R and RStudio (which is a graphical interface for R) is installed un laptops as well as the packages "readxl", "dplR", "treeclim", "pointRes", "plyr", "mgcv", "FactoMineR", "MASS", "lme4", "nlme", "reshape2", "lmerTest", "emmeans", and "gratia". Note, that the program is case sensitive.

It is also advisable that participants take their own datasets (crossdated tree-ring time series) with them, although sample datasets will be provided.

WORKSHOP II
Blue rings

Alan Crivellaro[1], Aleksei Potapov[2]

[1] *Forest Biometrics Laboratory, Faculty of Forestry, "Stefan cel Mare" University of Suceava, Str. Universitatii 13, 720229 Suceava, Romania*

[2] *Estonian University of Life Sciences. Institute of Forestry and Engineering. Fr. R. Kreutzwaldi 5, Tartu 51006, Estonia*

* *Correspondence: alancrivellaro@gmail.com*

KEY WORDS: plant cell wall lignification, astrablue, safranine, dendrochronology

This hands-on workshop dedicated to blue rings in dendrochronology will be structured in two parts. First, a presentation of how blue rings were described and a review of the current understanding of their formation hypothesis will be drawn. Then a hands-on, laboratory-led activity will explore sampling techniques in the field, wood sectioning, double staining and blue ring observations through the microscope. The workshop will offer the opportunity to update on personal experiences on blue ring occurrence analyses and formation hypotheses.

Excursion on Thursday, 17 August

Compiled by Alar Läänelaid, Jaan Pärn, Kristina Sohar
Guided by Jaan Pärn and Alar Läänelaid

Excursion route, 250 km in total (base map by Google Maps)

9.00 departure from **(1) Suur Töll Holiday Village**

12.5 km 11 min

9.15 (2) Loode Oak Forest: 15 min

One of the few natural oak forests and wooded meadows in Estonia. Moderate human disturbance (mowing) maintains a refuge for inter- and post-glacial tundra-steppe species. More than 70 plant species can grow on one square meter of wooded meadow. The Loode forest hosts 14 orchid species. Without mowing, the meadow would develop into a pine-oak forest with lower plant species diversity, like it was before the humans. Protected since 1955. 40 oak trees cored 2004 and 2005, oldest oaks since ca 500 yrs, mostly 400 – 200 yrs ago. Oak planting about 1800.

Läänelaid A, Sohar K, Meikar T (2008) Present State and Chronology of Oaks in an Oak Forest in Saaremaa Island, Estonia. Baltic Forestry 14:34−43.
https://balticforestry.lammc.lt/bf/PDF_Articles/2008-14[1]/BF%2014(1)%2034_43.pdf

Departure 9.30
14.3 km 12 min

9.45 (3) Salme ship burials: 15 min

A map dating from 1650 shows the river of Salme as a strait between the islands of Kuressaar and Sõrve (https://osiliana.eu/en/salme-ship-burials/)

Map 1650: strait (*salm* in Estonian dialect) between the (then separate) Saaremaa and Sõrve (*Sworw*) islands. Two boat graves (7 persons and 34 persons) of Scandinavian warriors, 7^{th} – 8^{th} century. Wood decayed.

Price TD, Peets J, Allmäe R, Maldre L, Price N (2020) Human remains, context, and place of origin for the Salme, Estonia, boat burials. Journal of Anthropological Archaeology 58: 101149.DOI: 10.1016/j.jas.2023.105827

Documentaries about Salme ship burials:
https://etv.err.ee/1608423851/salme-viikingid
https://arhiiv.err.ee/video/vaata/salme-viikingid-2
https://arhiiv.err.ee/video/vaata/salme-viikingid-3
https://arhiiv.err.ee/video/vaata/salme-viikingid-4

Departure 10.00

32.3 km 25 min

10.25 (4) Sõrve Lighthouse: 30 min

The first lighthouse in Saaremaa. 1646 primitive lighthouse on an island, 1650 stone tower, then relocated to peninsula, 1770 stone tower, built higher 1807, destroyed in World War II in 1944, temporary wooden structure 1945 – 1960; 1960 concrete lighthouse, height from base 52 m, from sea level 53 m.

Departure 10.55

15 km 15 min

11.10 (5) Jämaja Church and Cemetery: 20 min

Wooden church in Jämaja was probably in the 13^{th} century already. In the 14^{th} century a new church was built. In 1864 the church was re-built. Jämaja church roof constructions at present: dendro-date of nave 1795 (spruce), repairs 1862 (pine).

End of 18^{th} century cemetery is a national monument 1997. Chapel and crosses. Monument to the hospital ship "Moero" sunk by a Soviet aerial torpedo on 22 September 1944 with more than 3000 civilian victims.

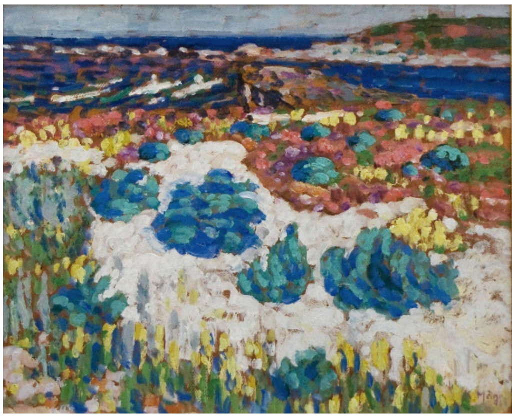
Tall boxwood (*Buxus sempervirens*) bushes. Boxwood is a naturalised Atlantic decorative species hosted by Saaremaa's mild sub-Atlantic climate.

Departure 11.30

16.4 km 15 min

11.45 (6) Kaugatoma Beach and alvar meadow: 15 min

Pictoresque pebble beach with brown algae *Fucus* and sea kale (*Crambe maritima)*. Alvar (also *loopealne* in Estonian) meadows are semi-natural grasslands with thin and stony calcium- and humus-rich soil on limestone bedrock. Alvars are valuable and biodiverse habitats.



Konrad Mägi "Saaremaa. Etude" (1913–14) (Enn Kunila's private collection)

Departure 12.00

35.3 km 43 min

Along a road: (7) Lõmala-Kaugatoma heritage route

The 11 km long route has been marked and preserved as a gravel characteristic of Estonia in the Soviet era. Time has stopped in the 1950s and 1970s. The surfacing is gravel, and the road is winding and narrow. Kilometre posts are made of concrete and mostly original. Speed limit is 50 km per hour. Historic landscape elements such as tank barriers, snow cates and a milk stand can be seen.

Heritage road from the 1950s and 1970s (Photo: Transport Administration)

12.45 (8) Viidumäe Nature Reserve: 1h

Established in 1957, destinated to protect distinctive habitats, plant communities and rare species around the ancient coastal terrace of Ancylus Lake (9500–8000 yrs BC). Rich peatlands are formed in low-lying depressions. Groundwater level is on the surface for most of the year (except summer). The peat soils are Eutric Histosols with variable thickness and decomposition rate. The peat layer is shallow enough for a contact between limestone bedrock and groundwater. Groundwater is relatively mobile and rich in calcium and magnesium, providing nutrients for a wealth of plant species such as orchids. The most famous species is the endemic of Saaremaa, the Saaremaa yellow rattle (*Rhinanthus osiliensis*). The bog-myrtle (*Myrica gale*) attracts attention with its special scent.

Bog-myrtle (Jan Kops and Herman Christiaan van Hall, Flora Batava, 1830)

Departure 13.45

9.4 km 11 min

14.00 (9) Lunch in Lümanda Village: 45 min

Bon Appetit!

Departure 14.45
8.3 km 7 min

15.00 (10) Kihelkonna belfry: 20 min

The external belfry – campanile was built in 1638, restored 1968, maintenance repair 2009 with new bell. Such free-standing belfries were once quite popular in Estonia, but today the one at Kihelkonna church is the only one surviving.

Konrad Mägi "Landscape with belfry" (1913–14) (private collection)

The roof constructions of the Kihelkonna church (built in the 2nd half of the 13th century) were dendro-dated. According to tree-ring dates, the present roof construction of the altar room (pine) was built in 1682. The present roof construction of the nave (pine) was built in 1875 and at the same year the roof construction of the altar room was partly replaced. One wall bar on the southern wall was preserved from the 1664 building stage. The tower was added only in 1899.

Departure 15.20
17 km 17 min

15.40 (11) Sepise yew tree: 30 min

58.449269 N, 22.051136 E

Yews (*Taxus baccata)* are among the world's oldest trees, with estimated ages of 3000–5000 yrs in Britain. Here, yew trees are rare as they grow close to their north-eastern distribution limit. Yews in the islands and western Estonia are remnants of the mid-Holocene warm Atlantic climate stage, supported by the current mild sub-Atlantic climate. Yews were often removed as poisonous for cattle and people. This is the tallest and stoutest yew tree in Estonia, and one of the biggest in the whole eastern Baltic region (girth 104 cm and height 12 m in 2000).

Departure 16.10
53 km 43 min

16.50 (12) Kaali meteorite craters: 25 min

This is a group of nine meteorite craters. There are numerous estimates for age of the meteorite fall. Estonian Encyclopedia, citing a work on ^{14}C dating of a peat layer containing glassy silicate microspherules, states a date no later than 4000 yrs ago.

Kaali Lake (Kaali järv) is on the bottom of the main crater (Encyclopædia Britannica)

Most recent estimates put its formation shortly after 1530–1450 BC (Losiak et al. 2016) when Saaremaa was already inhabited. In that case, the crater-forming event may have been witnessed by humans.

The greatest crater has a diameter of 110 m and depth of 22 m. In the Kaali Museum, a cross section of an oak trunk found from the crater is exposed.

Recently archaeologists analyzed an arrowhead from Switzerland made of meteoritic iron whose composition suggested its origin from the Kaali meteorite (Hofmann et al. 2023).

Losiak A et al. (2016) Dating a small impact crater: An age of Kaali crater (Estonia) based on charcoal emplaced within proximal ejecta. Meteoritics & Planetary Science 51: 681–695. DOI: 10.1111/maps.12616

Hofmann BA et al. (2023) An arrowhead made of meteoritic iron from the late Bronze Age settlement of Mörigen, Switzerland and its possible source. Journal of Archaeological Science 157: 105827. DOI: 10.1016/j.jas.2023.105827

Departure 17.15

13.1 km 11 min

17.25 (13) Valjala Church: 20 min

The oldest stone church on Saaremaa and possibly the oldest surviving church building in Estonia. Construction of Valjala church started immediately following the Livonian Crusade, in 1227. According to dendro-dates, the present roof constructions of the altar room and the nave were both built in 1851 from pine wood.

Departure 17:45

21.1 km 16 min

18.00 Arrival Suur Töll Holiday Village

List of participants

Ahto Kangur	*Estonian University of Life Sciences, Estonia*	ahto.kangur@emu.ee
Alan Crivellaro	*"Stefan cel Mare" University of Suceava, Romania*	alancrivellaro@gmail.com
Alar Läänelaid	*University of Tartu, Estonia*	alar.laanelaid@ut.ee
Aleksei Potapov	*Estonian University of Life Sciences, Estonia*	aleksei.potapov@emu.ee
Darius Valūnas	*Nature Research Centre, Lithuania*	darius.valunas@gamtc.lt
Guntis Brūmelis	*University of Latvia, Latvia*	guntis.brumelis@lu.lv
Iluta Dauškane	*University of Latvia, Latvia*	iluta.dauskane@lu.lv
Jaan Pärn	*University of Tartu, Estonia*	jaan.parn@ut.ee
Kristina Sohar	*University of Tartu, Estonia*	kristina.sohar@ut.ee
Kärt Erikson	*University of Tartu, Estonia*	k2rt.erikson@gmail.com
Marcin Klisz	*Forest Research Institute, Poland*	m.klisz@ibles.waw.pl
Marija Žukovskienė	*Nature Research Centre, Lithuania*	m.tamkeviciute@gmail.com
Maris Hordo	*Estonian University of Life Sciences, Estonia*	maris.hordo@emu.ee
Māris Zunde	*University of Latvia, Latvia*	maris.zunde@lu.lv
Megija Džeriņa	*University of Latvia, Latvia*	dzerina.megija@inbox.lv
Reeno Sopp	*Estonian University of Life Sciences, Estonia*	reeno.sopp@emu.ee
Roberts Matisons	*LSFRI Silava, Latvia*	robism@inbox.lv
Rūtilė Pukienė	*National Museum Palace of Grand Dukes of Lithuania; Nature Research Centre, Lithuania*	bsrupu@gmail.com
Sandra Metslaid	*Estonian University of Life Sciences, Estonia*	sandra.metslaid@emu.ee
Toomas Tarmu	*Estonian University of Life Sciences, Estonia*	toomas.tarmu@emu.ee
Vineta Vērpēja	*University of Latvia, Latvia*	vinetaverpeja@gmail.com
Virkeli Viiberg	*Estonian University of Life Sciences, Estonia*	vviiberg@gmail.com