Changes of deciduous tree species areas during the last decades in Lithuania

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Relevance of the research topic

⦿ The ongoing climate change already influence tree species range – species move to higher altitudes and change natural range;

⦿ Due to rapid environmental changes, in mixed forests zone, boreal tree species may become "unsuitable", while nemoral and temperate species "more suitable" for local conditions;

⦿ Lithuania belong to a hemiboreal forests, because there is a natural convergence zone between boreal and nemoral forests. Due to current climate changes it could be expected high species convertions in Lithuania.

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The investigation focused on:

Question 1:

The changes of nemoral tree species importance in Lithuanian forests.

Question 2:

Changes of European hornbeam range in Lithuania.

Question 3:

Predicting climatic conditions suitability, according to A2 and B1 climate change scenarios, for Lithuanian native forest tree species and possible immigrant species.

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Study site

- In Lithuania the area of forests cover is 33.5% of the total territory.

- The prevailing tree species:

  - coniferous – 55.5%, with Scots pine dominating (34.6%) and Norway spruce second (20.9%).

  - deciduous – 44.5%, mainly represented by birch (22.2%), black alder (7.6%), grey alder (5.9), aspen (4.6%) and oak (2.2%).

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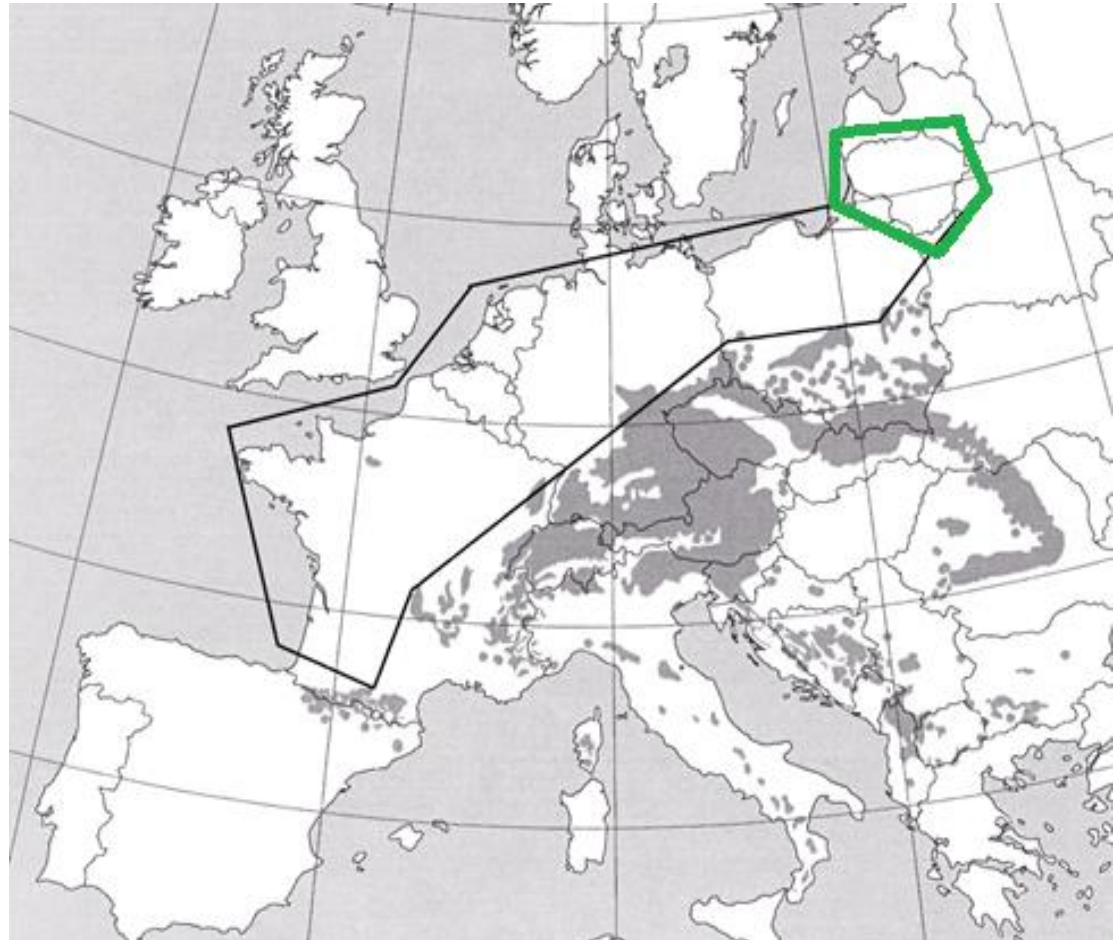
Material & Methods

- To answer **1st and 2nd questions** we used the **National Forest Inventory (NFI) data**. The NFI has been implemented on a continuous 5 years measurement cycle. Were used 1st (1998-2002), 2nd (2003-2007) and 3rd (2008-2012) NFI cycles (cover 15 years period).

  Selected species: *Tilia cordata* Mill., *Acer platanoides* L., *Ulmus minor* Mill.,

  Carpinus betulus L., *Ulmus glabra* Huds

  Changes of selected indices: a) number of plots with selected species;

  b) number of trees of selected species;

  c) total volume (m^3) of selected species.

  Data were collected at **5600 NFI plots.**

- To estimate *Carpinus betulus* L. range shift during the last eight decades, in 1928 established European hornbeam range (Rauktys, 1928) was compared with NFI data of 2012 (about 2 million stands).
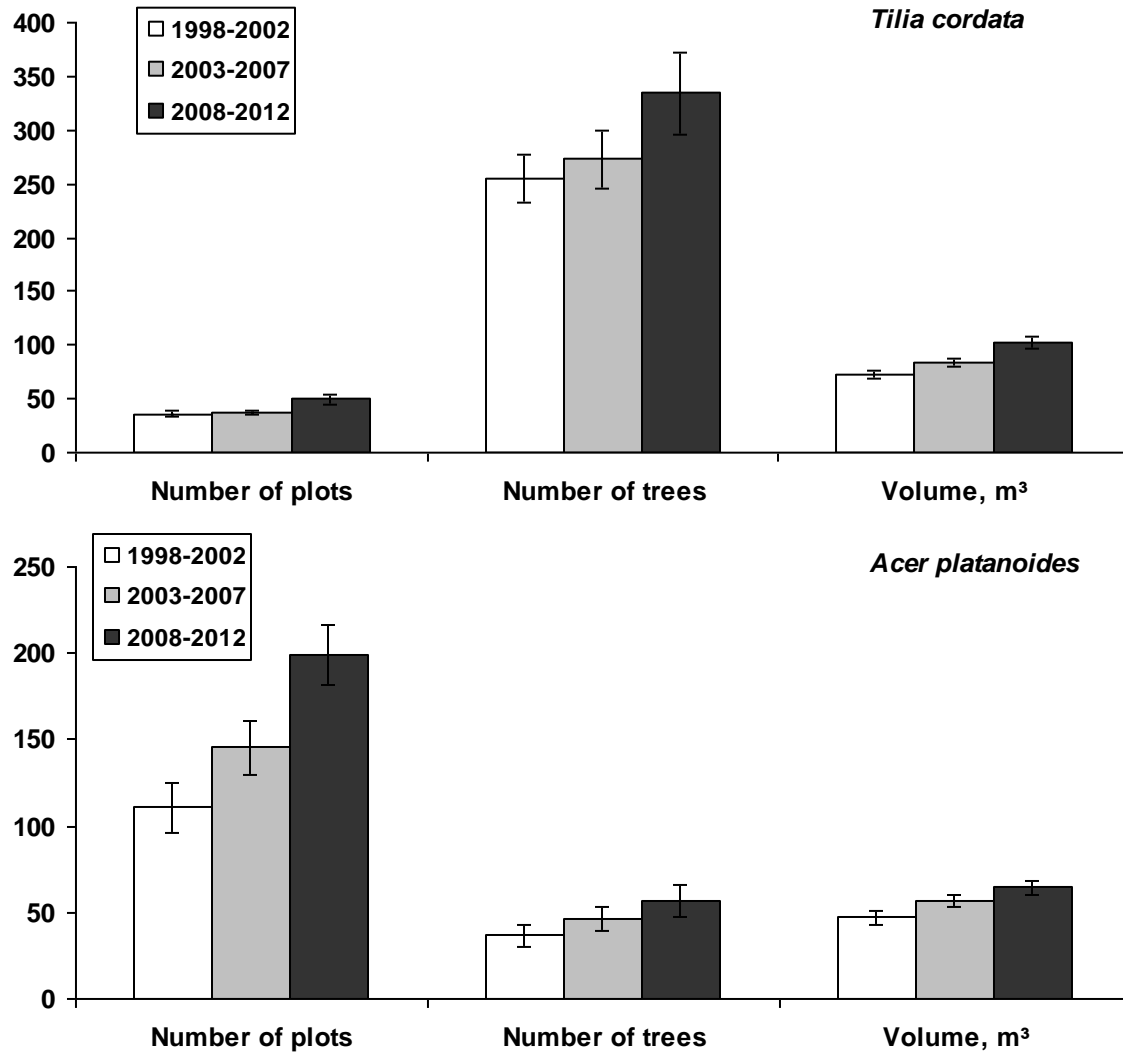
Material & Methods

◉ To answer to the **3rd question** the climate analogues approach was used. Based on the predicted climatic data for the A2 and B1 greenhouse gas emission scenarios of the HadCM3 Global Climate Circulation Model and climate maps by European Food Safety Authority (EFSA) we created climatic analogues for Lithuania in 2031–2060 and 2061–2090 using the method described by **Skov et al. (2009)** and implemented them in ArcGIS 9.3, ESRI, Redlands, CA, USA (http://www.esri.com).

Detailed methodology described in our publication – **Ozolinčius et al. 2014**

Configuration of Lithuanian climate change scenarios used in the simulation

Scenarios	Year	Changes in annual temperature, ºC	Changes in winter (February) temperature, ºC	Changes in precipitation,%
A2 (1)	2031-2060	+2.0	+4.0	no change
A2 (2)	2061-2090	+4.0	+7.0	+15-20
B1 (1)	2031-2060	+1.0	+2.0	no change
B1 (2)	2061-2090	+2.0	+3.0	no change

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Question (1): the changes of nemoral tree species abundance in Lithuanian forests.

Tilia cordata

Legend: 1998-2002, 2003-2007, 2008-2012

Categories: Number of plots, Number of trees, Volume, m³

Acer platanoides

Legend: 1998-2002, 2003-2007, 2008-2012

Categories: Number of plots, Number of trees, Volume, m³

Changes of number of plots with *Tilia cordata* and *Acer platanoides* and estimated number of trees and volume (m³).
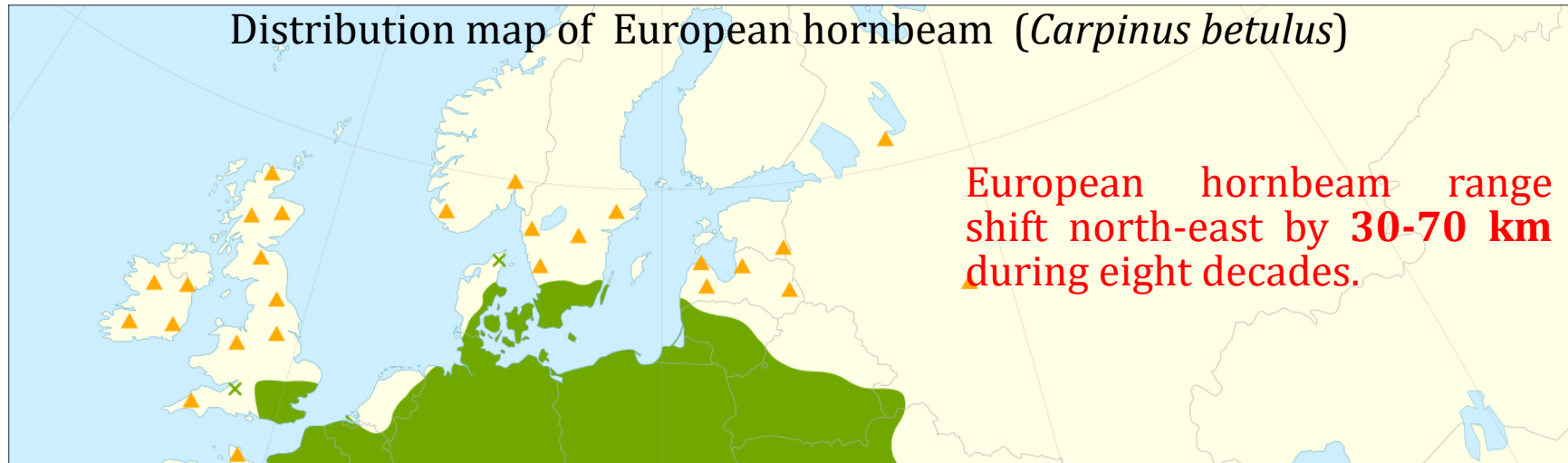
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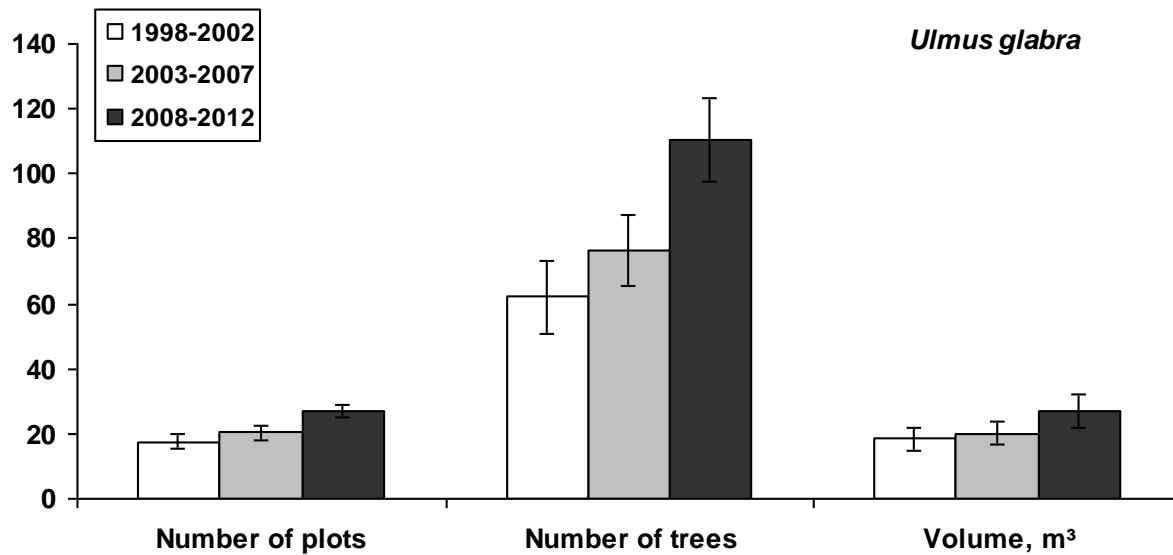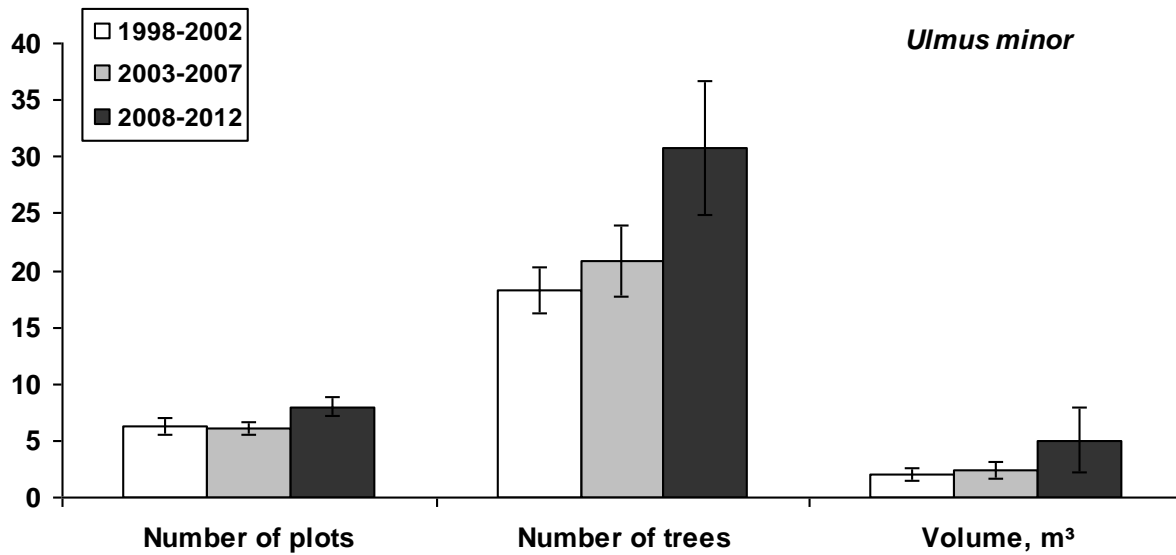
Changes of number of plots with *Ulmus minor* and *Ulmus glabra* and estimated number of trees and volume (m^3).

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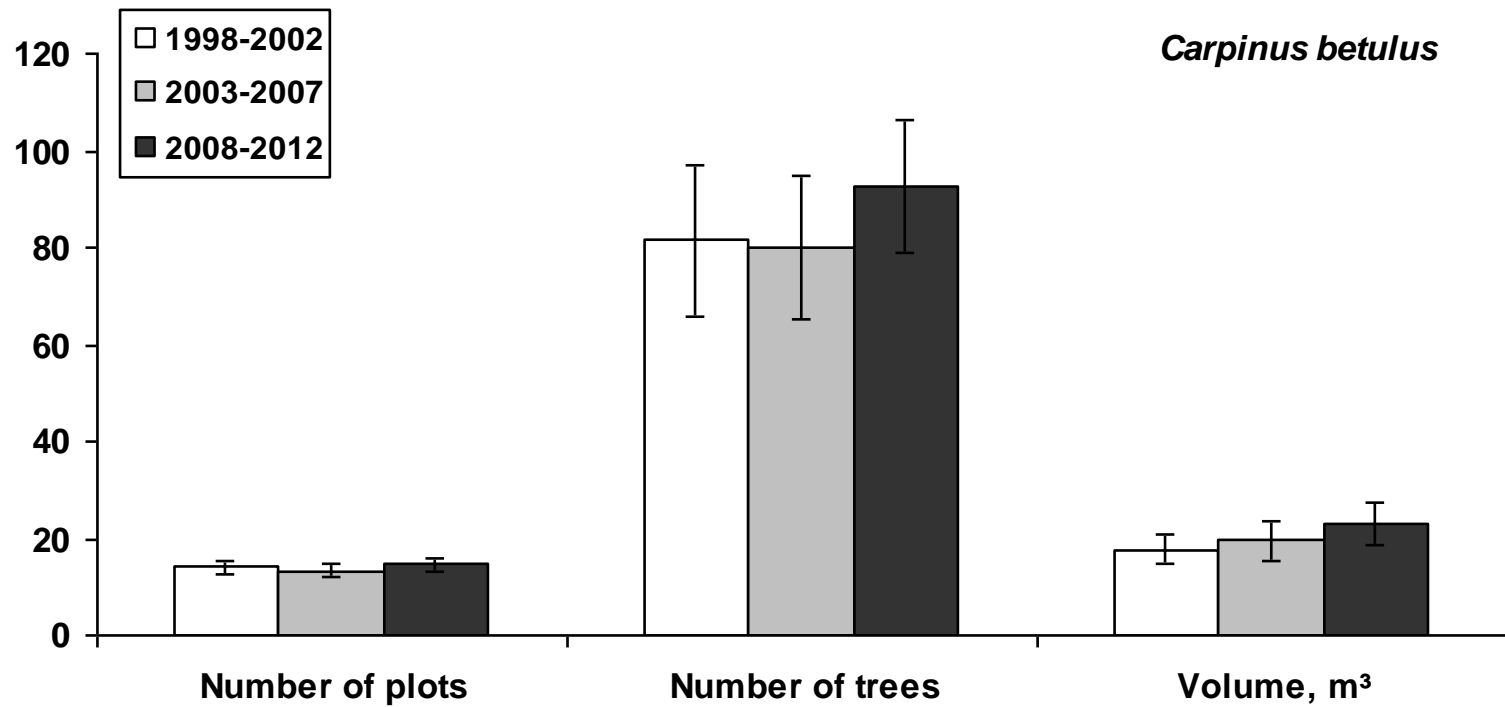
Changes of number of plots with *Carpinus betulus* and estimated number of trees and volume (m³).

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Question (2): changes of European hornbeam range in Lithuania during the 1928-2012.

Distribution map of European hornbeam (*Carpinus betulus*)

European hornbeam range shift north-east by **30-70 km** during eight decades.

Changes of European hornbeam habitat in Lithuania in 1928-2012. *lower limit - according Rauktys (1928); triangles - previously found hornbeam "islands".*
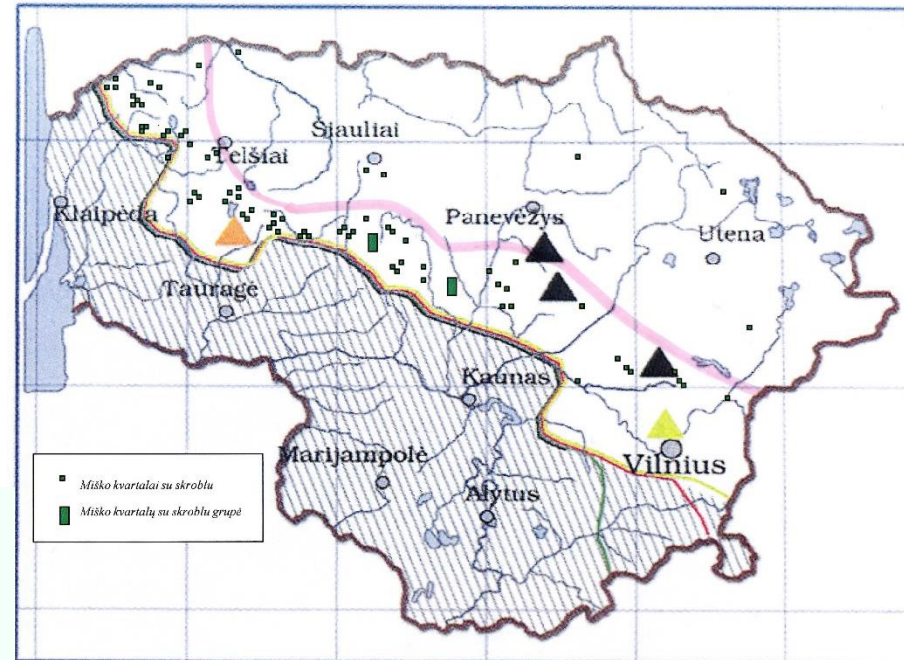
Question (3): Predicting of climatic conditions suitability predicting for Lithuanian native forest tree species and possible immigrant species

Climatic conditions suitability for **native** tree species under A2 and B1 scenarios:

Species*	Scenario A2		Scenario B1	
	2031-2060	2061-2090	2031-2060	2061-2090
Acer platanoides	+	+	+	+
Alnus glutinosa	+	+	+	+
Alnus incana	+?	-	+?	+?
Betula pendula	+	+	+	+
Betula pubescens	+	+	+	+
Fraxinus excelsior	+	+	+	+
Picea abies	-	-	-	-
Pinus sylvestris	+	-	+	+?
Populus tremula	+	+	+	+
Quercus robur	+	+	+	+
Tilia cordata	+	+	+	+
Ulmus laevis	+	+	+	+

+   suitable for growth;

+?   possibly suitable;

-    not suitable

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Possible immigrant species to Lithuania under the A2 and B1 scenarios:

Species	Scenario A2		Scenario B1	
	2031-2060	2061-2090	2031-2060	2061-2090
Acer campestre	+	+	+	+
Acer pseudoplatanus	+	+	+	+
Castanea sativa	-	+	-	-
Fagus sylvatica	+	+	+	+
Populus nigra	+	+	+	+
Prunus avium	+	+	+	+
*Quercus petraea**	+	+	+	+
Quercus pubescens	+?	+	-	+?
Sorbus domestica	+	+	-	+
Sorbus torminalis	+?	+	+?	+?
Tilia platyphyllos	+	+	+?	+

+   suitable for growth;

+? possibly suitable;

-   not suitable

Ozolinčius R., Lekevičius E., Stakėnas V., Galvonaitė A., Samas A., Valiukas. 2014 Lithuanian forests and climate change: possible effects on tree species composition. European Journal of Forest Research, 133 (1): 51–60.

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Conclusions

1. *T. cordata, A. platanoides, U. glabra, U. minor and C. betulus* abundance increased over the last 15 years in Lithuania. Climatic conditions became more suitable for nemoral tree species.

2. European hornbeam (*Carpinus betulus*) range shift to the north-eastern direction by 30-70 km during eight decades – about 500 m per year.

3. Modelled data (Ozolinčius et al. 2014) predicted that climate warming will affect the distributions of native species: the increase in the proportion of deciduous tree species and the significant reduction in the proportion of conifers, especially Norway spruce and partly Scots pine, are expected.

4. There is high probability that *Acer campestre, Acer pseudoplatanus, Fagus sylvatica, Populus nigra*, and *Prunus avium* will become potential immigrants to Lithuanian forests at the end of the twenty-first century.

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Thank you for your attention!

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