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lesního hospodářství
a myslivosti, v. v. i.

Alternative ways of calamity clearings restoration using birch and poplar as pioneer tree species

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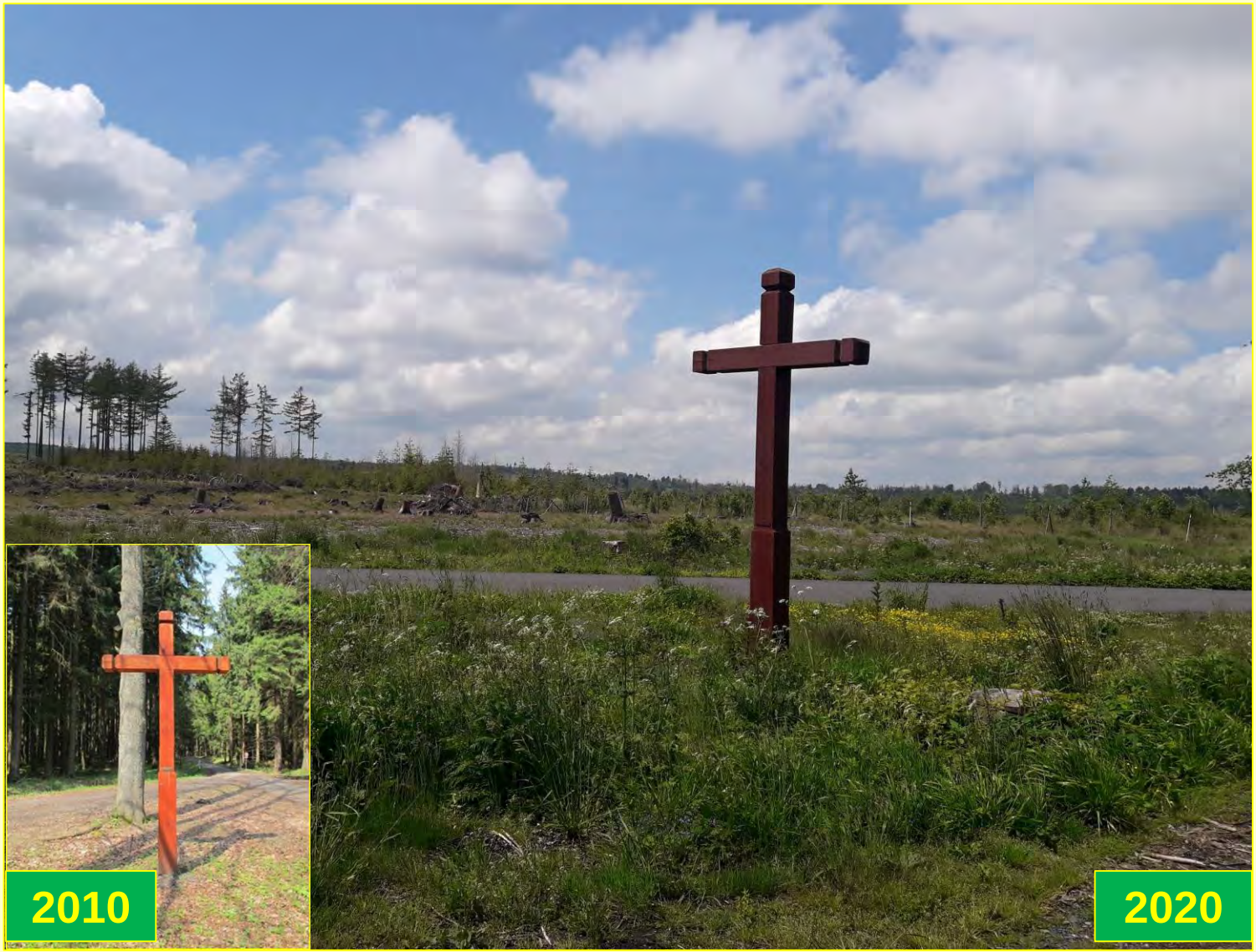
Consequences of Bark Beetle Calamity for the Future of Forestry in Central Europe
Two days on-line meeting March 23rd – 24th



At present in most regions of Czechia spruce stands increasingly frequent are dying due to severe bark beetle calamity present in most regions

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- Other dying species are ash trees (*Fraxinus excelsior, F. angustifolia*) which in recent years have been severely affected by **fungal pathogens** like *Phytophthora* sp. and especially *Hymenoscyphus fraxineus* – formerly described under the name *Chalara fraxinea*. This ascomycete fungus causes ash dieback
- The resulting large clearings are generally characterized by extreme weather conditions so successful recovery is difficult and complicated

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Urgent task: how to ensure reforestation on large-scale calamitous clearings?

Recommended and needed requirements for future forests:

- more stable and resistant stands

suggested solution

- using genetically suitable high quality and well adapted reproduction material appropriate to site condition
- greater species, spatial and age diversity - avoid of monoculture
- more utilization of natural regeneration and also natural succession processes where suitable and possible
- two-phase forest restoration using pioneer tree species

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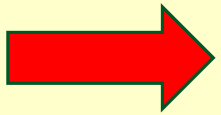
Using pioneer trees in reforestation large calamity clearings

- **Pioneer tree species** can play an important role in the restoration of these stands, among which **birch** and **poplar** have an irreplaceable role
- They can improve adaptability of main target tree species to the permanently ongoing changes in the environment
-  They create more favorable conditions for the renewal of **target trees**
- **Birch** is a typical pioneer tree, which spontaneously spreads to clearings and areas after forest calamities, where it is able to very well fulfil the function as preparatory **(pioneer) tree** during afforestation of clearings
- In most habitats, it quickly creates stands fulfilling the required functions, in particular it is able to improve the stand microclimate and water cycle and their leaf litter ameliorates the soil conditions

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Silver birch (*Betula pendula*)

- Widespread silver birch is characterized by high ecological valence, has a significant potential for natural regeneration and intensive growth in youth
- Characterized by very modest ecological requirements
- Able to prosper in a wide range of climatic and soil conditions, most often on poorer, more acidic and drier soils
- Almost absent on nutrient substrates, especially on limestones
- Can sustain even in extremely acidic habitats and peatlands with pH values up to 3.5
- Able to survive in harsh climatic conditions, is fully frost-resistant, tolerate also high summer temperatures

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Calamity clearing in Lusatian Mountains

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Silver birch as pioneer tree in Lusatian Mountains

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Silver birch as pioneer tree in Lusatian Mountains

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Pubescent (downy) birch (*Betula pubescens*)

- Taxa from the range of pubescent birch
  Betula pubescens ssp. *pubescens*
  Betula pubescens ssp. *carpatica*
- Better adaptation to the extremely wet habitats, especially in mountainous areas, characterized by high groundwater levels
- Forestry has therefore begun to pay increased attention to these previously neglected mountain populations in recent years.
- Seed orchard has been established in the Ore Mountains

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Betula pubescens as preparatory tree in the Ore mountains

Native poplar species

- Domestic poplar species are neglected in forestry due to their limited economical use, but as part of forest ecosystems they are irreplaceable
- They always formed the main component of the tree layer of floodplain forests
- All poplar species are characterized by very rapid growth ability, so very soon form better microclimate conditions on large deforested areas
- Natural regeneration of poplar is possible mostly only on pure, fresh soil surface without grass
- Among all poplar species, aspen (*Populus tremula*) has the highest priority in forestry. Recently, in connection with the ash decline, more attention has been paid to other domestic species, black poplar (*Populus nigra*), white poplar (*Populus alba*) and natural hybridogenous grey poplar (*Populus xcanescens*)
- In floodplain forests, poplars can also fulfil production function as target trees

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Ongoing research activities

The research is focused on:

- New approach of forest cultivation in areas with rapid large-scale deforestation with effective use of alternative tree species during forest restoration
- To present exact data for legislation amendment
- To ensure the long-term safety and success of the fulfilling production and non-production functions of the forest, including with regard to possible climate change
- The proposed procedures should primarily ensure the restoration of stable stands and also allow to spread the recovery period of calamity areas over a longer time in order to result also age-differentiated stands

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Ongoing research activities

- Field surveys, inventory and selection of genetically and phenotypical suitable trees with a pioneering growth strategy, especially birch and poplar, in order to ensure sufficient amount of high-quality forest reproductive material
- Research about possibilities of using poplars as production and preparatory tree species in the regeneration of floodplain forests affected by the large scale death of ash trees

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Methods

- Field surveys, inventory and selection of older high quality trees with a good shaped continuous trunk, thickness (dbh) at least over 20 cm, were selected
- The selection of birch was carried out at localities from the 3rd forest vegetation zone upwards
- The following parameters were evaluated: trunk shape, total height, breast-height diameter (dbh), health status (crown condition)
- Furthermore, GPS coordinates were measured for each tree. The trees are marked in the field with a blue spray at the base of the trunk
- In selected phenotypically quality individuals, the study of genetic structure is performed by DNA analysis using microsatellite markers, in order to verify, if they are not identical genotypes (important in case of proposal for approval as sources of reproductive material)

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Birch tree selection

Forest district Rychnov nad Kněžnou

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Birch tree selection

Dvůr Králové Šumava Boubín

Birch tree selection

Strakonice

Vodňany

Black poplar

Elbe lowland

Central Bohemia

Židlochovice

White poplar, Hluchov

Black poplar, (protected by the state), D. Kounice height 30 m dbh 159 cm, age about 200 years

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Quality stand of grey poplar – Forest district Znojmo, locality Dyjákovice, Southern Moravia

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Selection of grey poplar




LS Znojmo, revír Jaroslavice, lokalita Dyjákovice, Lužný les

Results

- A total of 161 quality silver birch trees were selected, measured and evaluated. The maximum height was measured 38 m, thickness (dbh) 56 cm
- A total of 228 individuals of black poplar and 172 white poplar were found, marked and described. The maximum height for black poplar was measured 40 m, thickness (dbh) 230 cm
- Selected ortets are sampled for the purpose of genetic characterization by means of DNA analyses using the Simple Sequence Repeats (SSR) method, multilocus genotypes and genetic diversity were determined
- To determine the clonal identity of selected silver birch gene sources 13 suitable high-resolution polymorphic SSR markers were selected and their PCR were optimized

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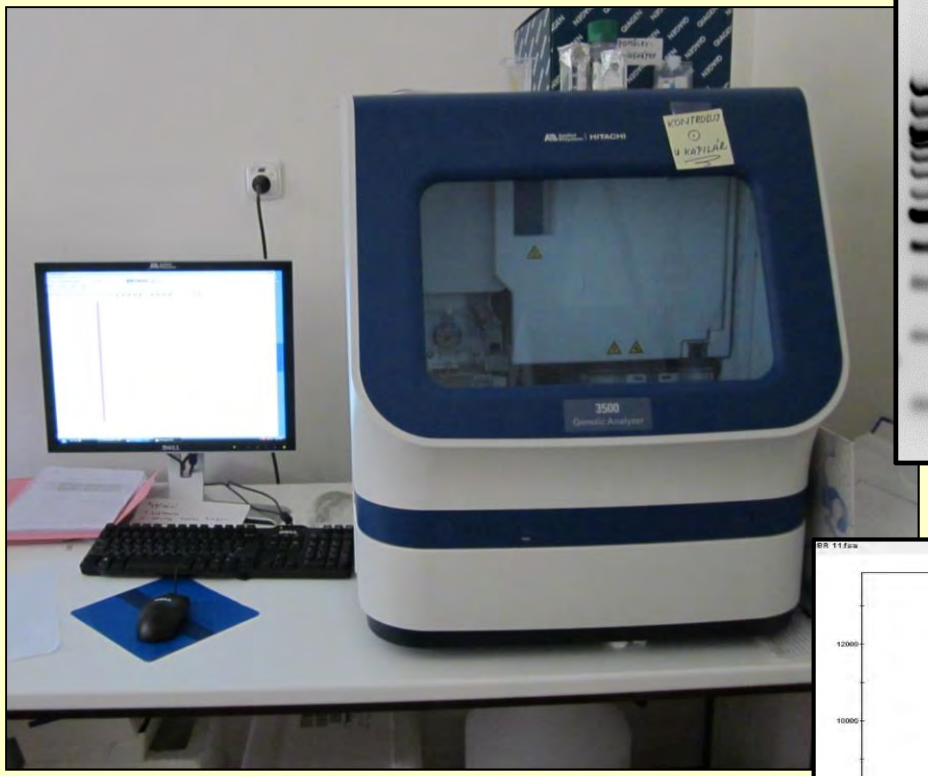
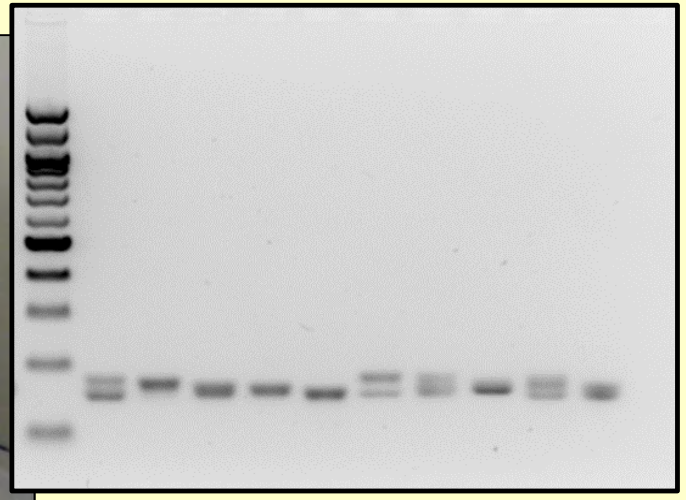
DNA analyses of selected silver birch gene sources





Example of testing birch samples
using polymorphic marker L5.4

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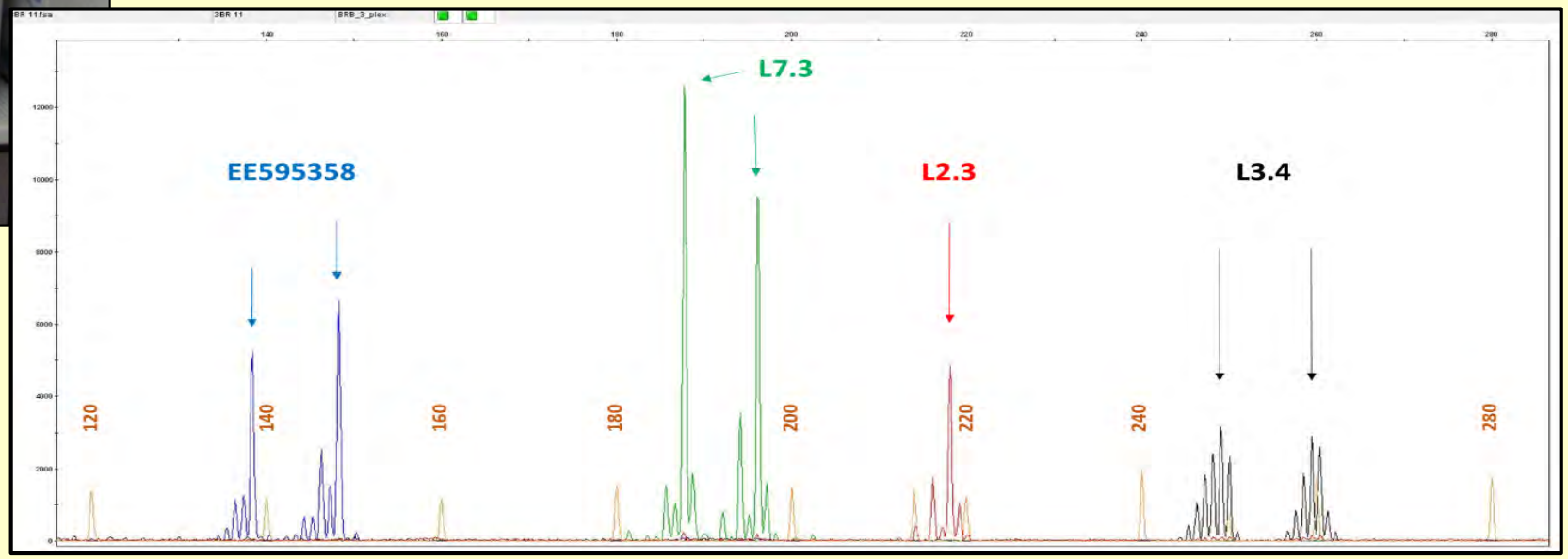
Measuring the size of amplification products was carried out using the genetic analyser Applied Biosystems 3500



Results of fragmentation analyses of 4 selected microsatellite loci

Results

- High-quality individuals are selected for approval as a source of qualified reproductive material
- The best quality gene resources could be the basis for establishment of a seed orchard
- The effect of using the preparatory tree species like aspen (*Populus tremula*) and cultivated poplars on the acceleration of the restoration by the main economic tree species was monitored on the calamity clearcut in the locality Kostelecký les forest complex

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Using aspen like preparatory tree (two-years plantation in locality Kostelecký les)

Autumn planting of one-year old poplar seedling on large calamity clearing after common ash, forest enterprise Židlochovice, locality Tvrdonice

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One-year plantation of grey poplar, forest district Znojmo, locality Tvrdonice

Research projects dealing with pioneer tree species

- Comprehensive solution of forest restoration and silvicultural management in regions with fast large-scale forest death
- Proposal of alternative tree species composition for forest ecosystems with reduced ecological stability due to physiological drought
- Conservation and reproduction of a valuable grey poplar population

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Thank you for your attention

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