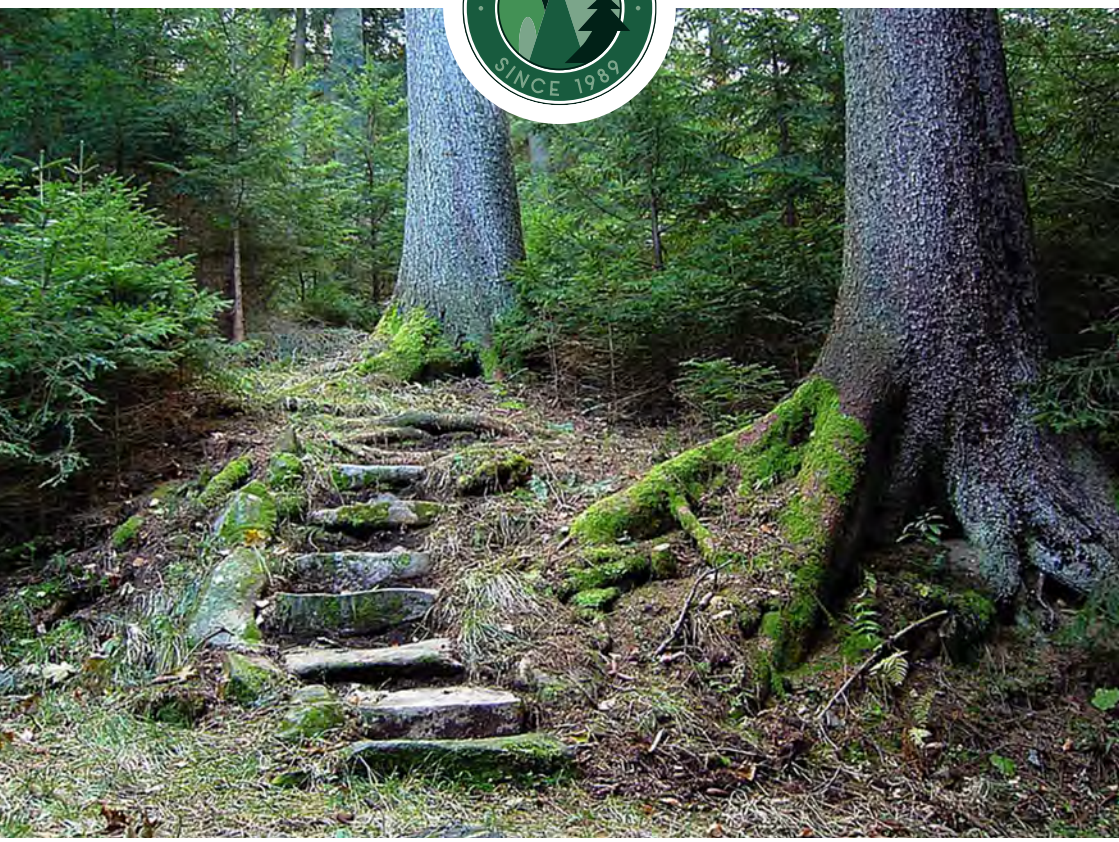


PRO SILVA

30th Anniversary Meeting 2019

"FORESTS FOR THE FUTURE - FROM SCIENCE TO THE PEOPLE"

MEETING PROGRAM, ABSTRACTS AND FIELD GUIDE

11th - 14th September 2019, Radlje ob Dravi

Contents

1. Conference Program

Wednesday, 11th September 2019

up to 16.00	**Accommodation,** registration at Manor House Radlje (Koroška cesta 68, 2360 Radlje ob Dravi)
16.30	**Welcome reception at Manor House Castle** Eckart Senitza – president of ProSilva - Alan Bukovnik – major of Radlje
17.30	**Presentation of Pahernik's room and the Centre of close to nature forest management** The first phase of the development of the centre will be presented, the historical exhibition on the beginnings of the close to nature forestry in Slovenia and in Europe.
18.30	**Presentation of various non-wood forest goods and services in the park at the Manor House Radlje** Topics: Forest pedagogy, tourism in forest areas, thematic hiking trails, European hiking trails.
20.00-21.30	**Dinner and social gathering.**
22.00	**Accommodation**

Thursday, 12th September 2019

9.00 - 9.40	Hall in Radlje Hostel, opening ceremony of the event **Welcome speeches,** cultural program
9.40 - 10.00	**Coffee break**
10.00 - 11.30	**Presentations** Leading topic: Linking science and practice (1) Contemporary research in the field of ecological forestry: From problem design to dissemination - Prof. Klaus Puetmann (Oregon State University, USA) (2) Integrating practitioners into academic research for improving of close-to-nature forestry - Peter Ammann (Fachstelle Waldbau, Lyss, Switzerland)
11.30 - 12.00	**Coffee Break**
12.00 – 13.15	**Lectures and workshop** (3) Thirty years of ProSilva Europe and challenges for the future – Prof. João Paulo Fidalgo Carvalho, (University of Trás-os-Montes e Alto Douro, Portugal), Bill (W.L.) Mason (Continuous Cover Forestry Group, Forest Research) et al. (4) Survey and Discussion on the development constraints and research priorities for problem solutions
13.15 – 14:00	**Lunch**
14.00 - 20.00	**Excursion to the Pahernik and Sgerm forest, Pohorje** Group M: Pahernik bus / Group L: Sgerm bus Topics: Pahernik foundation, farm selection management, freestyle silviculture, natural vegetation and environmental change, forest reserves, old trees and tree microhabitats, Sgerm spruce - the highest Norway spruce in the world.
20.00-23.00	**Dinner and social gathering:** Ribnica na Pohorju

Friday, 13th September 2019

8.30 – 16.30	**Excursions** Group M - Mislinja forests: - lunch at the farmhouse Topics: Gradual conversion of the spruce monocultures, ecological management of farm and forest management of state in Slovenia, forest protection, nature conservations, wildlife management. Group L - Lehen on the Pohorje: - lunch in Ribnica na Pohorju Topics: Autochthonous control method in the selection forests of Slovenia, forest monitoring, inventory and planning, forest health, Natura 2000, nature conservation, hunting and large carnivores.
17.00 - 19.30	**Pro Silva Annual Meeting 2019 – Radlje Castle**
20.00-23.00	**Dinner and social gathering in Radlje**

Saturday, 14th September 2019

7:30-9:00	**Driving from Radlje to Celje**
9:00-15:00	**Excursion to Celje Urban Forest** - Lunch in the field Topics: multifunctional forest management in the recreational areas, freestyle silviculture in urban forests, invasive and non - native species.
15:00	**Official end and farewells** – arrival to Ljubljana at 17:30 The participants will be dropped off at Ljubjana Main Train Station and Brnik Airport.

2. Invited speaker abstracts

Contemporary research in the field of ecological forestry: From problem design to dissemination

Prof. KLAUS PUETMANN (Oregon State University, USA)

The presentation starts with an overview of the increased global interest in "close to nature (CTN) – type" or ecological forestry activities. The discussion of possible reasons for and implications of this trend will include examples of different educational efforts aimed to inform landowners. Next, recent research efforts have documented various ecological and social responses to ecological forestry. They highlight that not all aspects of stand structure and composition respond to silvicultural treatments in a similar fashion. Consequently, the recent findings emphasize the importance to be very specific in defining management objectives. Finally, to stimulate discussions I present several challenges around the theme how ecological forestry can accommodate the provision of a wide range of ecosystem services in a variety of ecological and social settings. Specific issues include how ecological forestry can be implemented in forests with different natural disturbance patterns and ecological conditions, how the role of pre-forests or early successional habitat in forested landscapes can be accommodated, how ecological forestry can be integrated into a landscape with a diverse set of ownership constraints and objectives, and how ecological forestry can prepare foresters and forests for global change.

Integrating practitioners into academic research for improvement of close-to-nature forestry

PETER AMMANN (Fachstelle Waldbau, Lyss, Switzerland)

Since 1933 and the advent of positive selection, tending of young stands in Switzerland has undergone many developments. Some principles have been proven, but there were also approaches that were not successful or even counterproductive. The findings of 90 years of well-documented silvicultural history and 30 years of own experience lead to silvicultural concepts that follow natural processes as closely as possible. Do these also prove themselves in times of climate change? Do we need innovations for a rapid and yet nature based adaptation of forests?

The first part of the presentation introduces the concepts of biological rationalization and the development that led to it. In the second part a systematically analysed Lothar windthrow area case study is presented, on which these concepts were applied. At the same time, this case study is an excellent example of adaptation to climate change, from which numerous lessons can be learnt. In this context, we'll discuss the single tree selection principle in times of rapid climate change and present the its combination with irregular shelterwood in the sense of free style silviculture.

Thirty years of ProSilva Europe: achievements and challenges for the future.

BILL MASON, Continuous Cover Forestry Group, Great Britain
JOÃO PAULO FIDALGO CARVALHO, UTAD, ProSilva Portugal
JURIJ DIACI, ProSilva Slovenia
SAULI VALKONEN, Luke, Finland

Thirty years ago, a group of about 20 eminent European foresters from ten different countries met in Slovenia to discuss the future of European forests and specifically the need to adopt a more holistic and sensitive approach to forest management in our continent. The result of their deliberations was the foundation of ProSilva Europe as a union of foresters supporting close-to-nature forest management. The aspiration of our founders to increase the use of close-to-nature forest management has been reaffirmed many times over subsequent decades. ProSilva now comprises 20 full members and seven partner organizations within Europe, as well as five associate members in other parts of the world. The association now involves more than 5400 experts and forest owners across its member countries. Our members are involved in the management of a wide range of European forest types from the boreal to the Mediterranean zones while forest policies in many European countries now recognise the desirability of creating diverse and irregular forests to meet multifunctional societal needs.

However, during these three decades, there has not yet been a serious attempt to provide an overview of the use of close-to-nature (C2N) forestry across Europe and to consider the challenges that supporters of our approach have to confront in different parts of our continent. Therefore, during the summer of 2019 we circulated a questionnaire seeking information about the use of C2N in different partner countries. For the purpose of the questionnaire we used the term Continuous Cover Forestry (CCF) rather than C2N on the understanding that CCF referred more to the technical aspects of forest management rather than the more philosophical concepts implicit in C2N. The questionnaire covered aspects such as: the silvicultural systems that would be accepted as part of CCF in different countries; the

definition and size of a clear-cut; information on the extent and productivity of the forest resource in different countries; the proportion of the forest managed under different silvicultural systems and any changes over the last 30 years; information on road infrastructure and on management of forest operations; and lastly impressions of the main knowledge gaps about CCF and of the main challenges preventing greater use of CCF.

The questionnaire was sent to all full members of ProSilva and to personal contacts in some other European countries. At time of writing, replies have been received from 20 countries and more are anticipated in the next few days. Preliminary analysis of the returns shows the following:

1. All countries consider that single stem and group selection silvicultural systems are compatible with CCF, while 90 per cent would also include irregular shelterwood systems. Between 55 and 60 per cent of respondents would also allow group and uniform shelterwood systems as acceptable under CCF, particularly if these were being used as part of a programme of transforming regular stands to irregular structures.

2. About 30 per cent of countries have no rigorous definition of the minimum size of a coupe above which a site is considered to be clear felled. In most other countries the threshold size is between 0.1 and 0.5 ha, and this threshold is often defined in terms of gaps of more than one to two tree heights in width.

3. In a number of countries, it was difficult to find accurate information on the proportion of forests managed under different silvicultural systems, and replies were either personal estimates or no information was provided. Allowing for these shortcomings, there were only five countries (Switzerland, Italy, Slovenia, Germany, and Romania) where the majority of the forests were managed through CCF systems (i.e. single stem and group selection, and irregular shelterwood). Clear felling was the main silvicultural system used in eight countries, predominately in the boreal and Atlantic zones, as well as in parts of Eastern Europe.

4. Given the difficulty in finding reliable figures on the proportion of different silvicultural systems used, it was not surprising that estimates of change in these proportions over the last 30 years were problematic. Six respondents were unable to provide any data, while nine countries reported an increase in the use of CCF, with the remainder reporting no change.

5. Within the limitations of these data, the percentage of forests managed using CCF systems for all respondent countries combined was around 27 percent. If we exclude a major boreal forest country such as Finland, where use of CCF has only been approved very recently, this figure increases to 35 per cent.

6. Respondents identified 24 different knowledge gaps affecting the application of CCF. The limitation mostly commonly identified was the lack of skilled workers to implement CCF regimes (arguably this should be classed as a 'challenge' rather than a knowledge gap). The next two highest ranked gaps related to climate change aspects, namely information on the resistance and resilience of uneven aged stands compared to regular stands, and the need to consider tree species adapted to future climates. A number of replies considered that implementing CCF with new (mechanised) harvesting technologies was an area needing more information, while two other topics mentioned were the need for better information on the economic outturn of CCF management, and for better understanding of the motivations of private owners. The main silvicultural issue where a lack of knowledge was identified involved applying CCF with light demanding species such as pines and oaks.

7. By far the main challenge identified to wider adoption of CCF was that high populations of deer and other ungulates were creating regeneration failure through excessive browsing. The second most frequently identified challenge was that forestry grant schemes available to support private owners were felt to reflect the needs of even-aged forestry and were unsympathetic to CCF. Another problem

was perceived inadequate mechanisms for transfer of knowledge about CCF to private owners, while there was also concern expressed that, in some countries, the prevailing forestry culture and training was hostile to greater use of CCF.

The results from our questionnaire suggest that between one-quarter and one-third of European forests are being managed using silvicultural systems associated with CCF. Limited information also suggests that this proportion is probably increasing in response to societal demands and policy initiatives. However, in many countries, the lack of good data on the use of different silvicultural systems is a serious drawback. There do not appear to be major gaps in silvicultural knowledge that are preventing the wider use of CCF, other than with light demanding species. Greater understanding of the interaction between CCF management and forest resilience to climate change is highly desirable, not least if CCF can be shown to be an efficient way of meeting adaptation and mitigation goals across a range of forest types. As discussed at previous meetings, long-term reduction in populations of browsing animals is essential to delivering CCF. There are a range of infrastructural, cultural and policy challenges which need to be overcome such as training and sustaining a skilled labour force capable of implementing different silvicultural systems. There is also a need to identify and design subsidy schemes for private owners that are supportive of CCF. Lastly, there is a need for ProSilva to promote a pan European research action to bring together information on different aspects of CCF and, in so doing, to enthuse a new generation of researchers to provide the information necessary to allow a further expansion of CCF across European forests.

3. Excursion: Pahernik forest, 12th September 2019

General data of excursion site

Location: 46°31'00.5"N 15°12'58.7"E
Altitude: 950-1100 m
Mean yearly T: 6-7 °C
Precipitation: 1300-1400 mm
Forest sites: acidophilus mixed mountain forest *(Luzulo-Fagetum abietosum)* and silver fir forest with broadleaves (Galio-Abietetum)

Forests and Organization of Forestry in Slovenia

DAMJAN ORAŽEM (director, Slovenia Forest Service)

Slovenia is among the most forested countries in Europe. In 2018, the forest area covered 1.177.244 ha of land which represent 58,1 % coverage of forests. The surface of productive forests amounts to 1.062.974 ha, 98.762 ha are protection forests and 9.518 ha are forest reserves.

Most Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %), which have a relatively high production capacity. 77 % of forests in Slovenia are privately owned, 23 % of forests are public (owned by the state or local communes). Larger and undivided forest estates of state-owned forests enable good professional forest management, while private forest estates are small, with an average area ranging from 2-3 ha. Private forest property is becoming even more fragmented as the number of forest owners is increasing – according to the latest data, there are 413.000 forest owners in Slovenia.

The growing stock of Slovenian forests amounts to 355.332.000 m^3 or 302 m^3/ha. The annual increment is 8.801.000 m^3 of wood or 7,48 m^3/ha. Damages to forests are mostly caused by weather (wind, sleet, snow) and by insects (mainly by bark beetles). Spruce bark beetles are the most

common reason for sanitary felling. In February 2014, an ice storm devastated forests in Central Slovenia and damaged over 9.000.000 m^3 of wood on 600.000 ha, followed by subsequent wind damages and bark beetle attacks through 2019. In 2018, the annual harvest in Slovenian forests reached around 6.000.000 m^3, 72 % of which have been conifers. This cut falls behind the possible one according to forest management plans and amounts to 89 % of possible annual cut.

Slovenian forests are well preserved both in terms of vegetation and fauna. Good condition and the multifunctional role of the forests is also confirmed by the fact that forests covers a large share (70 %) of the Slovenian territory included in the European ecological network Natura 2000. There are 11 forest habitat types in Slovenia from the list of European endangered habitat types, determined by the Habitats Directive, mostly in a favourable condition.

Forest management and forest use in Slovenia are directed by The Ministry of Agriculture, Forestry and Food as the supreme state institution in the field of forestry and by the Slovenia Forest Service (SFS) as a public forestry service in all Slovenian forests, irrespecitive of ownership (Forest code. 1993). The SFS, with its headquarter in Ljubljana, is at regional level organized in 14 regional units, 69 local units and 396 forest districts. SFS employs about 700 staff; most of them are forestry experts. The most important tasks of SFS are: management planning, silviculture and forest protection, forestry technique, forest wildlife and hunting, public relations and education of forest owners.

The public forestry service is nearly entirely funded from the budget of the Republic of Slovenia whereas hunting reserves with a special purpose are mostly self-financed.

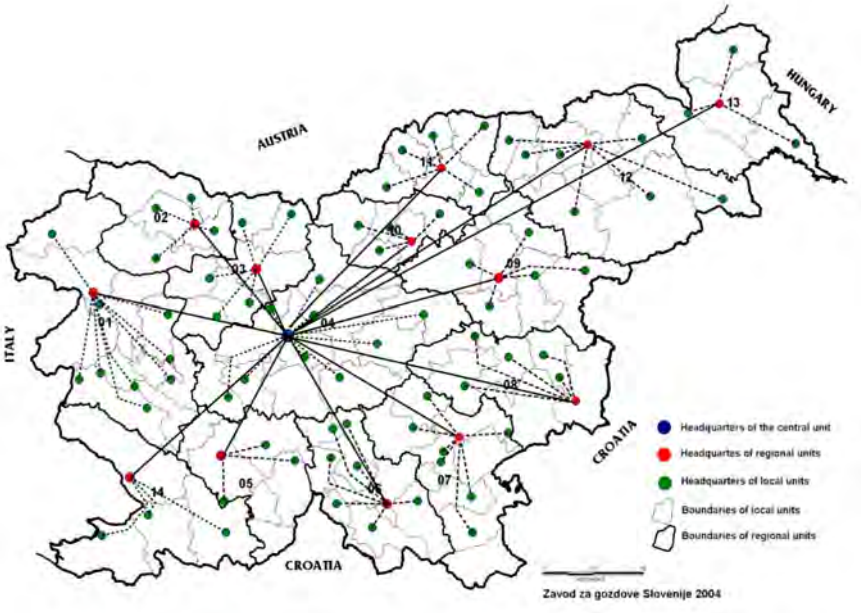


Figure 1: Organization of the Slovenian Forest Service

Pahernik forest and Pahernik foundation

ZDENKA JAMNIK, LJUDMILA MEDVED
(Slovenia Forest Service, regional unit Slovenj Gradec)

The Pahernik forest is a part of the Pahernik estate managed by the Pahernik Foundation. They lie on the northern slopes of Pohorje between village Vuhred (370 m a.s.l.) and the summit of Pohorje - Velika Kopa) (1542 m a.s.l.). They are part of a forested landscape, characterized by solitary farms called »celki«, reaching up to 1000 a.s.l In the lower positions the parent material are metamorphic rocks (gneisses, phyllites), and in the higher areas magmatic rocks (tonalite or granodiorite, dacite). Acid brown soils predominate, on which forest communities of fir *(Dryopterido-Abietetum)* and mountain beech *(Luzulo-Fagetum)* have developed. Special sites near water courses are overgrown by maple and ash forests *(Fraxinetum, Aceretum).* Sites at the top of Pohorje are overgrown by natural spruce forests *(Luzulo-Picetum).*

Data from forest inventory in 2013:

- Forest area is 570.13 ha, share of forest within the whole property 89%.
- The structure of the forest is small scale uneven-aged with small groups of even-aged spruce stands. Mature stands predominate (59%), followed by stands in regeneration (22%), pole stands (7%) and young stands (9%).
- The average growing stock is 453 m^3/ha, the annual increment is 10.8 m^3/ha/year and the allowable cut 8.0 m^3/ha/year. The share of conifers is 82%, with the highest share of spruce (67%) and fir (12%). Beech dominates among deciduous trees (16%), while noble hardwoods (maple, ash) are important for the diversity. The proportion of fir and beech in regeneration is increasing. The productive sites and regularly tended stands enable sustainable production of quality wood, which is the economic basis for all other activities of the Pahernik Foundation.

The yearly economic surplus is about 190 €/year and hectare. Average investment in regeneration, forest tending and protection is about 1 hour / ha / year.

- Logging is done moto-manually with a chainsaw. The dense network of forest roads (36.8 m/ha) and racks (117 m/ha) is a prerequisite for freestyle silvicultural system practised here.

The property plan for the Pahernik forests was made for the period 2014-2023. It is a practical tool for the owner and the manager, as its contents are influenced by the goals of the owner. It enables the fulfilment of the set goals, taking into account the rights, restrictions and duties arising from the legal regulations. It is an operational tool in the implementation of concrete management measures, taking into account the economy, timing, necessity and priority of actions in forests. The plan has two parts. Within the general part, information on the overall state of forests, objectives and measures are given. Within the operational part, special goals and measures and norms per forest stands are given. Both parts are complemented by maps. In addition to sustainable economic output special emphasis is placed on the nature protection and other non-wood forest services, for example NATURA 2000 sites cover 331 ha and 14 ha is forest reserve. Management of these areas takes into account measures set by nature conservation agency, e.g. measures for improvement of habitats. For example in the upper part of the property forest work starts after 1th of July due to the protection of capercaillie. Thus, the planned production in this area (60% of annual production) must be completed in three months. Nevertheless, the management of the Pahernik forests is economically successful. Due to regular tending, including pruning and favouring of individual quality trees, economic returns are expected to increase in the near future.

Pahernik forest has a research and educational purpose. Here scientific findings are verified in practice and results are presented to students, forestry experts and the general public. They are an example of close-to-nature management, an example of the coexistence of man and nature

through natural values, culture, history, education and management. The art of management reflects the collaboration between science and practice.

Pahernik foundation is operational since 2010 with the main goals: 1) managing of property with close-to-nature silviculture, 2) awarding scholarships to forestry students, supporting research, educational and other projects in the field of close-to-nature forestry and 3) preserving the memory of the Pahernik family. Since establishment the Pahernik foundation awarded 55 one-year scholarships for MSc and PhD students and approved co-financing for 120 research and educational projects. Among others the Pahernik foundation is involved in creation of the Centre for close-to-nature forest management in Radlje.

The main aims for the future are to: further develop close-to-nature silviculture, adapt forests to climate change and maintain the status of a research and development facility. We are currently conduction research on the regeneration ecology of forest gaps, including plating of wildlings and assisting migration of tree species, we are introducing situational tending (see talk of P. Ammann), and improving the stand structure.

Old-growth, forest reserves, and habitat for biodiversity in Slovenia

Assist. Prof. THOMAS ANDREW NAGEL (University of Ljubljana)
KRISTINA SEVER, Slovenian Forestry Institute

Habitats for biodiversity in Slovenia

Integrative forest management attempts to simultaneously fulfil both economic and ecological functions in a given forest region. In temperate uneven-aged forests, integrative management is likely to involve silvicultural systems that are synonymous with "close-to-nature" approaches. In theory, integrative management supplants the need for segregation of forests into unmanaged reserves and production forests. Slovenia may be the best example of long term integrative forest management worldwide: most of the forested landscape is managed with relatively low to moderate intensity silvicultural systems with frequent stand entry; clear-cutting is prohibited by law; forest composition is relatively natural and structure is heterogeneous within stands; large trees are abundant in many forest types; and natural regeneration is the main form of restocking. Because of the widespread notion that integrative management is sufficient for maintaining ecological functions, the national network of forest reserves covers less than 1% of the total forest area; reserves are typically small (e.g. < 20 ha) and occur on less productive forest sites. We discuss if this type of management in Slovenia is sufficient for maintaining forest dwelling species that require mature forest structures, such as those structures that are likely to develop in unmanaged stands, including dead wood, habitat trees, and microhabitats?

Marteloscope demonstration plots

In the frame of the Integrate+ project a Marteloscope plot was placed in the Pahernik forest. This plot is used for educating foresters and others about selecting trees with microhabitats versus those with higher economic value. All trees on the plot are numbered and mapped. Tree characteristics, tree microhabitats, and economic value are recorded for each tree. By using simulation software on tablet computers we can perform a virtual tree

selection and see the results of our intervention directly in the field. The Pahernik Marteloscope is 1 ha in size and has 524 trees, which amounts to a volume of 523 m^3/ha. The ecological value totals 3,166 points and is calculated based on the evaluation of tree microhabitats. The economic value of the stand is 23,786 € and is estimated based on tree volume, stem quality, and corresponding local timber prices.

Figure 2: Habitat tree
(illustration: Thomas Nagel)

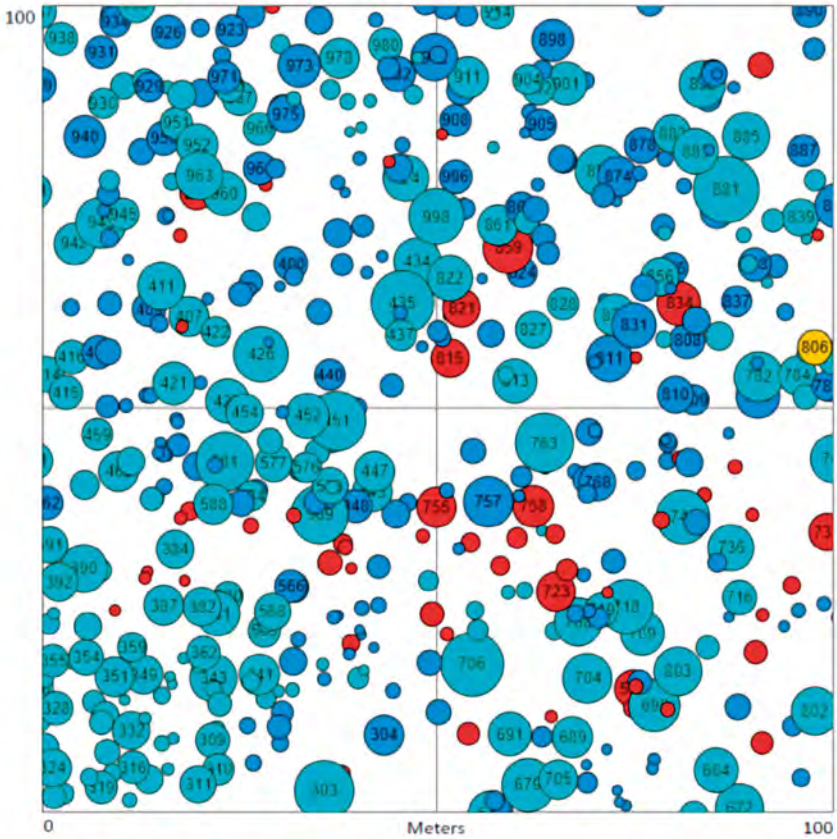


Figure 3: Map of Marteloscope Pahernik

Freestyle silviculture

JERNEJA ČODERL (Slovenia Forest Service, regional unit Slovenj Gradec)
Prof. JURIJ DIACI (University of Ljubljana)

In Slovenia, the oldest close-to-nature silvicultural system is single tree selection, which has been in use in many farm forests for centuries. Since the 1960s, the irregular shelterwood has become more and more prevalent in Slovenia. It does not require high density of roads and racks as selection system, and makes it easier to grow light-demanding tree species. However, it requires more direct tending, it can lead to even-aged stands and it may neglect tree individuality.

Pahernik forests were one of the first where irregular shelterwood was introduced. At the time, the density of forest roads was significantly lower, so adhering to the spatial order contributed to the preservation of regeneration and remaining stand. On our way to this stop, we saw some of the larger rejuvenation areas that result from such management. The gradual achievement of optimum forest road density offered opportunity for the introduction of a freestyle silviculture (FS) that respects tree individuality, natural differentiation processes and the promotion of uneven-aged mixed forests. For the verification of sustainability in forests where FS is applied, the control method and the frequency distribution of dbh is used, less emphasis is placed on models based on regulation of developmental phases.

The freestyle system in the Pahernik forest differs from high altitude spruce dominated stands, over mixed to beech stands and stands of noble broadleaves. On sites in higher elevation and with noble broadleaves, more light is needed, therefore freestyle silviculture favours regeneration in gaps and is thus close to irregular shelterwood, while on silver fir sites it is closer to selection system. This was difficult to achieve during 1980s and 1990s due to silver fir decline triggered by atmospheric pollution. Today the silver fir has recovered and at least in the medium term it is a substitute for spruce. Still, in this regard the problem of overbrowsing on larger part of Slovenia has to be solved. Overbrowsing is less pronounced on a silicate soils compared to carbonate substrate, where fir is competitively weaker.

The figure below shows the distribution of breast diameters across a 4 ha plot, which is used for training of selection system for stuff and students. However, in modern selection management based on tending there is much less emphasis on regulating forest structure as in the past.

The forest stands in Pahernik forest are approaching the optimal growing stock. Thus, natural regeneration and indirect tending are fully implemented. Most stands are mixed and uneven-aged. The remaining ones are some of the younger even-aged stands created by planting on abandoned agricultural areas, which need to be gradually converted to structurally diverse stands. In order to strengthen the overall stability of the stands, the emphasis is on maintaining high growing stock and increment, with simultaneous favouring of complex stand structure and regeneration on the entire surface of the holding.

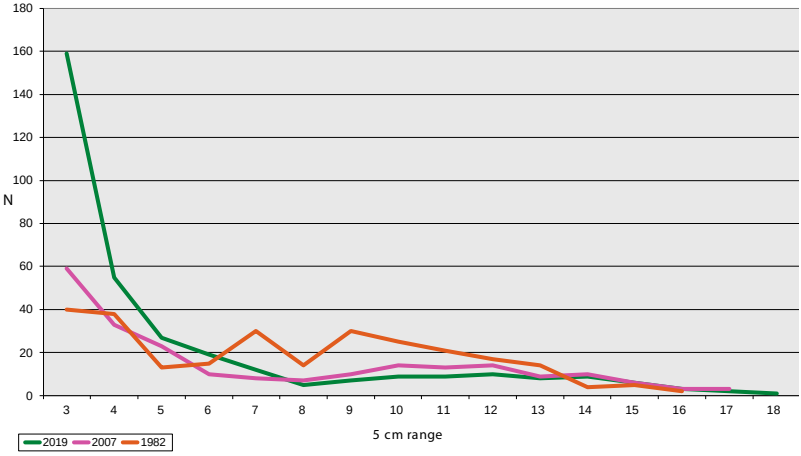


Figure 4: Development of the frequency distribution of breast height diameters on the experimental plot between 1982 and 2019

Some highlights:

- Freestyle silviculture is an essential component of the Slovenian school of close-to-nature, sustainable, and multifunctional forest management, developed by Prof. Dušan Mlinšek and put in practice and tested in Koroška region, especially in the Pahernik forests.
- Freestyle silviculture is a combination of forestry systems and their upgrading. It is based on natural regeneration, mixed uneven-aged stands and indirect tending.
- Silvicultural decisions are adapted to small scale differences in sites, stands and management goals.
- The focus is on managing stands and individual trees, but the emphasis is on individual treatment, tending of individual trees and the promotion of indirect tending.
- Optimal density of forest roads is a prerequisite for intensive work according to the principles of freestyle silviculture.
- Performance checking is based on the control method, in the sense of Mlinšek's cognitive approach, i.e. continuous observation of the tree response and adaptation of measures.
- Freestyle silviculture enables management for various good and services and adaptation of forests to climate change, as it is flexible.

Mapping of forest sites in Slovenia: the case of the Pahernik's estate

Assist. Prof. ANDREJ ROZMAN (University of Ljubljana)

Knowledge of forest habitats, their ecological conditions and tree species adapted to them is the basis of sustainable forest management. Preparation of maps of forest sites is thus a fundamental basis for silviculture and forest management planning by natural principles. This type of forest management has been present in Slovenia for decades. The production of a map of forest habitats takes place in the field and requires a good knowledge of plant species, forest communities and succession processes. In the process of detailed forest management planning, the most appropriate are phytocenological maps in the scale 1:5.000 or 1:10.000, which cover about half of Slovenia, while the remaining area is covered by maps in the scale of 1:25.000.

An example of a detailed phytocenological map is a map of forest communities of Pahernik's estate (Figure 5). These forests are dominated by mixed forests of fir and beech. At lower altitudes, especially in the valleys with higher air and soil moisture, there is a greater proportion of fir in the natural tree composition and with increasing altitude, the proportion of beech in the natural tree composition increases while fir above 1200 m a.s.l. slowly disappears. Spruce habitats are present only in the highest parts of Pohorje, however, due to past forest management, spruce is predominant in most forest habitats nowadays. In recent decades, despite the efforts of foresters, beech has been only slowly returning to its habitats and the acidic parent material, which favours the spruce's success, certainly contributes to this. Spruce monocultures are less resistant to different disturbances (e.g. ice storms, wind storms, bark beetle gradations) which have been occurring more frequently due to climate change in recent years.

Knowledge about forest habitats and their mapping gives us first orientations regarding tree species composition that will form the basis for future stability of forest stands. Nowadays, in times of rapid climate change, this seems even more important in terms of sustainable forest management.

With increasing average temperatures, the occurrence of longer dry periods and more intense weather events and related disturbances, certain tree species, such as spruce, lose their competitive ability, and other species thus increase their potential habitat. Knowledge of forest habitats and the ecology of tree species, considering the scenarios of future climate development, can already serve us today to design more stable and resilient forests of the future.

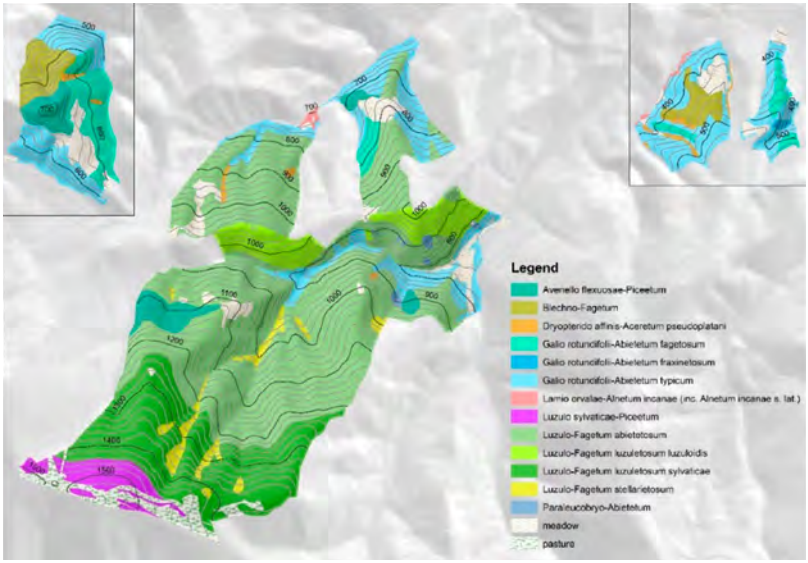


Figure 5: The phytocenological map of Pahernik's estate forests

Pahernik spruce monument

JERNEJA ČODERL (Slovenia Forest Service, regional unit Slovenj Gradec)

The Pahernik spruce is a in the forest of the Pahernik Foundation.

A special feature of the Pahernik forest is a remarkable old large-diameter Norway spruce. It is one of the largest in Slovenia and a value of national importance. It reaches a height of 48 m and a circumference of 420 cm. Age is estimated at 250 years. On the way to the spruce a monument to the tree, the Pahernik Forest and the Pahernik Foundation was raised. The Pahernik spruce is the only tree in Slovenia with a monument. The sculpture was erected in 2009 and is the work of the academic sculptor Jiri Kočica. The monument shows the intersection of nature and culture. In the central area is a depiction of spruce section in the chest height. It is surrounded by three bands in bronze that cast prints of Pahernik spruce bark. Tree – the Pahernik spruce is in the centre and turned upside down. The visitor can step into the space of the tree and catch its incredible volume at the junction of the trunk and roots. Central position means power and also responsibility towards all living things. The figures of a man and a woman representing Pohorje farmers stand outside and represent their attachment and respect for nature. They are made of Pohorje marble. A sculptural composition prepares the visitor of the Pahernik forest for the tour to the Pahernik spruce.

4. Excursion: Sgerm farm and forest, 12th September 2019

General data of excursion site

Location: 46°33'08.1"N 15°15'34.1"E
Altitude: 500-600 m
Mean yearly T: 8.7 °C
Precipitation: 1200 mm
Forest sites: silver fir forest with spruce and broadleaves *(Galio-Abietetum)*

Slovenia Forest Service: Regional Unit Slovenj Gradec

BRANKO GRADIŠNIK (Slovenia Forest Service, Head of RU Slovenj Gradec)

Regional unit Slovenj Gradec directs the development of more than 60.400 hectares of forests in Koroška. The average growing stock of all forests is something less than 390 m^3/ha, the annual increment is about 9m^3/ha, the planned annual cut is about 7m^3 per hectare. In the last few years forestry was faced with a number of problems that make sustainable forest management yet more demanding. Many of our forests have been severely damaged by different natural disasters (sleet-break, windbreak) and by the recurring gradation of bark beetle.

The region is one of the most forested area in Slovenia and in Europe. Forests cover almost 70% of the surface and we can say they are the essential element of the landscape. They have been preserved mainly because this area is less suitable for agriculture. Forests have an important role in the provision of life quality for local residents.

More than 75% of forests in region are privately owned. According to the latest data, there are about 6,600 owners. The average private forest estate is about 6.5 ha. Larger forest estates can be found in mountainous areas of the region; where forests represent an important source of income for owners and often decisively contribute towards the preservation of settlements in rural areas.

Most forests are located within the area of beech and fir-beech sites. The tree composition is dominated by spruce with almost 70%. The high deviation in terms of the actual spruce share compared to the potential natural vegetation, is primarily the result of spruce planting in the distant past, following the model of the German forest management school. Spruce was extensively introduced into deciduous sites, primarily beech.

Organic farm Sgerm

Owners: Damjana Sgerm–Kristan; Gregor Sgerm

Farm size: 52 ha in one piece

Agricultural land: 11.5 ha of meadows and pastures –
presently in rent to a neighbouring farm.

They grow vegetables and potatoes for their own needs. Because they are rebuilding the old stable, at present they don’t keep cattle, with exception of two ponies.

Forests on Sgerm farm (data from 2014): Forest area: 40,5 ha;
Growing stock: 531 m^3 / ha (conifers 510 m^3 / ha, broadleaves 21 m^3 / ha);
Possible harvest (2014-2023) 4530 m^3.

Single-tree selection management in the Pohorje region

ANDREJC SUZANA (Slovenia Forest Service, regional unit Slovenj Gradec)

The Pohorje farmer has always lived with the forest, nurtured and exploited it in a selection way. They used it to get the wood for their own needs, while more valuable wood was sold. Harvesting was done manually and with the help of horses. This is the form of management closest to the natural forest. It has established itself especially on the northern slopes of Pohorje on farms called “celek”, which would mean the land which, within their borders, ensure the existence of one farmer family. After the start of management planning two foresters, Pahernik and Pogačnik started promoting more advanced selection management. Different needs of the farmers and different ways of managing the forest have led to changes in the structure of the selection forest. It was changed mostly due to silver fir (fir) dieback to more large scale textured forest and the management changed to irregular shelterwood. Fir was replaced by Norway spruce (spruce), while European beech (beech) was cut constantly for firewood purposes.

Farm life has also changed in recent years. Many farmers are employed, cutting wood mainly for sale. Due to the economic aspect, logging is done in a more patchy way approaching irregular shelterwood. At the same time in some areas there is no logging at all, due to low prices of wood. This results in higher growing stocks, less regeneration and loss of a selection forest structure. Despite these changes, in the Pohorje forests, we can still find single tree selection forests in certain areas. One example is Sgerm farm. Its forests were managed in a selection way throughout the periods with greater or lesser deviations. In order to maintain the selection structure, in addition to suitable site and stand conditions, a professional approach by the forester and the collaboration of the owner is required. Selection management means special relationship to the forest, where emphasis is placed on the individual tree.

Sgerm property lies on the N slopes of Pohorje, at an altitude of 500-660 m. The area of the forest is 40 ha, which are predominantly covered

with rich soils that would normally support a growth of vegetation type including fir and a rich layer of ferns. At the latest measurements in 2014 there was a 530 m^3/ ha of standing wood volume of which 96 % was conifers and 4 % were broadleaves. Over the last 70 years growing stock was ranging between 380 m^3/ha and 530 m^3/ha and the tree species present are spruce, fir, beech and Scots pine. The needs of the farm for firewood are still holding back the spread of deciduous trees. All the area is covered with sufficient network of forest roads. Harvesting is motomanual and skidding is done with a tractor. The owners carry out logging in the forest themselves. The maximum harvest is planned at 73% of increment, amounting to 453 m^3/year.

Positive features of the selection management: logging at any time and choice of any assortments, dispersed logging and preserved stand climate, continuous natural regeneration, high resistance and resilience of the forest, constant timber supplies and constant yields, soil protection, less sanitary logging. Negative features of selection management: demanding in terms of knowledge, requires regular management, may favor shade tolerant tree species, more difficult to manage broadleaved species, requires high road density, dispersed silvicultural measures and logging throughout the entire stand resulting in more demanding harvesting and higher costs.

The idea of the single tree selection forest is still present in the Pohorje forests. Selection forest is not our goal, but a means of rational management in certain situations. When conditions change, the selection structure may change for a shorter or longer period. Since selection structure is not developed naturally in the forest in large areas, we must constantly maintain it. Proper implementation of selection management ensures the sustainability of the forest, the sustainability of yields for the owner and permanent provision of ecosystem services.

Sgerm's spruce, tallest native European tree

Prof. ROBERT BRUS (University of Ljubljana)

History of heritage tree protection in Slovenia

Slovenia is a land with rich tree heritage that includes some trees exceptional on a European scale. This is made possible by good natural conditions, and on the other hand, by the long nature conservation tradition that has been lasting since at least 1892, when the provincial government has protected Taxus baccata joined six years later by Daphne blagayana and Leontopodium alpinum. At the same time, it is certainly a mirror of people's attitude towards tree heritage. Foresters are most credited with preserving the tree's heritage in the forest, as the nature conservation spirit has been incorporated in their work for almost 150 years. Data collection of exceptional trees was first organized in 1914, when the then Ministry of Agriculture issued a call for the inventory. More similar actions followed; one of the largest, entitled The thickest tree in your hometown, was organised in 1978 with the help of Pionir magazine.

Register of tree natural values

Today, the Institute of the Republic of Slovenia for Nature Conservation supported by the Slovenian Forest Service is responsible for recording exceptional trees, monitoring their condition and preserving them. The legal basis for declaring and protecting tree natural values is the Nature Conservation Act (2004) and the Decree on the categories of valuable natural features (2004). Tree natural values are defined by criteria such as dimensions, age, exceptional habit and great testimonial, ecosystem or scientific significance. The list of exceptional trees is a part of the Register of Natural Values kept by the Institute of the Republic of Slovenia for Nature Conservation. There are 2529 trees on the list, of which 1434 are individual and others grow in groups of different sizes. Among the 91 different tree species in the list, by far the most common is linden *(Tilia platyphyllos)* with 43%, followed by common yew *(Taxus baccata)* with 7%, common beech *(Fagus sylvatica)* with 6%, pedunculate oak *(Quercus robur)* with 5% and Norway spruce *(Picea abies)* with 4% of listed trees. 22 % of heritage trees are of national and 78 % are of local importance.

Sgerm's spruce in Pohorje

Pohorje is the area with the highest density of tree natural values in Slovenia and Norway spruce is among most common heritage trees. Sgerm's spruce in the village of Orlica near Ribnica na Pohorju in Slovenia, named after the forest land owner where it was found, was first accurately measured in 1995 with an electronic theodolite and was 61.7 metres tall and had a BHD of 108 cm at that time. In 2012, it was remeasured with a measuring tape and extendible pole by a climber who climbed the top of the tree. At the mid-slope point the spruce was 62.26 m tall, its BHD was 124 cm and the age was estimated to around 270 years. Sgerm's spruce grows in a managed forest at the altitude of 550 meters, the parent rock of the site is sandy marl and sandstone and the plant association is *Dryopterido–Abietetum.*

In Europe there are a few taller trees, but they all belong to non-native tree species from the genera *Eucalyptus, Pseudotsuga, Abies or Picea.* At present, Sgerm's spruce from Pohorje is the tallest native European tree.

Figure 6: Sgerm's spruce (Photo Robert Brus)

5. Excursion M (Mislinja): Gradual conversion of spruce monocultures in Mislinja, 13th September 2019

General data of excursion site

Location: 46°28'13.4"N 15°14'35.8"E
Altitude: 1000 m
Mean yearly T: 6.5 °C
Precipitation 1250 mm (valley), 1600 mm (Pohorje)
Average annual temperature: 6-8°C; January: between -2 and -4°C; July: 16-18 °C;
Forest sites: acidophilus beech and mixed mountain forest *(Luzulo-Fagetum; Cardamino savensi-Fagetum)*

Introduction of Mislinja local forest unit

MIRKO CEHNER (Slovenia Forest Service, regional unit Slovenj Gradec)

- Area: 11.205 ha; Forest Area: 8226 ha (forest cover 73 %)
- Forest ownership: private 5460 ha, state owned 2766 ha
- Growing stock (2015): private: 399 m^3/ha; state: 452 m^3/ha;
- Increment (2015): private 9.41 m^3/ha/year; state: 9.26 m^3/ha/year
- Conifers/broadleaves ratio: private 87: 13; state 92: 8
- Allowable annual harvest: private: 40,700 m^3; state: 19,600 m^3
- Density of forest roads: 30 m/ha
- Density of skidding trails: 96 m/ha

The Mislinja local unit is one of five local units of the Slovenj Gradec Regional Unit. It is divided into four districts (revier). Unit geographically cover the NW part of Pohorje, which belongs to the Central Alps. The climate is mild mountainous in the valley and the lower parts of Pohorje,

and mountainous at the top of Pohorje. Annual rainfall is of 1250 mm in the valley and up to 1600 mm at the top of Pohorje. For centuries, forests have been managed promoting spruce, especially on Pohorje. Therefore, the current forest composition differs greatly from the composition of the potential natural vegetation associations. Pohorje is dominated by silicate (acidic) bedrock. The carbonate bedrock is characteristic for nearby Paški Kozjak unit.

Brička: Old example of gradual conversion of spruce monocultures

MIRKO CEHNER (Slovenia Forest Service, regional unit Slovenj Gradec)

Forest management history:

- Potential natural vegetation are mixed beech, fir in spruce forests with admixture of noble broadleaves.
- In the beginning of 17th century a major harvesting starts for glass-making, iron production and cattle pasturing.
- Industrial development at the end of 19th century in Mislinja valley (rail-way road, sawmills, paper factory) increases demand for wood supply.
- Management system was clear-cut and rotation period 80 years.
- After clear-cut, tree harvest residuals were burned, soil was ploughed, and potatoes were planted. In the second year rye seeds were sowed (direct seeding) together with spruce seed. After rye harvest spruce seedlings established. In the following years all naturally established broadleaves were systematically removed from spruce regeneration. This was the most common approach to establish spruce plantations.
- Clear-cut system was simple and it produced large quantities of wood.
- Drawbacks of clear-cut systems: soil acidification, accumulation of raw humus, utilisation of the growth potential of individual tree species was not possible, deterioration of soil fertility, increased risk of snow and wind damage, homogenization of forest landscape.

Beginning of close-to-nature forest management:

- Forest legislation prohibits clear-cut system in 1948.
- The principles of sustainability, sustainability and multipurpose have become fundamental principles of forest management.

- First systematic revitalization was conducted by J. Miklavžič in large-scale agromeliorative manner (soil liming, planting broadleaves). Project was not successful.
- After 1955, in state forests small-scale conversion of spruce plantations was adapted based on the following practises:
- promoting remaining broadleaves in mature stands as a seed source for natural regeneration,
- direct seeding of broadleaves (low success),
- planting of pioneer species *(Alnus* spp., *Sorbus aucuparia)*,
- under-planting of broadleaves *(Fagus sylvatica)* in gaps or under closed canopy.

Brička site:

- Strong damages from snow in 1951 and 1952 on 10 ha of forest.
- Management dilemma – to final harvest or leave the stand to further development!?
- In 1954, decision to under-plant beech seedlings on entire area of 10 ha.
- Protection of planted seedlings against browsing.
- In the last 60 years we observed significant increment of mature stand and under-planted beech.
- Average increment of mature forest stand (MAI) is 8 m^3/ha.
- Beech trees have different height growth patterns – dependent of light and temperature conditions.
- Under-planted beech has a function of soil improvement and will present future canopy layer (40 %).
- Improved soil conditions allow for natural regeneration.

State forests management in Slovenia

PETER KOLAR (Slovenian State Forests Company d.o.o. – SIDG)

As of July 1, 2016, the management of the majority of state forests was taken over by the Slovenian State Forests Company d.o.o. (SIDG). The company was set up to pursue the following major goals:

- Respecting the principles of close to nature, multifunctional and sustainable management of state forests to maximize the yield and quality of forest wood assortments
- Contribute to the establishment and development of forest-timber chains, the promotion of timber and timber products and the creation of green jobs.
- Increase the area of state forests in the long run
- Contribute to rural development, in particular the conservation of farms and rural areas in a mountainous and hilly environment with limited economic opportunities
- Contribute to nature conservation objectives, particularly in protected areas and Natura 2000 sites.
- In forestry and wood science, enable the training of professional staff and support education and research

Slovenia is covered by 4 management units (Kočevje, Postojna, Ljubljana and Maribor), which are divided into 28 forest units. SIDG manages about 235,000 ha of state forests, which represents 21% of all forests or 12% of Slovenia's surface. Soon after the company was established, it was confronted with several natural disasters. In 2017 there was a widespread bark beetle outbreak. In December 2017, Slovenian forests were struck by a strong windstorm. Another intense windstorm followed at the end of October 2018, and as a result of these windstorms, many forests are again under the influence of bark beetles.

SIDG works in state forests with its own employees and with external contractors, which it selects through a two-phase procurement process. In the first phase, qualified contractors are selected. In the second phase, the selected contractors bid for the tendered works and the best contractor performs the work. We started introducing our own production in 2018. SIDG's goal is to perform up to 20% of production with its own capacity.

SIDG sells timber from state forests in accordance with the Rules for the sale of forest wood assortments accepted by the Government of the Republic of Slovenia. SIDG sells most of the timber to local processors with whom it has long-term contracts. The rest of the wood is sold to buyers through public bidding, auctions, and direct sales (mainly firewood for households).

In 2018, SIDG cut 1.515.925 m^3 of timber in state forests. The share of sanitary logging was 85%. It created approximately 77 million EUR in revenue. It contributed 14.6 million EUR to the Forest Fund and generated 14 million EUR in profits.

Forest protection in Slovenia

ANDREJA KAVČIČ (Slovenian Forestry Institute)
MARIJA KOLŠEK (Slovenia Forest Service; Central unit Ljubljana)

In the forests of Slovenia, the greatest damage is caused by spruce bark beetles.

Of all the harmful factors, the greatest damage in Slovenia's forests is caused by the gradients of bark beetles, especially the species European spruce bark beetle (Ips T*ypographus).* Gradations generally follow damage to forests caused by natural disturbances such as windbreaks, ice breakers, snowfall, and prolonged dry and hot periods. They are also affected by the increased proportion of spruce in forests at less suitable habitats, which is a consequence of forests management regime over the centuries.

Harmful events have become more frequent and more violent due to climate change in recent years. Since 2014, when Slovenia was hit by catastrophic icestorm, the scope of work in the field of forest protection has increased significantly, and the image of forests has changed markedly. The icestorm was followed by several years long lasting bark beetles gradation, exceptional in size and damage, which ended in 2018 in the vast majority of Slovenia. At the end of 2017, forests were again damaged in a windstorm of extreme strength and magnitude, which was followed by few more powerful local windstorm events. In 2019, in the area of greatest damage by windstorms, the population of spruce bark beetles increased again.

Restoration of damaged forests began in 2014 and will mostly take place in a natural way. In forest restoration, we are increasingly faced with the problems caused by invasive alien species. Non-native plant species in some places already complicate the process of forest regeneration. Due to non-native diseases and pests, the range of target tree species that will be the main carriers of future forest stability is being reduced. For example, the invasive non-native *fungus Hymenoscyphus fraxineus,* which causes a lethal disease known as ash dieback, causes difficulties in forest restoration on habitats of common ash.

Forest protection service of Slovenia Forest Service

The Forest Protection Service, as a public service in Slovenia, is performed by the Slovenian Forestry Institute (SFI) and the Slovenian Forest Service (SFS). The Forest Act stipulates that the SFI directs and expertly manages the reporting and prognostic-diagnostic forest protection service, but for the performance of its tasks the SFS is designated.

In the framework of the Public Forest Service, the SFS ensures the implementation of protective works in forests as well as on individual forest trees outside settlements. Regarding forest management planning and annual work programs, SFS plans preventive protection and curative measures. Preventive measures are integrated into regular forest management, taking into account the principle of sustainable, close to nature and multipurpose forest management. Forest protection activities include the protection of forests from wildfires, natural disturbances, erosion, and gradations or outbreaks of forest pests, as well as the protection against damage to young forest by game.

Cooperation with forest owners and related fields of work is important for the successful operation of the SFS in the field of forest protection. In the area of large-scale protection of forests against fires and natural disturbances, we are embedded in a system of protection against natural and other disasters run by the Ministry of Defense. We are involved in the field of plant protection against quarantine pests, managed by the national plant protection authority, and in the field of forest protection against invasive alien species, managed by the ministry responsible for the environment. The closest cooperation in the field of forest protection is with SFI. One of the important results of cooperation between SFI and SFS in the field of forest protection is the web portal Varstvo gozdov Slovenije (www.zdravgozd.si).

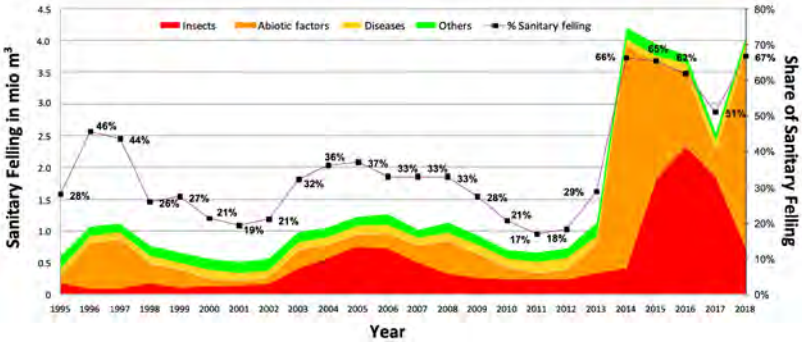


Figure 7: Sanitary felling by causes and in shares of total felling by year, 1995-2018

Forests and challenges of forest protection

Forests in Slovenia and Europe are facing increasingly bigger challenges. Human activities, climate change, more frequent and extreme weather conditions, outbreaks of harmful organisms, together with the arrival and spread of invasive alien species, are weakening and threatening the forests. Therefore, forest protection and its endeavours for healthy forests have become more important than ever before. Scientific research covering various forest health topics and the application of results into forestry practice are crucial for continuous stability assurance in highly complex ecosystems such as forests.

Table 1: Sanitary logging due to damage from icestorm, windstorms and gradations of bark beetles in Slovenian forests in 2014 - 2018

Record of logging by year and by cause of logging in millions m^3	Icestorm 2014	Bark beetle gradation that followed icestorm	Windstorm 2017, windstorms 2018	TOTAL
2014	2,97	0,41		3,38
2015	1,56	1,82		3,33
2016	1,01	2,32		2,06
2017	0,22	1,84		3,76
2018	0,10	0,74	2,92	3,38
Total 2014-2018	5,86	7,13	2,92	15,91

The Slovenian Forestry Institute and Laboratory of Forest Protection

The Slovenian Forestry Institute (SFI) is the central institution for research and development in forestry in the Republic of Slovenia. At the SFI, forest protection issues are covered by the Department of Forest Protection, which monitors and prognosticates the occurrence and spread of forest pests and diseases, carries out forest and tree health diagnostics, provides advisory service and creates new knowledge through basic and applied scientific research. The Department of Forest Protection takes part in the public forest service, and works in close collaboration with the Slovenia Forest Service (SFS), the main institution responsible for the realization of tasks related to forest protection in Slovenia, and the Ministry of Agriculture, Forestry and Food. One of the highlights of the collaboration between the SFI and SFS is a portal Varstvo gozdov Slovenije that is publicly available at www.zdravgozd.si. An integral part of the Department of Forest Protection is the Laboratory of Forest Protection with the key infrastructure supporting original research and development associated with forest protection and plant health, and professional staff offering expert support in solving a wide range of issues regarding these fields on the national and international levels. The Laboratory of Forest Protection has been authorized by the Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection to perform official forestry-related plant health tasks regarding quarantine and other potentially harmful alien insects and fungi, such as visual examinations, sampling, diagnostics, pest risk analyses, and collaboration in the development of national and international documents. An essential part of the Laboratory of Forest Protection are reference collections of insects and fungi associated with forests and woody plants, with specimens from Slovenian forest as well as potentially hazardous non-native species. The Department of Forest Protection staff collaborates with research laboratories worldwide and are members of international associations, e.g. EPPO and REUFIS, thus actively contributing to global forest protection and plant health issues.

Current actions for the future

Currently, forest protection in Europe is mainly concerned with bark beetles and biological invasions in forest ecosystems. Researchers are particularly interested in finding ways of preventive action, such as improvement of forest resilience to negative environmental influences and early warning and rapid response to possible future forest pests and diseases. For this purpose, we develop computer-based models, implement advanced technologies and introduce new diagnostic procedures. Early warning and rapid response systems for biological invasions have become one of the top priorities of the forestry sector. A consistent support from policies, forest owners and the general public is a prerequisite for any action to be effective. Therefore, the Department of Forest Protection of the SFI together with the SFS performs a number of awareness-raising and educational events for the relevant ministries and other forestry-related institutions, forest owners and the general public.

see also Excursion L – stop 4

Ecological and silvicultural basis for underplanting of beech beneath Norway spruce shelterwoods

Assist. Prof. MATJAŽ ČATER (Slovenian Forestry Institute)

EU project SUSTMAN (2002-2005) focused on underplanting of broadleaves under Norway spruce monocultures and to transfer scientific results into practical forestry by the silvicultural guidelines for the forest managers.

Background

At least 6-7 million ha of pure Norway spruce *(Picea abies)* in Europe are located outside its natural range; about 4-5 million ha are located on sites naturally dominated by broadleaves or mixed tree species. Former mixed broadleaved forests were overexploited due to agricultural use, litter harvesting, grazing and due to the need of fuel. An urgent need for timber, because of the industrialization process promoted afforestation with fast growing Norway spruce for its high growth rate and easy establishment. Accordingly, parts of the forested landscape in Western and Central EU are dominated by Norway spruce plantations, which in time resulted in higher exposure to forest decline, windthrows, pests, drought and soil deterioration. Climate change with increasing probability of climatic extremes additionally increases its vulnerability. Pure spruce forests have also been associated with lower public acceptance due to changed or decreased biodiversity, environment and landscape. Restoration of the former mixed broadleaved forests by conversion from Norway spruce to broadleaves is therefore believed as a step towards sustainable forestry. The conversion could be accomplished by underplanting of European beech *(Fagus sylvatica)* beneath spruce shelterwoods, which has been promoted in several parts of EU. Presented project provided a comprehensive fundament for forest conversion through planting of broadleaves under Norway spruce shelterwoods.

Underplanting

In Slovenia underplanting activities started already in the first half of the nineteenth century to create stable stands and improve soil conditions. Preferred species to underplant is beech, but also Sycamore maple, lime, ash, oak and Douglas fir, hornbeam, rowan and cherry have been used. Local provenances are preferred and planting is the dominant method. 1 - 5 year old bare-root seedlings are preferred with a large variation in height; 200 to 10 000 seedlings per hectare are used. Canopy management does not follow any standard methods, as the shelter trees can be kept from 5 till up to 20 years or even up till 40 years and more. Consequently, there are a number of ways to remove the shelter trees.

Selection of sites for underplanting

1. Risk evaluation

The risk potential for Norway spruce stands should be determined, evaluating the site- and stand-factors. The former leads mainly to drought risk that originates from site characteristics such as low rooting depth either through shallow soil or through restricted rooting due to impaired soil aeration. Both limit water availability for tree roots when climate extremes and irregular precipitation induces drought stress. Slender trees with a high height/diameter ratio became increasingly unstable and storm events can easily disintegrate existing forest stands. Restricted rooting on heavy soils and high-water table may limit the rooting depth and impair of tree anchorage, thus further decreasing tree stability.

2. Suitability assessment

The assessment of suitable sites for broadleaves is based on soil water availability, soil nutrient regime and climate. Many broadleaved tree species require fertile sites for good growth. Information from former land use and growth of Norway spruce stands may also indicate where fertile sites can be found.

3. Selection of conversion methods

Management decisions are related to the resource input level. The resource input will in most cases directly depend from the magnitude of expected timber production, general benefits and subsidies. Stands with the highest conversion priority are selected. The resource input is strongly linked to the intensity of conversion process (costs per hectare) and to the area subjected to conversion. Taking in account the heterogeneity of forest systems in countries with a large share of man-made Norway spruce monocultures may provide a variety of approaches. Several regeneration methods based on a various of felling regimes from clear-cut to group-selection or single-tree harvesting can be chosen.

Root distribution and competition

Norway spruce usually develops shallow root system with maximum root densities in the organic and upper mineral soil layer, while beech distributes root systems to greater depths (Figure 8, left). Severe belowground competition between spruce and beech can occur mainly during the first years of underplanting, when young beech trees are restricted to the top-soil layers. Results show, that most spruce fine roots were concentrated on the top 20 cm of the soil, while no spruce fine roots were found below 40 cm. Underplanted beech roots penetrate deeper than spruce roots and are also found below than 1 m soil depth, minimizing the interspecific competition.

As spruce trees show greater rooting depths in the vicinity of the stem, a minimum distance between underplanted seedlings and mature spruce trees should be provided. Advance planting emphasises sub-soil properties that allow beech to build up deep root systems, where the deformation of root systems plays an important role (Figure 8, right), resulting from the root cut prior to planting and possibly irregular placement during planting. Reduced rooting depths caused by such deformed root systems may impair the competitive ability of beech and could lead to reduced stability of such beech plantations in later ages.

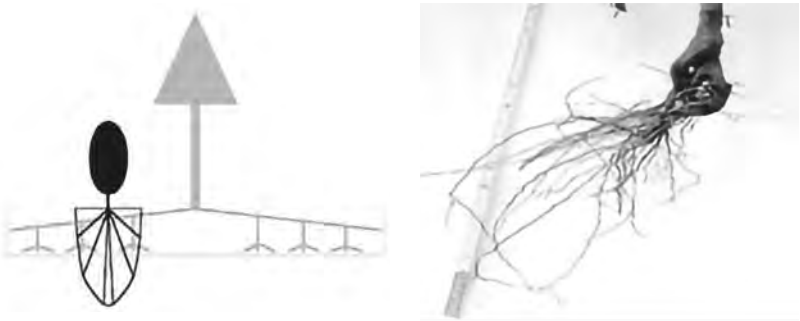


Figure 8: Shelterwood mature spruce tree - gray with underplanted beech seedling - black (left). Root system of beech seedling showing strong distortions (right).

During moderate dry period beech seedlings transpired about 1.5 kg water/day and 2.3 kg water/day during drought. Contrary to this, mature spruce trees transpired about 35 times more (54.5 kg/ day). Mature spruce trees are highly sensitive to drought while underplanted beeches are more drought tolerant. Root competition is stronger in the vicinity of Norway spruce trees. To avoid root competition thinning of the shelterwood tress is recommended, or an earlier release cut than usually applied.

Light climate, canopy influence and plant reaction

The shade tolerance in seedlings is maintained by leaf orientation, morphological plasticity, low leaf construction costs, and expansion of the leaf area. Light input does not only influence survival and growth, but also the quality of the introduced plants. It is necessary to determine how the light input depends on the canopy closure of the mature spruce stand. The gap fraction of a canopy is a good variable for indirect sensing of crown coverage, integrating canopy structure and closure.

Some management implications:

1. Under uniform shelterwoods relative light input is directly linked to canopy; it increases slower than the canopy closure
2. Growth of plants is linked to light input, when the nutrient supply meets the species requirement
3. Protection against leaf loss due to browsing is of high importance for plant survival and performance in shade
4. Initial survival and later vigour of beech plants is further influenced by water supply

Seedling establishment, plant type, spacing and site preparation

Preparative measures commonly associated with forest regeneration are site preparation. Spot wise application confines the risk of nutrient losses and ground water pollution. Site preparation creates soil beds that facilitate root growth and water uptake, it removes or represses ground vegetation that competes for nutrient and water with the seedlings and may improve the microclimate or the chemical soil conditions. Competition between spruce and beech should be controlled by spatial separation of species and careful management of light conditions by means of a slow harvesting progress. It is not feasible to define simple pathways for the conversion of Norway spruce forests. Even under comparable circumstances various silvicultural options exist. The success of conversion depends on a precise definition of its goals and the harmonisation of the single steps during the regeneration process.

Canopy management, plant quality and harvesting

Practical observations show that the canopy density affects the growth form of the young trees underneath. However, important parameters like branching pattern, branch thickness, number of proleptic shoots, crown form, self-pruning, and extent of felling and logging damages are almost not covered by scientific investigations connected to the underplanting. The extent of slant of the young beeches is increasing with the canopy density

of the old stands, or with decreasing light intensity. The relationship is not linear: with light intensities falling short of 10 % or even 15 % the mean angle of deviation of the stem axis respective of the last terminal shoot from vertical axes increases more and more. There is a threshold value between 10 and 15 % light.

Cutting types which are characterized by keeping overstory for longer periods imply many repeated harvest entries. Young beech can grow under completely closed overstory, where light intensity should not drop below 10 - 15 % to avoid the deterioration of stem. Natural regeneration of spruce is significantly hampered by dense ground vegetation cover, particularly of grasses and should be initiated in an early stage of the whole cutting process. After establishment (approx. 4-6 years after germination) the young spruces require more light (30 % of open light intensity) to gain sufficient height growth and a competitive advantage over beech. The competition between beech and spruce should be mitigated by arranging a groupwise mixture, with monospecific groups of at least 20 m in diameter.

Remnants of natural forests at Jauh farm

MIRKO CEHNER (Slovenia Forest Service, regional unit Slovenj Gradec)

Embedded within large property forest complex (3000 ha) managed by intensive clear-cut system with sowing of spruce, Jauh farm managed to survive all the past challenging times. Farm is 15.5 ha in size, entirely in one parcel. Half of the farm is agricultural land, the other half is forest. In the forest owned by the farm small remnants of natural forest are represented.

Forest characteristics:
Growing stock (2015): conifers 405 m^3/ha; broadleaves 54 m^3/ha;
sum 459 m^3/ha; mixture:
spruce 85 %, Scots pine 3 %, beech 8 %, sycamore maple 2 %,
and other broadleaves 2 %.
Farm property has been abandoned, owners live in the valley.
3,4 ha remained as agricultural land, the rest of the property is nowadays forest.

Organic Farm Miklavž

Owner: Jože Jeseničnik
Present farm management: the size of the farm is 30 ha, the whole estate is territorially rounded in one piece, farm management is organic,
Agricultural land: 9 ha of meadows, pastures, fields; 6 ha of meadows are rented
Farm products: rye, oats, buckwheat, potatoes
Livestock: 15-18 cattle, 4-5 pigs, 10-15 hives of bees
Tourist farm: old typical farmhouse from 1843 - protected
Forests on farm Miklavž (data from 2015): Forest area: 21,00 ha; Growing stock: 492 m^3 / ha (conifers 397 m^3 / ha, broadleaves 95 m^3 / ha), Possible harvest (2016-2025) 1705 m^3

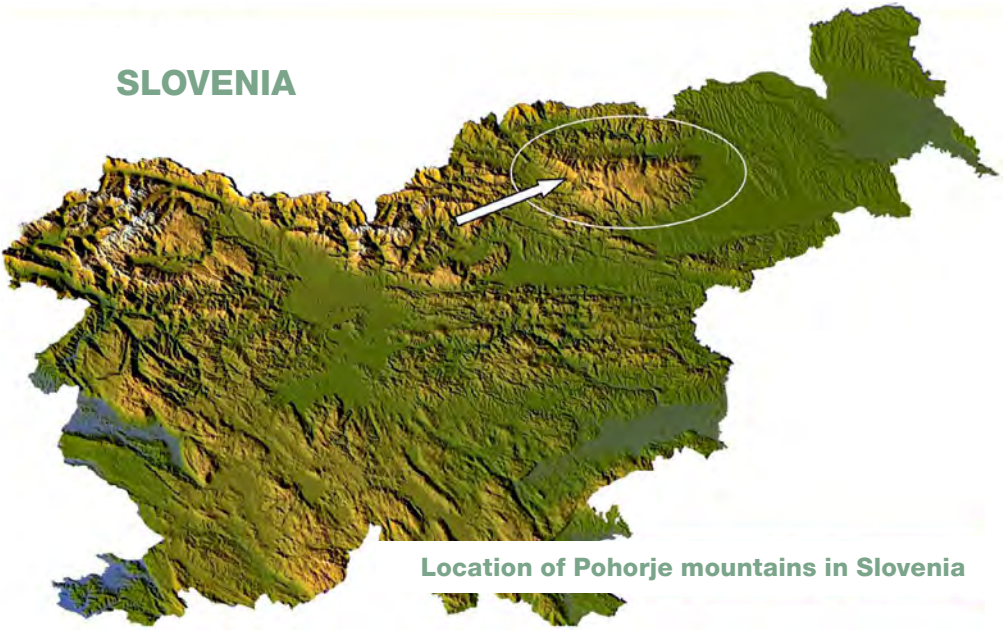
6. Excursion L (Lehen): Autochthonous control method in the selection forests of Slovenia, 13th September 2019

Pohorje mountain

Pohorje is a mostly wooded, medium-high mountain range south of the Drava River in north-eastern Slovenia. Pohorje is a young mountain massif and represents the south easternmost part of the Central Alps. It is the only mountain chain in Slovenia made of silicate rock. Its peripheral parts consist of Paleozoic metamorphic rock, and its central parts of igneous rock, particularly granodiorite (known also as the Pohorje tonalite) and dacite. Near the village of Cezlak lies the only known deposit of cizlakite in the world.

Pohorje has dense surface water network due to impermeable rock base. It is characterized by high forest cover (70%). Forests consist mostly of beech, spruce and silver fir. On the outskirts of Pohorje, these forests pass into preserved, edaphic conditioned natural spruce, bog forests and high bogs. The whole area represents the habitat of rare and endangered plant and animal species.

Pohorje forests were mostly deciduous at the end of the 18th century, and in the 19th century, they have been changed significantly due to the heavy introduction of spruce. Conversion of man – made spruce forests into forest with more natural tree composition represents one of main forest management challenges today.



Location of Pohorje mountains in Slovenia

General data of excursion site (stop 1)

Location: Top of Ribniško Pohorje: 46°29'37.7"N 15°15'52.9"E
Altitude: 1525 m
Mean yearly T: 4° C
Precipitation: 1600 mm
Forest sites: spruce forest *(Sphagno-Piceetum; Luzulo-Piceetum)*

Integration of nature conservation in the forest management planning system

JURIJ GULIČ (Pohorje d.o.o., Ljubljana)

Case of project experiences and participation of stakeholders in the Pohorje mountain area

Social changes affect the perception of nature and ultimately of the management of protected areas. The traditional hierarchical (top-down) and restrictive, prohibitive approach has slowly retreated to integrated management of protected areas through the involvement of stakeholder groups (second generation). The primary function(s) of protected areas, the protection of biodiversity, has expanded with a new sustainable development function. With the increasing complexity of social relationships and forms, a modern protected area is being identified, which, unlike the original administration and management, is characterized by networking and promotion.

The management of protected areas consists of several interconnected elements through which the sustainability of natural, cultural and social resources is ensured. Governance elements have content in the areas of legal, administrative, social, institutional, scientific, financial and planning skills that are intertwined and lead to the sustainable use and fulfilment of the objectives of the protected area. The management of (protected) areas requires a multidisciplinary approach based on scientific and administrative work related to local experience (e.g. projects NATREG, WETMAN, ALPA, EGP SUPORT, ENJOYHERITAGE, LIFE TO GRASSLANDS …).

Protected areas management (Natura 2000 ecological network) in Slovenia is based on sectoral management approach. Which means that for each Natura 2000 site, key sectors are identified that manage nature and its assets in accordance with its sectoral legislation and in accordance with the more detailed and specific guidelines given in the Operational Program and nature conservation guidelines of the Institute of the Republic of Slovenia of nature conservation.

The system of integrating nature protection content into the forest management planning system is based on several legal regulations; the most important are the Nature Conservation Act - ZON (Official Gazette of the Republic of Slovenia, No. 96/04 with amendments) and the Forest Act (Official Gazette of the Republic of Slovenia, No. 30/93 with amendments). The Slovenian Forest Service prepares forest management plans for forest management and hunting management areas, forest management plans for forest management units, annual hunting plans and forest management plans. Nature conservation contents based on elaborated nature conservation guidelines are included in all levels of forest management planning.

Through the implementation of international projects and a partnership approach, in the past decade, we have developed and implemented a number of methodological approaches in the Pohorje area, with the aim of strengthening the management of nature conservation in forests. Joint development policies ensure the attainment of environmental protection objectives and promote sustainable development, which is particularly true of durable and sustainable forest management in the Pohorje region.

General data of excursion site (stop 2)

Location: 46°29'55.7"N 15°15'50.1"E
Altitude: 1440 m
Mean yearly T: 4.5 °C
Precipitation: 1550 mm
Forest sites: Norway spruce and acidophilus beech forest
(Luzulo-Piceetum; Luzulo-Fagetum; Cardamino savensi-Fagetum)

Natural succession of abandoned pastures and underplanting of beech

SAMO SUŠEK (Slovenia forest Service, Regional unit Maribor)
ALOJZIJ KLANČNIK (retired local forester, Slovenia forest Service)

After abandoning of grazing and fire management, the pastures are overgrown with spruce, rowan and pioneer species. Beech returns only later, because it is limited by the lack of seed trees. While spruce forests are likely potential natural vegetation on the top of Pohorje, beech joins on only slightly lower altitudes. Rarely preserved natural forests indicate that the beech was once strongly represented practically up to the top of the Pohorje. Unlike in the Julian and Savinja Alps, the silver fir starts to appear in much lower altitudes, between 1000-1200 m.

A natural succession takes place in this part of the forest, and the forest has been protected as a forest reserve since the 1980s. Foresters were aware of the manmade spruce dominance and its negative consequences, therefore they underplanted deciduous trees, often as wildlings, even before setting up the reserve.

When Klančnik Alojzij started working as a local forester about 4 decades ago, he was notified by older forest workers about an interesting beech plantation at higher altitude. Today we can estimate that it is over 60 years old. About 25 years ago, a part of the plantation was enclosed by a 2 m

high fence in order to monitor the impact of game (red deer, chamois) on the development of beech regeneration. The result was visible already after a few years when enclosed seedlings began to increase their height growth. Today, the difference between the fence and remaining regeneration area, where the beech has an interesting – "bonsai" like shape is clearly visible.

Wildlife and hunting in Slovenia and region

IZIDOR COJZER (Slovenia Forest Service, Regional unit Maribor)

As game species are considered all free ranging animal species, which are by the law allowed to hunt. Those are the following species:

- roe deer *(Capreolus capreolus L.),*
- red deer *(Cervus elaphus L.),*
- wild boar *(Sus scrofa L.),*
- chamois *(Rupicapra rupicapra L.),*
- fallow deer *(Dama dama L.),*
- mouflon *(Ovis ammon (aries) musimon Schraber.),*
- alpine ibex *(Capra hircus ibex L.),*
- brown hare *(Lepus europaeus Pallas),*
- alpine marmot *(Marmota marmota L.),*
- edible dormous *(Glis glis L.),*
- coypu *(Myocastor coypus Molina),*
- muskrat *(Ondatra zibethica L.),*
- red fox *(Vulpes vulpes L.),*
- racoon dog *(Nyctereutes procyonoides Gray.),*
- pine marten *(Martes martes L.),*
- stone marten *(Martes foina Erxleben.),*
- European badger *(Meles meles L.),*
- grey partridge *(Perdix perdix L.)*
- pheasant *(Phasianus colhicus L.),*
- mallard *(Anas platyrhynchos L.),*
- eurasian jay *(Garrulus glandarius L.),*
- common magpie *(Pica pica L.),*
- hooded crow *(Corvus corone cornix L.).*

The management of large carnivores is under the Ministry of the environment and spatial planning.

The most abundant big game species are roe deer and wild boar, which inhabit almost the whole country of Slovenia, while red deer and chamois are present in smaller area. Aline ibex inhabits small areas in Karavanke and Julian Alps. Fallow deer and mouflon are non-native species and were introduces in some small spatially limited colonies.

The objective of the sustainable management of large herbivores (red deer, roe deer, chamois, mouflon and fallow deer) and wild boar is to sustain vital game populations with stable sex and age structure, which are in balance with populations of other species and their environment.

Small game populations have declined in the past decade, however, now the situation started to improve due to several reasons. This was partially due to the stricter legislation and regulations on usage of chemical protection agents.

Considering game management, Slovenia is divided into 408 "unprofessional" hunting grounds (average size of app. 4,500 ha; min: 2,000 ha; max: 10,000 ha) managed by "hunting families" (hunter clubs, LD) and 12 special purpose hunting grounds (LPN) have been established in Slovenia. According to the Wildlife and Hunting Act, 10 of the special hunting grounds (LPN) are managed by the Slovenia Forest Service, one by Triglav National Park and one by State Protocol (Brdo pri Kranju). Both, hunter clubs (LDs) and special hunting grounds (LPNs) are grouped into 15 hunting management districts (LUO).

Currently, there are 416 hunting families (LDs) operating in the territory of the Republic of Slovenia, which are united in 18 regional associations of hunting families, regional associations are further united in Hunting Federation of Slovenia.

The Hunting Association of Slovenia with about 22.000 hunters is conducting the sustainable management of game and nature protection, education hunters and informing society about game conservation. Slovenian Forest Service prepares annual and 10-year management plans for game species and protected large carnivores.

Game management in Slovenia is based on sustainable use of game as a renewable natural resource. Management planning in populations of game species in Slovenia is based on various expert platforms, which rely on various parameters, such as: previous harvest of individual game species; trends of damage on agricultural crops, cattle, forests, transport infrastructure and other; trends of (bio)indicators in populations and their environment; evaluation of conditions in hunting units, carried out by hunting unit managers; empirical experience and knowledge of animal population managers and planners.

General data of excursion site (stop 3)

Location: 46°30'43.0"N 15°14'50.2"E
Altitude: 1200 m
Mean yearly T: 5.5 °C
Precipitation: 1400 mm
Forest sites: acidophilus beech and mixed mountain forest
(Luzulo-Fagetum; Cardamino savensi-Fagetum)

Freestyle silviculture in medium-sized forest property

SAMO SUŠEK (Slovenia forest Service, Regional unit Maribor)
ALOJZIJ KLANČNIK (retired local forester, Slovenia forest Service)

During our trip we descended for about 200 m in altitude. This forest is located in an area of mixed mountain forests, where spruce and beech trees are gradually mixed with individual silver fir trees. To the left and to the right of the road are private forests of large and medium estates. However, the management and forests are fairly similar, due to the same local forester.

74% of forests in Slovenia are private property, 26% of forests are public (owned by the state or communes). Private forest estates are small, with an average area of only 3 ha and even these are further fragmented into several separate plots. In Alpine part of Slovenia properties are larger and this enables a more effective forest management.

The forest is privately owned by Edward Pivc, who owns about 20 ha of forest. This is a typical medium-sized estate. The owner is not heavily dependent on forest income. The off-farm employment income, later pension and the income from the small-scale farming is high enough. It could be said that he is inclined towards having a rich and preserved forest. Most recent fellings were for the use on the farm as firewood and for building material. However, he carries out regular sanitary fellings. Also other private forests

in Slovenia significantly recovered after World War II., when the average growing stock was more than half lower than today. This was mainly due to additional sources of income and also organisation of public forest service.

This is a partly uneven-aged and partly even-aged stand of spruce and beech with a growing stock of about 400 m^3 / ha, and the proportion of spruce and beech in mixture is somehow balanced. The estate has both diverse, attractively regenerated slightly older stands, as well as middle-aged stands, which are the result of heavier logging after the WWII., and are fairly even-aged. Thoughtful, conservative farmers often safeguarded parts of forests as a reserve for difficult times. However, in times of climate change, the decision of accumulating growing stock has to be linked also to careful risk assessment.

General data of excursion site (stop 4)

Location: 46°32'35.5"N 15°19'37.5"E
Altitude: 480-600 m
Mean yearly T: 8.7 °C
Precipitation: 1200 mm
Forest sites: silver fir forest with spruce and broadleaves *(Galio-Abietetum)*

Control method in Slovenia: Characteristics, use and applicability for research purposes

Assist. Prof. MATIJA KLOPČIČ (University of Ljubljana)
ALEŠ POLJANEC (Slovenia Forest Service, Central Unit)

Control method (CM) is an important approach for managing complex systems, including forest ecosystem. It is a circular process consisting of several consecutive components: setting forest management (FM) objectives – define and perform FM measures – control or monitoring (including forest inventory and FM measures records) – analysis of FM objectives realization (were they achieved or not and why) – setting (corrected or new) FM objectives. The essence of CM is to monitor changes in forests in order to recognize 1) if FM was successful in realizing targeted FM objectives (e.g. sustainable use of forest resources, provision of ecosystem services) and 2) to adapt FM to new conditions (e.g. adapting FM objectives, guidelines, and measures considering past experiences, new forest characteristics, predicted future environmental (e.g. climate change) and socio-economic changes). Thus, an important feature of CM is the ability to frequently adapt FM objectives and practice, and also to adapt forest inventory to monitor indicators relevant for controlling forest parameters of interest. CM was primarily developed in France (Gurnaud, 1878) and Switzerland (Biolley, 1923), while Hufnagl (1890) and Schollmayer (1906) developed their own CM for mixed mountain forests in Slovenia almost at the same time.

Forest inventory (monitoring) is essential in CM. Within the first CMs they were performed as a full (or later partial) enumeration of trees (namely full callipering). In the 1960s the control sampling method (CSM) was presented by Schmid-Haas (1963) in Switzerland. It embraced all crucial elements of the

original CM, just forest inventory was based on permanent circular sampling plots with detailed spatially-determined registration of individual trees. This enabled foresters to monitor dynamics of individual trees as well as dynamics of forest stands on the plot (stand) level. This new forest inventory approach was time and cost efficient compared to the original methods. In Slovenia the CSM was introduced in the 1970s (Grilc, 1972) in the Forest Management Region Bled (in the Alps), while in the 1990s it was introduced across all forests in Slovenia.

In Slovenia, the control (monitoring) consist of two parts: 1) forest stand dynamics is monitored using two forest inventory methods, namely i) permanent sampling plots and ii) forest stand maps, and 2) FM practice is monitored via records of realized FM measures, namely i) records of harvests and ii) records of tending and forest protection measures. These two data sources enable foresters to recognize changes in forest stand structure and composition, to relate these changes with the realized FM measures, to evaluate if FM objectives were achieved or not (or to what degree), and to reconsider FM objectives and measures to be taken in the next planning period.

Permanent sampling plots (PSP) are important forest inventory method used for evaluating forest stand dynamics (changes) on forest type and forest management unit (FMU) spatial levels since PSPs in each FMU (n=254) are re-measured every 10 years. PSP consists of two concentric circular plots of 0,02 and 0,05 ha. On the smaller plot trees 10-30 cm in dbh are registered, while on larger plot the same is done with trees 30 cm in dbh or larger. For each tree coordinates are taken, and tree species, dbh, social status, damage, for some trees also height and quality are measured or assessed. In total there are more than 102.000 PSPs in Slovenia, each year approximately 10 % of them are re-measured. In some regions, we already have data from 5 consecutive measurements on a single tree level, but in majority data from 2-3 consecutive measurements are available.

PSPs are not important just for FM planning, but also for research purposes. Recently many scientific papers were published, and post-graduate and graduate thesis were completed using this data source. There were studies on quality and value of tree species, namely European larch *(Larix decidua;* Kadunc and Poljanec, 2011) and European beech *(Fagus sylvatica;* Poljanec and Kadunc, 2012), on (diameter) growth of individual trees (Klopčič et al.,

2010) and stands (Poljanec et al., 2012; Klopčič et al., 2012), on changes in tree species composition in relation to natural species composition (Bončina et al., 2018), regeneration and recruitment (Klopčič and Bončina, 2012; Klopčič et al., 2012, 2015), large herbivores' influence on forest stand structure and dynamics (Klopčič et al., 2010), forest site productivity (Poljanec and Bončina, 2013; Bončina et al., 2014), and modelling (future) forest stand dynamics (changes) (Ficko et al., 2015, 2016; Mina et al., 2016; Klopčič et al., 2017). Some visually presented results are given on figures 10 and 12 below.

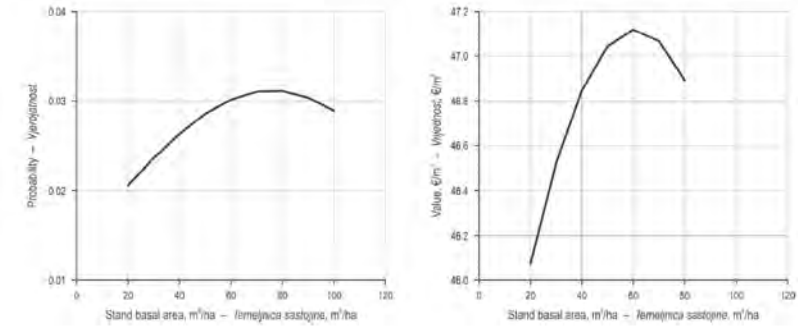


Figure 10: The probability of the highest-quality European beech timber assortments and timber value (€/m^3) in relation to stand basal area (Poljanec and Kadunc, 2012)

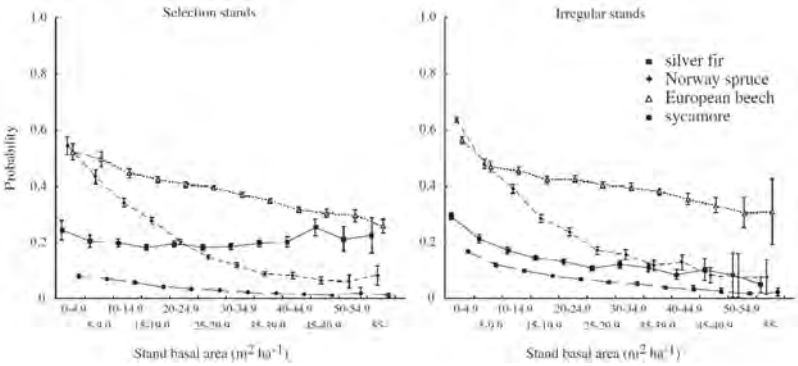


Figure 11: Predicted probabilities of a recruitment occurrence of the analyzed tree species in regard to stand basal area and stand structure in mixed mountain fir-beech-spruce forests (Klopčič and Bončina, 2012)

Selection management in regional unit Maribor and control method in Lehen

LJUBO CENČIČ (Slovenia Forest Service, regional unit Maribor)

Edvard Pogačnik introduced selection management and the control method in the Pohorje Massif. A successful bank clerk, Edvard Pogačnik (1877, Cerknica, Slovenia – 1962, Slovenia) bought an estate in Lehen, Pohorje in 1906, which he then expanded to 195 hectares by 1918. As a layman, he browsed scholarly books in vain trying to learn how to manage conifer forests which were not suited for clear cutting. By observing forests, he realized that the only way he would be successful was to maximize the number of healthy, well-growing trees in a given area.

He expanded the Pohorje tradition of farmer selection with his own insights, which he gained with years of experience. On his estate he introduced selection management and a control method that he developed independently. An analysis of the development of the Pogačnik forests from 1909 to 1938 showed that he successfully turned exploited forests into stands with a selection structure. Pogačnik's selection forest, boasting high yields, abundant natural regeneration and a documented tradition, would eventually become the subject of scholarly research (the forests were designated for research in 1948, and the Forest Management Unit Lehen was established in 1950 to manage them) and a role model for post-war forest management.

The management technique was based on: observation of the nature and processes in the forest, consistent recording of standing and cut wood biomass, planned management based on acquired data. The selective forest management of Pogačnik has significantly upgraded farmer selection management. Still, the origin of his management is in farmer selection forests and it had limited influence due to smallness of his forests.

The influence of the forest management on silver fir forests has been investigated on the basis of the documented development of the »Pogačnik« forests in Lehen since 1909. The research was based on the data from the documentation, which Mr. Pogačnik delivered to the Slovenian Forest

Institute after the Second World War. The analysis of the development of these forests from 1909 to1938 has shown that the conversion of understocked forests into selective stands has been successfully carried out. He succeeded in transforming young stands into structured selection stands with a short harvesting return interval of 4 - 5 years.

In the silver fir forests of Dravsko Pohorje (site unit Galio rotundifolii-Abietetum), due to the ecology of the sites the freestyle silvicultural system, combining selection and irregular shelterwood system are appropriate. This enables application of selection principle over the whole area and use of irregular shelterwood in areas where gap approach is more appropriate due to oak and noble broadleaves regeneration or low vitality silver fir. On the other hand, patches of even-aged stands, which are a consequence of the silver fir decline in 1980s, have to be gradually transformed into uneven-aged stands. The goal for species mixture in selection forests is: silver fir 50 %, spruce 40 %, beech 5 %, other broadleaves species 5 %. With irregular shelterwood a lower share of silver fir and a higher share of spruce is expected. The target diameter for spruce and silver fir in selection forests is 70 cm and the optimum growing stock between 400 and 540 m^3/ha.

Forest health in Slovenia

TINE HAUPTMAN and ROMAN PAVLIN (University of Ljubljana)

Organization of the forest protection in Slovenia

Forest protection tasks are performed as a part of the public forestry service by two main organizations: The Slovenian Forestry Institute (SFI), which is also the central institution for research and development in forestry, and Slovenia Forest Service (SFS), the main institution responsible for the realization of tasks related to forest protection in Slovenia. Department for forestry and renewable forest resources (UL, BF) is responsible for education and research work. All three institutions are included in plant protection system, supervised by Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection, and carry out official monitoring of quarantine forest species. Success in maintaining a healthy forest also depends largely on the responsible and active forest owners.

The main forest health related problems

Altered forest composition, as a result of past management practices, and the climate change with extreme weather events (drought, wind throw, ice storm) are usually trigger factors for the outbreak of secondary saproxylic species, especially bark beetles. There are approximately 15% of forests with strongly increased share of spruce, and the actual conifer share in wood stock is 45% (year 2016) instead of potential (appropriate for the site conditions) 20%. Ice storm in February 2014 has catastrophic impact on most of the forest in Slovenia, resulted in sanitary felling of 5.86 Mio m^3. Additional two wind throws (December 2017 and October 2018) resulted in another 2.92 Mio m^3 (without sanitary felling in 2019). After all this events, in the affected areas, populations of bark beetles increased strongly. Another forest protection issue presents the non-native fungus Hymenoscyphus fraxineus, which causes the ash dieback.

Spruce bark beetles
(Ips typographus and Pityogenes chalcographus)

After the drought and high temperatures in the summer of 2003, the first large bark beetles outbreak in the 21st century followed. One year after the catastrophic ice storm, which affected a large part of Slovenia in February 2014, the bark beetles outbreak exceeded all previously recorded sanitary felling data and reached the peak in 2016. It is obvious that the sanitary cut after the ice storm was performed too slowly (see Table 2 and Figure 12).

Table 2: Sanitary felling of trees due to damage from ice storm, bark beetles and windbreaks in Slovenian forests, 2014 – 2018, in mio m^3 (source: SFS data).

Year	Ice storm 2014	Bark beetles 2014-2018	Windthrows 2017,2018	TOTAL
2014	2.97	0.41	-	3.38
2015	1.56	1.82	-	3.38
2016	1.01	2.32	-	3.33
2017	0.22	1.84	-	2.06
2018	0.10	0.74	2.92	3.76
TOTAL	**5.86**	**7.13**	**2.92**	**15.91**
2017	0.22	1.84	-	2.06
2018	0.10	0.74	2.92	3.76
TOTAL	**5.86**	**7.13**	**2.92**	**15.91**

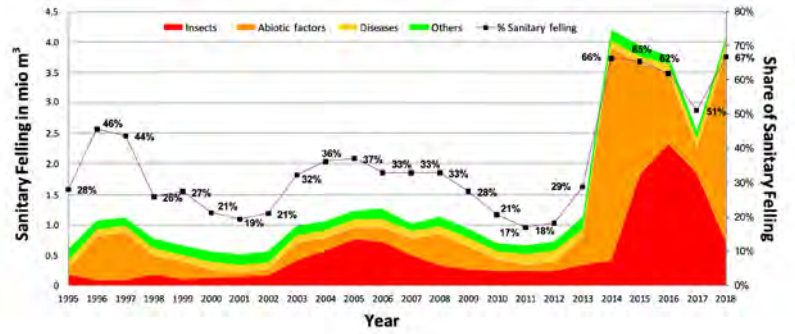


Figure 12: Sanitary felling by causes and in shares of total felling by year, 1995-2018 (Source: SFS).

Foresters often don't understand the importance of the integral method of controlling bark beetles, which consists of three groups of measures: prevention, preventive suppression *(prophylaxis)* and curative measures (suppression). Excessive reliance just on suppression measures (curative) can lead to catastrophic bark beetle infestation. In addition, there are opinions, that bark beetles outbreaks justify the use of hazardous and high-risk insecticides. The statement of the Department for Forestry is clear: the use of insecticides contradicts to the modern view of the forest protection, based on ecosystem approach and close to nature management. We also strongly oppose the use of poisoned nets (Storanet®) and insect traps that operate on the principle "attract and kill", like Trinet®. Such products are not suitable for the use in forestry, as they are completely non-selective and have negative impact on predatory and parasitic bark beetle antagonists, too.

Ash dieback *(Hymenoscyphus fraxineus)*

In the past, our forests have been affected by two fungal epidemics, the Dutch elm disease and the chestnut blight. Currently, the biggest problem is caused by the non-native fungus *Hymenoscyphus fraxineus,* which threatens mainly the populations of common ash *(Fraxinus excelsior)* and narrow-leaved ash *(Fraxinus angustifolia).* In Slovenia, the symptoms of ash dieback were first observed in 2006 in north-eastern part of Slovenia. Over the next 2 years, the disease expanded throughout the country. Severity of the disease appears to be higher in sites with higher relative air humidity and relatively lower temperatures. Other harmful organisms (for example, *Armillaria* spp. and *Scolytinae*) speed up the process of ash decline. Resistance of individual ash trees is crucial for the existence of ash in our forests, therefore management in ash stands is focused on retention and propagation of resistant or tolerant ash trees.

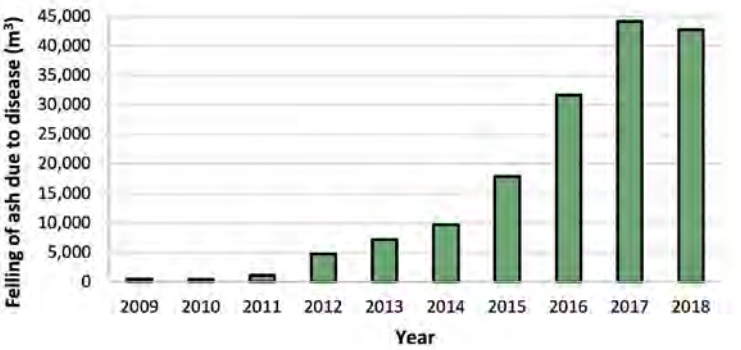


Figure 13: Felling of ash *(F. excelsior and F. angustifolia)* in last decade is mainly due to ash dieback disease, caused by *Hymenoscyphus fraxineus* (source: SFS data).

7. Excursion to Celje Urban Forest, 14th September 2019

General data of excursion site

Location: 46°13'47.9"N; 15°15'12.4"E
Altitude: 240-440 m
Mean yearly T: 9.8 °C
Precipitation: 1113 mm
Forest sites: moderately acidophilus beech forest *(Castaneo-Fagetum)*

Forest as a Brand: The story of the Urban Forest of Celje

ROBERT HOSTNIK, MSc and Boštjan Hren (Slovenia Forest Service)

The urban forest of Celje has undergone a unique transformation in the last twenty-five years. At the end of the 1980s, when Celje was known mainly for its industrial pollution problem, it seemed that this forest was forgotten by everyone: from the numerous fragmented private owners of these forests, the state, the local community and also the Celje city people. In the mid-1990s, a group of Celje foresters made a proposal to develop the social functions of these forests and involved the local community - the City Municipality of Celje.

Celje City Forest Project

The project started in 1996 at the initiative of the Celje local unit of the Slovenia Forest Service, with the aim of protecting and managing these forests with the help of the local community in a way that ensures the sustainability of their ecosystem services.

The urban forest of Celje has, over the past two decades, become an example of good practice that was followed by some other Slovenian cities. Main activites inside Celje City Forest Project included development of sustainable forest management, based on freestyle silviculture, protection of urban forests by law, harmonization of public and private interests and the development of recreational and educational infrastructure. The long-term oriented purchase of privately-owned parts of the forest by the Municipality of Celje, for the development of their social functions is unique in Slovenia.

Today, the City Forest on the southern outskirts of Celje, with its 114 hectares of publicly owned forest area and 15 kilometers of equipped walking and multifunctional trails, is the largest landscaped public green space in the city. The number of visitors to the City Forest is growing steadily from year to year, and the interest of kindergardens, primary and secondary schools in education about nature is increasing. At the Tree House, as the new center of the City Forest, in addition to educational activities, various cultural activities regularly take place, such as concerts, recitals, exhibitions, lectures and seminars.

In the last two decades, the urban forest has become a recognizable feature, brand and even a landmark of the city of Celje.

Future development

In addition to continuing sustainable forest management, collaborating with forest stakeholders and users, maintaining forest infrastructure and equipment, continuing to develop new contents and strengthening the brand, educational program development and training for school youth and development of payments for ecosystem services will be important challenges in the future.

The Slovenian Forest Service is preparing an initiative to establish a Slovenian Center for Urban Forests and one of the centers for forest pedagogy, which would be aimed at educating schoolteachers and new forest pedagogues.

Citizen scientists can improve the early detection of invasive alien species in forests

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The detection of invasive alien species (IAS) in forests at the early stage after introduction is a challenge. In many countries, professionals are already surveying for the presence of regulated invasive fungi and insects in the frame of plant protection (Directive 2000/29/EC); however, for species falling under the IAS EU regulation 1143/2014 such network does not yet exist in several countries. Even when experts are employed, they cannot cover the whole country area. Therefore, "more eyes" are needed in the field, and citizen scientists can help look for invasive alien species. In the project LIFE ARTEMIS, we setup a system which supports citizen scientists to find IAS as a part of an early warning and rapid response system in forests. First, we prepared an alert list and an observation list of IAS. Then we developed an information system including an Android application, "Invazivke". In 14 meetings and workshops with volunteers throughout the whole country we showed the information system "Invazivke" and the species of interest for recognition together with additional information. Up to now, 143 observers are actively reporting IAS in the information system Invazivke. A total of 65.698 observations were submitted and checked via the website or the mobile app (last access 13th August 2019). The mobile phone app was mostly used and 93.9% of the data was correct. Here, we present the first results of this project and discuss them in the context of the early warning of IAS and citizen science, showing how this data can be used in further research and actions.

Cutleaf Coneflower -
Rudbeckia laciniata
(photo: Maarten de Groot)

Himalayan Balsam -
Impatiens glandulifera
(photo: Maarten de Groot)

Oak lace bug -
Corythucha arcuata
(photo: Simon Zidar)

Ash dieback -
Hymenoscyphus fraxineus
(photo: Maarten de Groot)

Figure 14: Some of the most problematic invasive alien species in forests in Slovenia

8. Excursion map


Vizinga
Radlje ob Dravi
Vas
Spodnja Vižinga
Vuhred
Drava
Vuhreščica
Kozji Vrh
Remšniški potok
Brezniški potok
Potočnikov potok
Javnik
Maribor
Ožbalt
Rdeči Breg
Jurčičev vrh
Antonski graben
Spodnja Orlica
Zgornji Janževski Vrh
Sgerm farm & forest
Velka
Lovrenc Pohorj
Sveti Anton na Pohorju
Pahernik forest
Ribnica na Pohorju
Hudi Kot
Črni potok
Ribniški potok
Josipdolski potok
Globaški graben
Josipdol
Lehen na Pohorju
Recenjak
Kumen
Jezerski vrh
Glazuta
Lovrenška jezera
Dovžanka
Radoljna
Mislinja excursion
Mislinja

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10. Notes

11. QR code

PROSILVA ONLINE SURVEY

During the Prosilva conference after the main talks a discussion will be organized on the following topic: Prosilva development constraints and research priorities for problem solutions. An online survey – Prosilva For Future Forest - was set up, to get information from Prosilva members about important topics to be discussed during the meeting.
The survey is available online through URL address
https://forms.gle/krLSkCWt4UmUHo9X6 or by using following QR code:

Please fill in the questionnaire (it will take you 5 minutes to do it) and follow the instructions online.

Pahernikova ustanova

ObčinaRadljeobDravi

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Slovenski Državni Gozdovi

Zavod Republike Slovenije za varstvo narave

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Koroški Pokrajinski Muzej

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