



BOOK OF ABSTRACTS

*International Scientific Conference
Krkonoše Mountains – Nature and People
Špindlerův Mlýn, 11–13 September 2019*



SPRÁVA KRKONOŠSKÉHO NÁRODNÍHO PARKU

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International Scientific Conference
Krkonoše Mountains – Nature and People

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The aim of the conference

The aim of the conference, organised regularly every three years, is to present the latest results of research related to the Krkonoše Mts. and the neighbouring ridges of the Sudetes Mts. The conference is also a unique form of information exchange between scientists from Poland and the Czech Republic doing their research in the Krkonoše Mts. and for transboundary cooperation between the two national parks.

The results presented at the conference should not only enrich the existing scientific knowledge of one of Europe's most naturally valuable mountain ranges and thus contribute to its conservation, but should also be the basis for updating

a number of environmental educational documents and teaching programmes. In addition to presenting the results in a traditional scientific and professional format, the results will also be interpreted in a popular-scientific form which will find practical usage amongst the wider lay public.

The conference is regularly attended by scientists from a wide range of scientific institutions, university-based academics, lecturers and other teaching staff, representatives of state administration, educational centres, important regional and national stakeholders and other representatives of the professional public.

Conference Topics

- Presentation of the latest scientific knowledge relating to research, scientific understanding, networking, management and nature conservation of the Krkonoše Mts.
- Examples of effective management tools implemented in mountain protected areas – possibilities and limits.
- Activities and expectations of people living on the territory of the Krkonoše Mts.
- Current environmental conflicts and possible solutions in the Krkonoše/Karkonosze National Parks.
- Practical utilisation of scientific results, research and monitoring activities for environmental education centres and educational programmes.

Sessions

Introductory plenary session

Pinus mugo (Mountain Pine) and its role across the European mountains

Three general contributions summarizing our knowledge about various aspects of *Pinus mugo*

Plenary session I

Research, management and protection of Mountain Pine shrubs in the High Sudetes

Plenary session II

Geodiversity of the Krkonoše Mts. and the High Sudetes (geology, geomorphology, pedology, paleoecology)

Plenary session III

Snow, water, avalanches and abiotic factors in the Krkonoše and the High Sudetes Tundra

Plenary session IV

Forests and forest management in the High Sudetes

Plenary session V

Fauna of the High Sudetes

Plenary session VI

Flora of the High Sudetes

Plenary session VII

Socio-economics, history and other social sciences, including nature conservation of the Krkonoše Mts. and practical utilisation of scientific results, research and monitoring activities for environmental education centres and educational programmes.

Poster Sessions

Case studies and preliminary studies on all aspects of conference topics. Participation of at least one of the authors during the poster presentation is required.

Conference Organizers

Krkonoše National Park Administration and Karkonosze National Park Administration under the auspices of the Ministry of the Environment of the Czech Republic.

CONFERENCE STEERING COMMITTEE

PhDr. Robin Böhnisch	Krkonoše National Park Administration, Czech Republic
prof. Jakub Hruška	Czech Geological Survey, Czech Republic
prof. František Krahulec	Institute of Botany of the Czech Academy of Sciences, Czech Republic
prof. Piotr Migón	University of Wrocław, Poland
Dr. Andrzej Raj	Karkonosze National Park Administration, Poland
RNDr. Jan Štursa	Krkonoše National Park Administration, Czech Republic
prof. Bronisław Wojtuń	University of Wrocław, Poland

CONFERENCE ORGANIZING COMMITTEE

Mgr. Martin Erlebach	Krkonoše National Park Administration, Czech Republic
Mgr. Radek Drahný	Krkonoše National Park Administration, Czech Republic
Ing. Václav Jansa	Krkonoše National Park Administration, Czech Republic
Mgr. Jakub Kašpar	Krkonoše National Park Administration, Czech Republic
Mgr. Luděk Khol	Krkonoše National Park Administration, Czech Republic
Ing. Josef Taláb	Krkonoše National Park Administration, Czech Republic

Conference Programme

Tuesday 10th September 2019

17.00

Accommodation

Harmony Club Hotel, www.harmonyclub.cz

This night is not included in the conference fee. You will pay individually in the hotel reception. If you want to book accommodation for this night, please contact us.

Wednesday 11th September 2019

7.30–12.00

Registration/Accommodation

9.00–10.00

Little snack for incoming participants (coffee break)

10.00–10.30

Conference opening (welcome and opening speeches)

Moderator: Ladislav Miko (European Commission, Brussels)

11.00–12.30

INTRODUCTORY PLENARY SESSION

to the theme:

***Pinus mugo* (Mountain Pine) and its role across the European mountains**

(three requested key speeches)

Chair: *Ladislav Miko*

11.00–11.30	<i>Jan Štursa:</i> Growth strategy of <i>Pinus mugo</i>
11.30–12.00	<i>Jozef Šibík:</i> Plant communities dominated by <i>Pinus mugo</i> s. l. from a European perspective
12.00–12.30	<i>Wojciech Pusz:</i> The overview of health problems of <i>Pinus mugo</i> in the High Sudetes
13.00–14.00	Lunch

1st PLENARY SESSION

14.15–15.00	Research, management and protection of Mountain Pine shrubs in the High Sudetes Chair: <i>Jan Štursa</i>
14.15–14.30	<i>Josef Harčarik, Lubomír Jiříšně:</i> Planting management of <i>Pinus mugo</i> in the Krkonoše Mts.
14.30–14.45	<i>Miroslav Zeidler:</i> Giant trouble with dwarf pine at eastern High Sudetes

2nd PLENARY SESSION

15.00–15.30	Geodiversity of the Krkonoše Mts. and the High Sudetes (geology, geomorphology, pedology, paleoecology) Chair: <i>Piotr Migoń</i>
15.00–15.15	<i>Marek Kasprzak, Andrzej Traczyk, Krzysztof Migala, Krzysztof Krakowski, Petr Tábořík:</i> Low temperatures of ground in the Karkonosze / Krkonoše Mts.
15.15–15.30	<i>Marek Křížek, David Krause, Tomáš Uxa, Zbyněk Engel:</i> Distribution and ¹⁰ Be exposure age of patterned ground/sorted polygons above the alpine timberline in the Krkonoše Mts.
15.30–16.00	Coffe break

3rd PLENARY SESSION

16.00–16.30	Snow, water, avalanches and abiotic factors in the Krkonoše and the High Sudetes Tundra Chair: <i>Martin Erlebach</i>
16.00–16.15	<i>Michal Janouch:</i> Monitoring of ultraviolet radiation in the Krkonoše Mountains (2004–2019)
16.15–16.30	<i>Jakub Hruška, Vladimír Majer:</i> Recovery of surface waters from acidification between 1980's and 2018
17.00–18.00	Poster session
19.00	Dinner and evening free program

Thursday 12th September 2019

7.00–8.30 | Breakfast

4th PLENARY SESSION

8.30–9.45	Forests and forest management in the High Sudetes Chair: <i>Andrzej Raj</i>
8.30–8.45	<i>Jindřich Chlapek:</i> Management of mountain spruce forest and subalpine habitats in Jeseníky Mts. – under pressure of local interests and scientific findings
8.45–9.00	<i>Radek Plch, Vilém Pechanec, Emil Cienciala, Václav Jansa, Karel Pulkrab, Pavel Cudlín:</i> The prediction of forest development in the Krkonoše Mountains National Park
9.00–9.15	<i>Małgorzata Danek:</i> Growth of European larch (<i>Larix decidua</i> Mill.) in northern part of Karkonosze and its relation to climate and climate change – comparative study

9.15–9.30	<i>Michal Prouza:</i> Current health status of ash stands and spatial distribution of resistant ash with focus on Ash dieback (<i>Hymenoscyphus fraxineus</i>) in KRNAP
9.30–9.45	<i>Jiří Rozsypálek:</i> The principles of the effectivity of tree microinjection as a method of individual tree protection against the important fungal pathogen of ashes
9.45–10.00	<i>Jan Komárek, Tomáš Klouček, Peter Surový, Karel Hrach, Přemysl Janata, Bedřich Vašíček:</i> Close-range Remote Sensing towards precise detection of bark beetles infestation: The potential of Unmanned Aerial Systems for early intervention
10.00–10.45	Coffee break

5th PLENARY SESSION

10.45	Fauna of the High Sudetes Chair: <i>To be completed</i>
10.45–11.00	<i>Jiří Flousek:</i> How are the birds in the Giant Mts?
11.00–11.15	<i>Miroslav Martiš:</i> Ground beetles (Col., Carabidae) of the ridges and glacier valleys of the Krkonoše Mts.
11.15–11.30	<i>Konrad Wiśniewski, Oleg Aleksandrowicz:</i> Ground beetles (Coleoptera: Carabidae) of mires in the Karkonosze and Izera Mountains
12.30–13.30	Lunch

6th PLENARY SESSION

13.45–15.00	Flora of the High Sudetes Chair: <i>Michael Hošek</i>
13.45–14.00	<i>Marek Malicki, Lidia Przewoźnik, Bronisław Wojtuń, Ludwik Żołnierz:</i> Population status of selected rare and endangered alpine

- plant species of the Krkonoše/Karkonosze Mts.: preliminary results of the field monitoring of some vascular plants
- 14.00–14.15 *František Krahulec:*
Residual sexuality of facultatively apomictic plants: the case of *Pilosella* (*Hieracium* subgen. *Pilosella*)
- 14.15–14.30 *Adam Rajszy, Bronisław Wojtuń:*
Nitrogen assimilation abilities of vascular plants from different high-mountain habitats of the Karkonosze mountains
- 14.30–14.45 *Lucie Kupková, Markéta Roubalová, Lucie Červená, Markéta Potůčková, Jakub Lysák, Stanislav Březina:*
Potential of remote sensing data and methods for monitoring of tundra vegetation
- 15.00–16:00 Poster session and coffee break

7th PLENARY SESSION

- 16.00–17.00 **Socio-economics, history and other social sciences, including nature conservation of the Krkonoše Mts. and practical utilisation of scientific results, research and monitoring activities for environmental education centres and educational programmes.**
Chair: *Jacek Potocki*
- 16.00–16.30 *Jiří Kulich:*
Building environmental responsibility – science or art?
General Challenges and Examples from the Krkonoše Mts.
- 16.30–16.45 *Jakub Kašpar:*
Fifty nine people a day on every square kilometer – what will come next?
- 16.45–17:00 *Michal Skalka:*
How educational paths in Krkonoše Mts. National Park (don't) work
- 17:00–17:15 *Tomáš Janata:*
Implementation of adaptive management cycle in permanent forestless areas management in Krkonoše Mts. National Park

17.15–17:30	<i>Michael Hošek:</i> Why the Krkonoše Mts. NP has been supporting protected landscapes instead of national parks in Georgia?
17.45–18.30	Moderated Plenary Closing session, Conference feedback and conclusion
20.00	Gala conference evening (Entertainment with music and dancing)

Friday 13th September 2019

7.30–8.30 | Breakfast

FULL-DAY GUIDED EXCURSION

(two options according participant´s registration)

8:30–17:30

Individual participant´s departure.

Excursions will start at 8:30 a.m. (front of Hotel Harmony)
Travel snack will be provided.

A Ridges of the Western Krkonoše Mts.

(Full day, physically demanding route, walking part of tour c. 13 km)

FOCUS:

- Arctic-alpine tundra phenomenon of the Western Krkonoše Mts. and its geobiodiversity (glacier cirques, subarctic peatbogs, frost sorted soils)
- New zonation of the Krkonoše NP
- Management of Mountain Pine scrub
- Forest management below the ecotone of upper forest limit
- Tourism hot spots – conflicts and their solutions

Trail: hotel Harmony (bus) – Špindlerova bouda – Petrova bouda – Dívčí a Mužské kameny – Vysoké kolo – Labská louka – Vrbatova bouda – Horní Mísečky (bus) – hotel Harmony)

B Forest and ridges of the Eastern Krkonoše Mts.

(Full day, less physically demanding route, walking part of tour c. 8 km)

FOCUS:

- Forest management at the 7th and 8th forest vegetation zones (natural dynamics, forest interventions, supporting of natural processes, non-intervention areas, areas after air pollution disaster and consequences)
- Hydrology of the mountain landscape
- Sporting and recreational infrastructure of the Svatý Petr Ski Area – conflicts and their solutions

Trail: hotel Harmony (bus) – Špindlerova bouda – Hollmanova cesta – U Bílého Labe – Dřevařská cesta – Svatý Petr – Špindlerův Mlýn)

The trails can be changed depending on weather.

Marek Banaš & Miroslav Zeidler

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Vegetation shift in herb and mosse layers after the clear-cut of non-indigenous dwarf pine

Keywords: *Pinus mugo*, Hrubý Jeseník Mts., artificial plantation, impact on microrelief, soil and vegetation

Human impact and climatic change in recent decades caused the encroachment dwarf pine (*Pinus mugo*), into mountain grasslands in Hrubý Jeseník Mts. (eastern High Sudetes Mts.). Range expansion of the woody species posed a major threat to the biotic and abiotic components of the alpine ecosystem, soil and micro-climatic parameters, geomorphological structures, animals, plants and plant communities. Hence, small-scale preliminary removal of the species was performed and experimental plots were established to compare the dwarf pine plantation, the clear-cut area, and alpine grasslands. This study was set on Keprník Mt. (1 423 m a.s.l.) after a clearing of dwarf pine polycormons (ca 2 ha in total) in 2009. Ten fixed plots were established within each of the three distinct habitats (alpine grasslands, secondary planted dwarf pine, clear-cut site) that were monitored in two-years interval. The plant species composition of the herb layer was recorded by means of phytosociological relevés and some soil parameters evaluated. The three assessed habitats differ in thickness of litter layer: dwarf pine > clear cut > (sub) alpine grasslands. The chemical analyses (carbon, nitrogen, humus, moisture, pH) of soil horizons show some differences between the monitored habitats. Cover of the herb (E1) and the moss (E0) layers differ between dwarf pine, clear cut, and (sub) alpine grasslands even after 9 years. Species abundance of vascular plants is higher on plots with (sub) alpine grassland compared to dwarf pine and clear cut habitats, but it rises in time on managed plots. Abundance of mosses rises slowly on each of the three habitats but changes in time differ on each habitat. On the clear-cut area, invasive species are missing, but plant composition remained transitional and expansive graminoids prevailed. The species composition follows changes in environmental factors after the clear-cut. The recovery processes after dwarf pine clear-cut is slow and achieving (sub) alpine grassland as target community is obscure.



Adam Bednařík, Pavel Jurajda, Veronika Bartáková,
Zdenka Jurajdová, Libor Mikl, Anna Bryjová & Jiří Křesina

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Occurrence and genetic structure of brown trout populations (*Salmo trutta m. fario*) in the Krkonoše Mts.

Keywords: native brown trout population, genetic variability of brown trout, fishery management, natural reproduction

In 2018, the population and genetic structure of brown trout (*Salmo trutta m. fario*) were evaluated in water courses of the Krkonoše Mountains National Park (KRNAP). The streams in question have not been subject to fishery management (including recreational fishing and stocking) since 2006; nevertheless, brown trout populations were highly abundant. These populations show a natural age structure and natural reproduction is clearly sufficient for population recovery. The upper limit of brown trout occurrence occurred at the Elbe River, close to its confluence with White Elbe River. Upstream of this site, brown trout is replaced by non-native brook trout (*Salvenilus fontinalis*), which were historically stocked there and still reproduce successfully. Genetic analysis, carried out on fish samples from six water courses (including two control sites with fish stock management), revealed that at least three genetically unique brown trout populations occur in the KRNAP, located in the upper parts of Klínový creek, the Úpa River (in the Obří důl valley) and in the Jizerka creek. The three populations are genetically distinct from each other and isolated from genetically homogenous populations occurring in water courses under fishery management. Native brown trout populations are ecologically important as individual traits such as migratory, territorial and anti-predatory behaviour, body morphology and age and body size at maturity enhance survivability of local populations under different environment conditions. As such, future studies should focus on maintaining the genetic structure of the remaining brown trout populations in the Krkonoše Mts. and further analysing their genetic variability.



*Stanislav Březina, Záboj Hrázský, Jan A. Šturma,
Alžběta Čejková & Clive Hurford*

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Management monitoring of montane meadows in the Krkonoše Mts.

Keywords: meadow vegetation, frequency, cover, indicators, change

The results are based on the analysis of data from 85 transects and 17 phytocological relevés sampled in 2013–2017 period. Most transects have been used to sample more indicators, so the total number of indicator values is significantly higher than the total number of transects. Compared between two time levels (i) at the start of the project and (ii) at the end of the project changes in the frequency of typical species are statistically significantly different for the areas with implementation of the measures and for the areas without measures. The number of typical species significantly decreased in cases of sites with no measures. In case of measures implementation, there was no statistically significant difference between the start and end of the project in terms of typical species frequency or indicator values. In the 3–4 year timeframe, therefore, no statistically significant changes in vegetation were observed in the areas with the implementation of the measures. The goal of the project was the frequency of typical species “stabilize or increase” and the target was achieved in its minimal variant (stabilize). A longer period of time may still show whether the optimistic variation of the target could be achieved, i. e. whether the presence of typical species will increase.



Jindřich Chlapek

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C

Management of mountain spruce forests and subalpine habitats in Jeseníky Mts. – under pressure of local interests and scientific findings

Keywords: Jeseníky Mts., natural spruce forests, (sub-) alpine grasslands, ecosystem changes, management activities

Jeseniky Mts. represent the easternmost part of the High Sudetes Mountains. Natural mountain spruce forests and (sub-)alpine grasslands and shrubberies belong to the key habitats in the Jeseníky Mts. Protected Landscape Area. These ecosystems are covered by several national nature reserves, together with the 1st zones of national parks the highest level of nature protection according to the Czech law on nature conservation. Significant shifts in the structure of ecosystems and their species composition have been reported recently. The most probable causes of these changes lie in the cessation of traditional human agricultural activities and the global changes, periods of drought, longer summer season and nitrogen deposition in particular. The management response poses a big challenge for the staff of the Protected Landscape Area Administration. However, not only scientific findings play a role in decision making process, many stakeholders try to express and enforce their particular interests. Foresters both of the state and private forest as well as the local NGO's are the most visible actors. The presentation describes the overall situation in the Jeseníky Mts., current level of knowledge, ongoing projects and management activities and possible solutions of current situation of limited resources and capacities and hard pressures from different sides.



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Jaroslav Čepl, Valerie Poupon & Jan Stejskal

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Vulnerability of forest tree species in upcoming climatic change and possibility of assisted migration

Keywords: climate change, species composition, forest habitats, reproductive material of key species

Given the ongoing climate change, a number of future scenarios have been developed. In 2014, for the Intergovernmental Panel on Climate Change, the scientific community defined a series of four scenarios, which describe different climate futures, called Representative Concentration Pathways (RCPs). They are labelled according to the approximate total radiation exposure in 2100 compared to 1750: 2.6 Wm⁻² for RCP2.6, 4.5 Wm⁻² for RCP4.5, 6.0 Wm⁻² for RCP6.0, and 8.5 Wm⁻² for RCP8.5 scenario. Under these scenarios, models that predict future climate development across Europe have been developed. It is expected that the change in the climatic conditions of habitats will be associated with a change in species composition. Based on a comparison of the current distribution of forest tree species with their predicted future distribution, vulnerability maps for selected species were developed. For example, in the Krkonoše National Park, we can expect a decline of Norway spruce in lower altitude areas, a significant loss of fir, and at the same time we can expect an increase of beech in areas with higher altitude. As a rapid changes in habitat conditions are predicted, local populations of slow-growing forest trees are not expected to accumulate the necessary genetic adaptations. Thus, migration of better adapted variants of a given species is expected, mainly along the longitudinal and altitudinal gradients. However, this is also a slow process that can result in a temporary or total loss of a given species in a given habitat. A possible strategy to maintain key species is assisted migration of reproductive material from selected provenances where current conditions (and hence local adaptations) are most similar to future conditions of the sites of interest.

Małgorzata Danek

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D

Growth of European larch (*Larix decidua* Mill.) in northern part of Karkonosze and its relation to climate and climate change – comparative study.

Keywords: tree rings, *Larix decidua* Mill., climate-growth relationship, Karkonosze, Sudetes

Over the last several years the study on tree-ring growth of larch (*Larix decidua* Mill.) in Polish part of the Sudetes and Carpathians were conducted. The aim was to provide information on the influence of climatic factors, such as temperature and precipitation on larch growing in the mountain areas. The study revealed spatial diversity in the response of larch tree-ring growth to climatic factors, not only between the regions (Carpathian vs. Sudetes) but also at the subregional level. Within Sudetes, the main differentiating factor is altitude, however other site-related factors are also of some importance. The climatic factor of main importance, positively influencing the tree-ring growth, is temperature in May – the beginning of the tree-ring formation period. Also the negative influence of the water stress in summer of previous year on growth is distinct. Presented study is focused on the results obtained for larches growing in the Polish part of Karkonosze and showed in the context of neighbouring areas of the Polish Sudetes, and selected sites from the Polish Carpathians located at similar altitudes. Additionally, changes of larch growth – climate relationship over the last 100 years are presented and discussed in the context of the recent changes in climate. The study was supported by the National Science Centre, Poland (projectNo.2014/13/B/ST10/02529).



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Marek Depeš

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Recent dispersion trend of fir clubmoss (*Huperzia selago*) above the tree line on Luční and Studniční Mts. in the Giant mountains

Keywords: *Huperzia selago*, fir clubmoss, Giant mountains, habitats above the tree line

Poster deals with studies of recent dispersion trend of fir clubmoss (*Huperzia selago*) above the timber line on Luční Mt. and Studniční Mt. in the Giant Mountains. Part of it contains analysis of records of the species occurrence above the timber line along with providing of characteristics of northern hillside of Luční Mt. and Studniční Mt. Experimental part consists of observing changes in abundance and cover of fir clubmoss together with other taxa of vascular plants, mosses and lichens found in permanent experimental plots set up in 2015 on the northern slopes of Luční and Studniční Mt. Influence of alpine heathlands and grasslands vegetation on the ability of vegetative dispersion of *Huperzia selago* is observed. Vegetative reproduction of the species in form of observation of propagules (bulbils) germination in simulated laboratory conditions is also part of the experiment.

Jan Doležal, Tomáš Urfus, Anna Krahulcová & František Krahulec

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Residual sexuality in facultatively apomictic *Pilosella rubra* and its reflection in *Pilosella* populations

Keywords: *Pilosella rubra*, Residual sexuality, Hybridization, Hybrids of facultative apomicts

Pilosella rubra is a stabilized $2n+n$ hybridogeneous hexaploid species endemic to the eastern part of the Krkonoše Mts. It had originated from the hybridization of two tetraploid species: *P. aurantiaca* ($2n$ female gamete) and *P. officinarum* (n male gamete). The morphologically identical plants were also found in several other regions, but their reproduction did not correspond to a good stabilized apomict as in *P. rubra*. To determine the degree of its residual sexuality, two approaches were chosen. Firstly, we crossed the hexaploid *P. rubra* with the tetraploid *P. officinarum* as pollen donor. The progeny consisted of five different cytotypes: hexaploids of apomictic origin, triploids (polyhaploids), pentaploids ($n + n$ hybrids), octoploids ($2n + n$ hybrids) and heptaploids ($n + 2n$ hybrids). We found the residual sexuality in *P. rubra* of 11.1%, involving all progeny cytotypes except the mother-like hexaploids. Secondly, we collected seeds from *P. rubra* directly in the field, in the species/cytotype-mixed population. We detected the composition of the progeny grown from the seeds. In this case, we cultivated of one order higher amount of progeny than in the crossing experiment. Thus, more cytotypes were detected among the progeny, but the residual sexuality found in *P. rubra* was similar (9.1%). Because the ploidy of co-occurring pollen donors was unknown, the origin of several cytotypes in the progeny could not be unequivocally distinguished. On the locality where the seeds of *P. rubra* have been sampled, occurred the plants which corresponded to $n + n$ hybrids (*P. rubra* x *P. floribunda*, *P. rubra* x *P. officinarum*], both hybrids pentaploid. In addition, we found there also an octoploid plant ($2n + n$ hybrid), which morphologically corresponded to some of the progeny plants from the crossing experiment (*P. rubra* x *P. officinarum*). These octoploids also corresponded to the species of *P. rubripilosella*, which was described from the Krkonoše Mts at the end of 19th century.



Martin Erlebach, David Hanuš & Dušan Romportl

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Assessment of the Green Infrastructure functionality and its benefits in the Krkonoše Mts and its surroundings

Keywords: green infrastructure, landscape functionality, connectivity, ecosystem services, landscape fragmentation, MaGICLandscapes

Green infrastructure (GI) is a one of the fundamental environmental and landscape ecological concept which is often connected with strategical and policy documents at European level and national level as well. European Strategical Documents define GI as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services and benefits in both rural and urban settings. From landscape ecologists point of view GI is an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife. The most important attribute of GI is its functionality. Functionality can be understood as the interaction ability of green infrastructure. A functional GI enables a variety of ecological flows (fauna, flora, materials, energy, etc.) and provides many ecosystem services and benefits (for human and wildlife). There are a lot of approaches to assess GI and its functionality. Project MaGICLandscapes (Managing of Green Infrastructure in Central European Landscapes) tries to make unified processes of GI assessment in central European countries. One of the case study area of the project is KRNAP and its surroundings. In KRNAP we used GuidosToolbox software to analyse connectivity of GI elements. GuidosToolbox includes MSPA (Morphological Spatial Pattern Analysis), a customized sequence of mathematical morphological operators targeted at the description of the geometry and connectivity of the image (map of GI) components. For GI fragmentation analysis we used Effective Mesh Size Index. All these indices are based on geometric principles and can thus be applied at any scale and to any kind of raster (or vector) data. The results show that a more suitable approach for analyse GI functionality in landscapes characterized by very high proportion of GI (as KRNAP) is using of fragmentation indices. They can reflected other specific conditions influencing GI functionality (tourism intensity etc.).



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Functional micro regions of the Krkonosé Mts derived from the spatial patterns of the vector and scalar socioeconomic geographical information

Keywords: spatial pattern, human behaviour, scalar and vector data

The aim of this paper is to reveal spatial organization of geographic information based on two types of data of human behavior (locational and interactive) in the larger region of the Krkonosé Mountains. The identification of spatial organization of human behavior (especially movement), i.e. the revelation of human behavior in space, has become one of the central themes of interest to the Krkonosé National Park Administration and in other protected areas. In protected areas the main aim is to reveal spatial patterns of behavior of a growing number of visitors. However, there is a very significant problem with the availability of spatial data, especially in mountain areas. To analyze the spatial structure, the authors proceed from the geographical concept of functional (vector data) and formal (scalar data) regions as well as the core-periphery dichotomy. Formal areas (peripheral areas) are defined by principal components analysis and cluster analysis; travel to work areas (functional regions) are defined by a standard rule-based regionalization algorithm. The results show that there is some form of interrelationship and complementarity between the spatial distribution of scalar data and vector data, i.e. between spatial structure and spatial interaction patterns, which together form the spatial organization of the geographical environment. This approach based on geographical methods of revealing spatial patterns of information can be useful in many spatial economic tasks, regional planning, etc. as well.



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The process of revision of the Territorial System of Ecological Stability in KRNAP

Keywords: territorial system of ecological stability (TSES), revision of TSES, network unification, designed branches, anthropogenically conditioned local TSES

The territorial system of ecological stability (TSES) was acquired during 1993–2015 by a number of landscape designers with different methodological approaches. The digitization of available materials performed by the KRNAP Administration in 2015 showed a number of shortcomings and high differences within the definition of the local level of the TSES in the individual territorial plans of municipalities. Therefore, within the framework of the MaGICLandscapes project, which addresses the issue of green infrastructure, the KRNAP Administration has decided to carry out a revision of the TSES for the whole territory of the national park. Other impulses were the issuance of a new Methodology for the delimitation of TSES (MoE 2017) and the need to respond to changes in the landscape. The goal is to analyse the current state, update and possibly redefine the composition parts of individual hierarchical levels. We would like to pay attention to the issue of defining branches of an anthropogenically conditioned local TSES. During the study, field surveys will be carried out to check the current state of the landscape, to identify and verify the risks and to check the design delimitation of the boundary. The main objective is to unify the TSES plan for the entire territory of the national park and its subsequent gradual implementation into the regional principles of spatial development and land use plans. The boundaries of all component parts will be defined preferentially outside the existing conflicts of interest, with priority to land boundaries. An important part will be the elaboration of the text and tabular parts of the revision. Any change to the delimitation must be justified in order to be defensible in the commenting processes of the KRNAP Administration.



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Management of the Dwarf Pine in the Giant Mountains

Keywords: The Giant Mts., dwarf pine plantations, management

Dwarf Pine (*Pinus mugo*) stands in the Giant Mountains (Krkonoše) cover 2 180 hectares, which represents approximately 4 % of the territory of Krkonoše National Park and its buffer zone, making it one of the most significant vegetation formations in the area. Natural *Pinus mugo* stands occupy less than 75 % (1 500 ha) of the total Dwarf Pine area, whereas over 25% consists of artificial plantings (about 680 ha). Planting of Dwarf Pine in the Giant Mts. was carried out especially in two periods. In the first one, from 1879 to 1913, it was planted on an area of 261 hectares. In the second one, between 1952 and 1992, another 292 hectares of land above the treeline was afforested. Management plan of the KRNP Administration, prepared in 2005–2006, proposed a 10 to 90% reduction of artificial dwarf pine plantations on a total area of 180 hectares. Thinning includes post-war *Pinus mugo* plantations because they have the most negative influence to several geomorphological and botanical phenomena, e.g. frost sorted soils and protected and endangered plant species. Two phases of thinning has been realized in the area of 85,1 hectares in the western part of the Giant Mts. (esp. Labská louka) in the period 2010–2015. Currently, third phase was prepared in the eastern part of Krkonoše National Park (e.g. Stříbrný hřeben, Studniční hora) in the area of 73,8 hectares. All these projects are financially supported by EU-funds (ERDF and CF).



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Bank of seeds of endangered plant species of the Giant Mountains – 15 years of project implementation

Keywords: species conservation, saving of genepool, long-term seed storage, low temperatures, germination tests

Seeds have been collected for the seed bank of endangered plant species of the Krkonoše Mountains since 2000 and by the end of 2016 it contained seed samples of 129 taxa of vascular plants. Part of the seed bank is stored at the Research Institute of Plant Production in Ruzyně and currently contains 241 seed samples of 122 taxa. A duplicate (backup) collection exists at the KRMAP Administration and contains 182 seed samples of 98 taxa. In order to establish the character of seed germination prior to storing the seeds and to verify it during storage, optimal methods of overcoming seed dormancy must be found.

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Bryophyte survey of the Krkonoše Mts. National Park

Keywords: Bryophyte, Bryophyte survey, The Krkonoše Mountains National Park

The knowledge of bryophyte diversity in the Giant Mountains is very unequal. Although it is one of the most bryologically explored areas in the Czech Republic and even through Central Europe, but the knowledge of some habitats especially in the lower parts of the mountain range is totally inadequate or missing. The attention of bryologists has been focused mainly on the exploration of glacial cirques and alpine areas, therefore other habitats have not been systematically processed. The remaining part of the National Park and its protective zone is still without significant systematic surveys, although this part of the area is mostly influenced by direct human activities (housing development, possible pollution, change and intensification of forest and agricultural industry during the 20th century). In 2018, the five-year project Inventory bryological survey of KRNAP and its protection zone (CZ.05.4.27 / 0.0 / 0.0 / 17_078 / 0005169) was established. Attending bryologists are Bradáčová J., Holá E., Jandová J., Kučera J., Manukjanová A, Mikulášková E., Plášek V., Procházková J., Štechová T., Táborská M., Zmrhalová M. The aims of the project are: (A) Systematic survey of bryoflora in the KRNAP area. (B) Identification of species diversity centres in these area. (C) Provide a Regional Red List of Bryophytes of the Giant Mountains according to IUCN criteria. In 2018, the first field work was carried out. 25% of sites were processed. Several new places with endangered species have been revealed: *Campylophyllum halleri*, *Dicranum elongatum*, *Lophozia ascendens*, *Moerckia blyttii*, *Obtusifolium obtusum*, *Paludella squarrosa*, *Tetralophozia setiformis*.



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Why the Krkonoše Mts. NP has been supporting protected landscapes instead of national parks in Georgia?

Keywords: International Development Aid, Biodiversity Conservation, Management Planning, Georgia, Protected Landscape, Capacity Building

Although one would assume that national parks in Georgia would be an appropriate partner for a cooperation with the Krkonoše Mts. NP Directorate, the situation is different from that. National parks in Georgia are primarily designated in areas with very low human impact (wilderness), i. e., out of settlements and other infrastructure. Protected landscape as a category is there much more suitable for a technical support from our site, because of much more similar characteristics to ours. This presentation is aimed to present similarities and challenges of that particular support of the Czech Development Cooperation in Georgia, and what could be a feedback for the Czech nature conservation.

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Recovery of surface waters from acidification between 1980's and 2018

Keywords: surface waters, acidification, geochemical maps, recovery

Krkonoše Mts. were heavily acidified by acidic deposition originating mostly from burning of high sulphur content lignite in power plants in Czechoslovakia, Poland and eastern Germany. Acidification peaked in 1980's and resulted in a widespread forest decline and acidification of soil and surface waters. Three regional surveys of surface water chemistry were done in Krkonoše in 1985–1991, 2008 and 2018. Samples were taken from 135 streams in the national park and their close vicinity during hydrologically stable conditions (baseflow) and vegetation season (May – September). Ca, Mg, Na, K, Fe, Mn, Sr, Li, Zn, SiO₂, Al, As, Be, Cd, Cu, Pb, Cl, NO₃, SO₄, F, dissolved organic carbon (DOC), pH, conductivity and total dissolved P were analysed. Stream water pH increased since 1980's from median 6,20 to 7,16 in 2008 and coincidentally also in 2018. The most acidic streams (pH<5,5) were found on the highest elevations, dominantly in central and western part of the mountains. Acidified area declined until 2018 to ca. 1/3 of area detected in 1980's. Recovery was caused by decline of atmospherically derived SO₄ – median 11,4 mg/L measured in 1980's declined to 6,4 mg/L in 2008, but increased to 8,1 mg/L in 2018. Nitrates (originating from coal burning, car and industry emissions) declined more pronounced (median 4,19 mg/L declined to 1,75 mg/L in 2008 and 1,75 mg/L in 2018). Declined was caused by reduced deposition and increased N utilization in acidification recovered forest soils. Trace elements (Cd, Be) and toxic Al declined steadily due to decreasing acidity. Pb has decline significantly as a result of ceasing use Pb in gasoline in 2000's. Most of surface waters are in a good ecological status, only small areas in high elevations are still slightly/episodically acidified.



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Recovery of mountain farming using the adaptive management cycle tools incorporated into the LUHOP application

Keywords: meadows, mountain farming, adaptive management cycle, LUHOP

The history of the Krkonoše Mts. mountain meadows dates back to the middle of the 16th century. 400 years of development were interrupted by displacement of a large part of the original German-speaking population. The meadows were abandoned or included in the centralized socialist system. Since a change in political conditions and consequent socio-economic changes at the end of the 1990s, the economy has gradually recovered. One of the basic aims the Krkonoše Mountains National Park Administration is facilitated return of farmers to the meadows, created the conditions for regular care by cuttings trees, rehabilitation of the water regime, stones collection, fertilization, etc. New farmers are connected with landowners and the agreed management measures were realized. The measures were incorporated in a 3–5 years management plans and resulted from previous analysis of objects of protection and management goals. For planning, implementation and evaluation of project interventions new principle of the Adaptive Management Cycle has been introduced. New style of work with informations and new processes were formalised in the newly created LUHOP application database. On the LUHOP platform, we can work with map data, get an overview of the occurrence and conditions of objects of protection, prioritize conservation activities, specify management goals, set an optimum management plan, collect data from monitoring, and evaluate effectiveness of our activities through audits.

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New palynological records from the western and central part of the Krkonoše Mts.

Keywords: pollen analyses, C14 dating, holocene

In 2016, we have informed about the results of 41 palynological analyses from the eastern part of the Krkonoše Mts. obtained in course of two projects POPFK in years 2009–2013 and 2014–2017 respectively. We now present the results of next 34 pollen analyses concerning the western and central part of the Krkonoše Mts. – from the alpine summits to the submontane areas again. History of Holocene development of the Krkonoše Mts. landscape based on all of 75 pollen analyses and C14 datings is confronted with referential profile Labský důl.



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Monitoring of ultraviolet radiation in the Krkonoše Mountains (2004–2019)

Keywords: UV radiation, ozone layer, total amount of stratospheric ozone,
Labská bouda station

The first warnings that the Earth's stratospheric ozone layer is in danger from chlorofluorocarbons and other anthropogenic substances were first proven by scientists in the early 1970s. The Montreal Protocol with its Amendments and Adjustments has played an important role in the reduction of using ozone depleting substances (Barnes P.W. et al.). Not only changes in stratospheric ozone, but also climate change have altered the solar ultraviolet radiation (UV radiation) at the Earth's surface. As part of the extension of the long-term monitoring of UV radiation in the Czech Republic, a UV-Biometer was installed in late 2003 in cooperation with the KRNAP Administration at the meteorological station Labská bouda in the western part of the Krkonoše Mts. This is the first and only instrument for measuring UV radiation in a national park in the Czech Republic. The measurements show a statistically significant increase in UV radiation during the spring and summer months in the 2004–2019 period. This increase may be another potential stress factor affecting the vitality and the future stability of mountain spruce stands. Stratospheric ozone damage and climate change interact in direct and indirect ways that could well have consequences for water safety, human well-being and ecosystem sustainability such as in the Krkonoše Mts.

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What does the Krkonoše Mountains look like from the MODIS satellite?

Keywords: NDVI index, climate change, the MODIS satellite, forest tree phenology

Almost everyone knows the satellite image of the Krkonoše Mountains. The picture shows a mostly green color, which, however, does not differ in any way. However, using the data and images of the NDVI index (Normalized difference vegetation index) allows us to describe the current state of vegetation based on the reflectance of solar radiation in the visible and near infrared (NIR) spectrum. Plants aging or suffering from stress have a reflectance structure different from that of healthy plants. Healthy plants reflect only 8 % of red light and 50 % of light in the near infrared spectrum. In contrast, plants under stress reflect 30 % of red light and 40 % NIR [1]. The vegetation indices are calculated from the satellite data and can be useful for monitoring the impact of climate change on forest tree phenology. The NDVI index from the MODIS [2,3] satellite was used to evaluate temporal and spatial changes in the Krkonoše Mountains between 2000 and 2018.



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Low temperatures of ground in the Karkonosze / Krkonoše Mts

Keywords: ground thermics, permafrost, ERT, Karkonosze / Krkonoše Mts

Despite the keen interest in the glacial and periglacial history of the Karkonosze Mts. and the superficial frost processes occurring on the surface, a discussion on the occurrence of relict and contemporary, isolated patches of permafrost (defined as a rock body whose temperature for at least 2 years is ≤ 0 °C) here was limited so far. This position was likely influenced by the opinion expressed by Jahn (1977) that in the highest parts of the Karkonosze Mts. and other ridges of the Sudetes permafrost disappeared approximately five thousand years ago. The compiled climatological data sets from two meteorological observatories in the Karkonosze Mts. – Mt. Śnieżka (1 603 m a.s.l.) and Szrenica (1 362 m a.s.l.) – indicate that even 100 years ago, in the highest parts of the Karkonosze Mts., there were favourable thermal conditions for the existence of near-surface permafrost. Also today, in the high altitude belt above 1 250–1 450 m a.s.l., mainly on the northern slopes, especially in places where the snow cover is easily blown off, in the gaps between the rock blocks, the temperature at the ground surface may maintain low values all year round. Therefore, in the light of obtained data, there is a high probability that isolated patches of contemporary permafrost in the Karkonosze Mts., in specific terrain conditions, occur. Geophysical research done by electrical resistivity tomography proves that in specific terrain situations, 40–50 m below the surface, there are extreme high-resistivity rock bodies, isolated from the surface, suggesting possible permanently frozen state (relict permafrost). There is no direct evidence, however.

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Fifty nine people a day on every square kilometer – What will come next?

Keywords: visitors' management, human pressure, nature overload

The Krkonoše Mts. National Park is one of the most densely visited protected areas in all Europe and, if compared to the scale of the area, one of the most visited parks worldwide. Almost every day the National Park Administration has to solve problems connected with this issue and answer the question what is the red line of acceptancy. How much visitors can natural values of this mountainous national park survive? How to deal with this situation in terms of visitors' management, how to adapt tourism infrastructure, what to do in case we have almost no regulatory instruments based in current legislation? Since 2017 we have, for the first time in the history of the National Park, exact data describing the real numbers of visitors, their flows during the year and around the National Park area. What can we do with data we have in practical terms of management and communication?



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History of aviation in the Krkonoše Mountains

Keywords: tourism, aviation, museum, Czech part, Polish part, nature preservation

History of aviation in both (Czech and Polish) parts of the Krkonoše Mts. region offers a large variety of possible tourist attractions such as museums, small local expositions, educational trails and information boards, which could help to reduce the number of tourists and visitors of exposed parts of the protected areas. Concerning the history of aviation itself, the Krkonoše mountains and its foothills represent a unique and one of the most interesting regions of the world, including the so called pioneer years of aviation (before the outbreak of the First World War), trailblazer years of glider flying, commercial aviation bloom, mountain meteorology research and aviation industry development in the interwar period, as well as secret weapons research or famous exploits of Allied aviator prisoners of war during the Second World War. Above-mentioned tourist facilities and attractions represent opportunities for both mountain (in terms of attendance decrease) and foothill areas (attendance increase) of both sides of the Krkonoše mountains that remain unutilized so far.

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Krkonoše Mountains in end of Ice age and post Ice age

Keywords: team results, flora, fauna, settlement, landscape of Europe

The results of team project POPFK 2014–2017 „Vegetation and mezo/microrelief development of the Krkonoše Mts. in course of Holocene and beginning of its influencing by humans are the basis of newly prepared popular – science brochure. Changes of landscape, vegetation, fauna and settlement are noticed since 30 000 years BP – since period documented by real records from the Krkonoše Mts. area – and are compared with important changes of landscape of Europe.



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Close-range Remote Sensing towards precise detection of bark beetles infestation: The potential of Unmanned Aerial Systems for early intervention

Keywords: spectral change; forest infestation; pest outbreak; consumer-grade camera.

Forest disturbances as a necessary part of forest dynamic cause changes in the forest ecosystem. Sort of biotic disturbances is insect outbreaks, which used to be damaging to the forest, especially for the matter of wood. Due to these aspects, outbreaks of the insect in forests are hot research topics nowadays for the ecologists but also for forest managers as well as forest administrations, and therefore bark beetles disturbance are extensively studied not only in central Europe. The valuable source of bark beetle life cycle is non-intervention part of protected areas and cost-effective solution for local monitoring of its spreading are Unmanned Aerial Vehicles. UAVs equipped by proper sensor offer a cost-effective solution for early monitoring of local spread many times per season. Here we present a non-invasive methodological approach for detailed scale monitoring of bark beetle distribution and seasonal dynamics in a part of the Krkonoše Mts. National Park. The study uses UAV-borne imagery collected within the low altitude aerial surveys using consumer-grade RGB camera and modified Near-Infrared camera in June, in the first and the second half of August, and in October. A time series of UAV-borne mosaics in the very high spatial resolution was assessed using supervised object-based image classification. Results indicate that even with the casual or low-cost customized camera is possible to detect bark beetle attack stages on individual trees level with sufficient accuracy. It is clear that UAV technology is a powerful and rapid-to-deploy tool for monitoring of bark beetle infestation; however, for refinement of classification accuracy, a further study focusing on using state-of-art sensors are needed.



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Residual sexuality of facultatively apomictic plants: the case of *Pilosella* (Hieracium subgen. *Pilosella*)

Keywords: *Pilosella*, Facultative Apomixis, Residual sexuality, Polyploidization

Apomixis (asexual reproduction by means of seeds) is rather common and successful in several families, as Poaceae, Rosaceae and Asteraceae. Apomixis can either be obligate (as in *Alchemilla* or *Hieracium* s. str.) or facultative, when some proportion of sexuality is retained. *Pilosella* belongs to the latter type. Residual sexuality in *Pilosella* has been studied in heteroploid crosses when apomictic mother plant was hand-pollinated by pollen from a sexual plant (6x female, 4x male), and vice versa. The reciprocal crosses allowed us to distinguish the way of origin of the progeny and evolutionary consequences. Surprisingly, we found that apomictic mother plants produced more variable progeny than the sexual ones with respect to ploidy level. The reason was that the apomictic mothers produced a high proportion of the fertilized unreduced gametes, and also the polyhaploid progeny (the progeny with a half of the chromosome set of the maternal plant). Owing to parallel hybridizations in the field, the apomicts stimulate ongoing polyploidization and contribute to diversity in the mixed populations.



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Snow avalanche activity in the Sudetes reconstructed using dendrochronological methods

Keywords: snow avalanche; dendrochronology; Krkonoše; Hrubý Jeseník;
Králický Sněžník

Snow avalanches play significant role in ecology, forestry, surface evolution and risk prevention. In the Sudetes Mts., the avalanche disturbances contribute to enhanced biodiversity of the avalanche paths. As the avalanche paths are mainly located in the area of different levels of nature protection and almost no collision with infrastructure, they are nowadays not undergoing any avalanche-blocking management. The information about avalanche activity (i. e. magnitude and frequency) is valuable for understanding the complex role of avalanches in the mid-mountain environment. The presented poster shows the results of avalanche events dating using dendrochronological methods in 12 avalanche paths in both western (i.e. the Krkonoše Mts.) and eastern (i.e. the Hrubý Jeseník Mts. and the Králický Sněžník Mts.) parts of the High Sudetes. Total of 501 trees (*Picea abies* (L.) Karst.) located within the avalanche paths and on their borders were sampled and analysed by standard field and laboratory methods. In the Krkonoše Mts., the dendrochronological results were validated by the avalanche catalogue gathering information about observed avalanche events since the second half of the 20th century. Moreover, meteorological data and evidence about avalanche events in different paths were used for the validation in the Eastern High Sudetes because of absence of avalanche catalogue in this area. The avalanche frequency in the Eastern Sudetes is lower than in the Krkonoše Mts., having high variability among avalanche paths. The resulting validation accuracy of 55 % provided the ability to use dendrochronological methods for revealing avalanche frequency in the areas without catalogue information.



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Distribution and ^{10}Be exposure age of patterned ground/sorted polygons above the alpine timberline in the Krkonoše Mts.

Keywords: patterned ground; sorted polygons; last glacial period; exposure dating; Krkonoše

Sorted polygons are one of the types of patterned ground. Patterned ground including sorted polygons in mountainous areas has a high paleoenvironmental significance. Most of sorted patterned ground (i.e. sorted polygons, sorted nets, sorted stripes) in the Krkonoše Mts. is overgrown by vegetation and is presently inactive. However, deflation summit areas with low snow cover allow the recent activity of sorted circles, and of some of non-sorted patterned-ground types such as peat hummocks and probably some non-sorted stripes. Relict large-scale sorted polygons are widespread on high-elevated surfaces in central European uplands, providing evidence of regional periglacial conditions even with permafrost conditions in the past. The extent of sorted patterned ground above the alpine timberline in the Krkonoše Mts. is based on detailed field geomorphologic mapping. Sorted patterned ground occurs on summit planation surfaces with flat ground or gently-inclined slopes, and covers the total of 343.2 ha. Sorted polygons (11.6 ha) are the highest-elevated patterned-ground type in the Krkonoše Mts. Results of ^{10}Be exposure dating indicate two main phases of polygon formation during the last glacial period. The earlier phase occurred during the MIS 4 whereas later formation was constrained to the MIS 2. Knowledge of spatial distribution and age of patterned ground could be helpful for understanding of the Quaternary geomorphologic evolution of the mountain landscape and for nature protection planning in the Krkonoše Mts.



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Building environmental responsibility – science or art? General Challenges and Examples from the Krkonoše Mts.

Keywords: environmental education, "know and protect", interpretation of local heritage, example of new interpretation technics

How to effectively develop competencies for responsible behaviour towards people and nature? Is it planned casual sequence of steps based on accurate knowledge or is it spontaneous intuitive process based on emotions? This question of professional discussion for over 50 years can be illustrated by experience with different programs applied in env.education and education for sustainability (EE/EfS) in the Krkonoše Mts. Research applies into EE/EfS in two levels: Research of educational processes as such and using research processes and results as educational content. Regarding educational research half a century brought a shift from simple „know and protect“ idea to multidimensional picture involving both affective and cognitive aspects. Different programs contribute to different domains of competencies – sensitivity to nature, sense of place, inquiry skills, system thinking, action skills... Youth and adult residents and visitors of Nat'l park should be involved in appreciating nature and local traditions through outdoor or place-based learning or interpretation of local heritage as well as in understanding links between locality and outer world through global education. On using research processes in EE/EfS it is worthwhile to stress the inquiry-based learning – it can be applied into bioindication through invertebrates in a brook, exploring of historical development of human-nature interaction or survey of sustainable development indicators in community. The importance of scientific results (current and correct data) we can illustrate on multiple educational programmes. Concurrently creative activities such as drama or arts are applied as well. It seems that EE/EfS is of ambiguous nature – both science- and art-related – and the important issue is balance and openness.



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Potential of remote sensing data and methods for monitoring of tundra vegetation

Keywords: remote sensing, vegetation, tundra, monitoring

Relict Arctic Tundra is a unique ecosystem that is very sensitive to various environmental factors and is subject of a strict protection. Follow the request of the KRNAP Administration to monitor effectively the vegetation changes, methods are sought to remove the shortcomings of the field mapping (time demands, subjective error). One of the methods tested, which has the potential to remove the disadvantages mentioned, is remote sensing. The main objective of this study was to determine to what extent the three selected types of grass species (*Molinia caerulea*, *Calamagrostis villosa* and *Nardus stricta*) can be differentiated within the area of interest in the eastern part of the tundra using remote sensing data (PlanetScope, Rapid Eye and APEX sensor hyperspectral data). These vegetative categories were selected for the purpose of verifying the assumption of the Administration of the Krkonoše National Park on the increase of the *Molinia caerulea*, *Calamagrostis villosa* at the expense of the original *Nardus stricta*. The work also deals with the question of the period in which the selected vegetation species, which change its appearance, colour and coverage during the vegetation season, is best distinguished and which of the available terms is most suitable for classification. The overall accuracy of the RapidEye best classification result (multitemporal composite using Random Forest classifier) was 80.67%, the best overall accuracy of monotemporal classification of APEX data reached 76.06%. The usability of the remote sensing methods for monitoring of vegetation changes in tundra will be further tested in the joint project of PřF UK (Charles University, Faculty of Science) in Prague and KRNAP using data captured from UAV (multispectral, hyperpectral data and LiDAR data).



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Diversity of *Ribes petraeum* (*Grossulariaceae*) leaf traits in Europe

Keywords: *Ribes*, rock currant, mountains, biometric, morphology, taxonomy

Ribes petraeum Wulfen is European mountain species grows on dispersed localities on moist slopes and rocky debris within sycamore forests and subalpine tall-forbs and scrubs. The purpose of the present study was to biometrically verify differences in leaf characteristics between selected populations – Pyrenees, Alps, Dinarides, Sudetes, Carpathians and mountains of Balkan Peninsula. Detailed biometric analysis was abaxial leaf side (leaves from long- and short-shoots) and characterized by the following set of traits: petiole length; midrib length; blade width; middle lobe length; middle lobe width at its widest part; middle lobe width at the base; number of veins of the middle lobe; lateral vein length; angle between midrib and lateral vein; basal angle. The standard deviation and coefficient of variation were calculated for each of the examined traits. Statistical analyses (Discriminant Correspondence Analysis, Cluster Analysis) showed intra-population geographical and taxonomical variability: subsp. *atlanticum* (Pyrenees), *petraeum* (typical species – Alps, Dinarides and Sudetes) and *carpathicum* (Dinarides, Sudetes, Carpathians and Balkans). Three distinct groups characterized by a specific combination of morphological traits of size and shape of the leaves. In the Western Sudetes Mts the samples were characterized by a relatively short leaf petiole and generally small blade (subsp. *petraeum*), and the Eastern Sudetes Mts the leaves had long lateral veins and dense venation (subsp. *carpathicum*). The geographical isolation of mountain massifs and the lack of gene flow probably they led to the development to develop these taxa. Relations between sudetic samples suggested two separate migration routes of the species from Eastern Alps and Western Carpathians to the Sudetes.

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Suitability of agricultural management of meadows in the SCI Krkonoše, agricultural subsidies (CAP) and their influence on the type and quality of management

Keywords: management, meadows, agricultural subsidies, The Krkonoše Mountains national park

The meadows in the Krkonoše Mts (Krkonoše SCI, the Krkonoše Mts National Park and its Buffer Zone) include the following Natura 2000 habitats: 6230* – Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas in Continental Europe), 6510 – Lowland hay meadows and 6520 – Mountain hay meadows). The specific-species composition is the result of a unique combination of plants from alpine zones and lowlands, influenced by the history of colonisation and farming of the mountains. Nowadays, extensive agricultural management plays the main role in the favourable conservation status of the meadows. Grassland habitats are often exposed to inappropriate management, leading to deterioration of their quality. Unsuitable agricultural management was identified on more than 20 % of the meadows area in the Krkonoše SCI. The most unsuitable forms of management (e.g. mulching), or the complete absence of management (abandonment of meadows), occurred more frequently on unsubsidised meadows. The suitability of the practice of management is evaluated similarly in both groups of localities (with or without subsidies), or even more little bit positively on unsubsidised plots. Therefore, agricultural subsidies (CAP) ensure the presence of basic management and prevent the reduction in area of meadows due to abandonment. However, they do not influence the quality of its practice in any way; thus, they do not influence the improvement of the quality of the meadows. The obtained data will serve mainly to set up a system of care for the most endangered meadows in future.



Population status of selected rare and endangered alpine plant species of the Karkonosze Mts: preliminary results of the field monitoring of some vascular plants

Keywords: endangered plants, flora monitoring, population dynamics, sites condition

During the last three years we carry out study which aim is to verify status of the rare plant species in the Karkonosze Mts. We intend to create the precise database coupled with digital map, which will be useful for analyses of changes in the species resources and management. We will present data concerning some rare, endemic and relict species. *Pedicularis sudetica* was found in almost all known localities. However, that species shows some unstable character with varying size of populations from year to year. *Cryptogramma crispera* occur in all historic sites. A dynamic increase of individual's number has been observed in the Wielki Śnieżny Kocioł where the size of the population was doubled within last two decades reaching ca. 800 individuals. *Woodsia alpina* remains still critically endangered in its only locality on the basalt outcrop in Mały Śnieżny Kocioł. Although *Rubus chamaemorus* remained at two known localities, its abundance in the bog near Sokolnik decreased by half in recent ten years. *Cardamine resedifolia* was found in all historic sites but population in Wielki Śnieżny Kocioł revealed clear decline in last years. The populations of *Saxifraga moschata* subsp. *basaltica*, *S. bryoides* and *S. oppositifolia* in Mały Śnieżny Kocioł are numerous and stable. *Saxifraga nivalis* is still critically endangered species however, in the recent time it has been observed a lot of seedlings and new flowering individuals. The populations of *Arabis alpina* is one of the most endangered plant, we recorded only 12 individuals.

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Changes in abundance and vitality *Pedicularis sudetica* subsp. *sudetica* in known localities of the Czech side of the Krkonoše Mts. during the last 20 years

Keywords: Giant Mts, long-term population dynamics, monitoring, *Pedicularis sudetica* subsp. *sudetica*, plant counts, small permanent plots, statistics

The abundance and vitality of the populations of *Pedicularis sudetica* subsp. *sudetica* were evaluated in all known localities on the Czech side of the Krkonoše Mountains over 20 years as part of monitoring of habitats and species organized by the Nature Conservation Agency of the Czech Republic and the Administration of Krkonoše National Park: 1) Changes in abundance based on repeated plant census at localities during 1989 and 2018 (after 6 years) – especially juvenile plants (up to 5 leaves), individuals (up to 10 plants) and stumps; in fertile plants the number of all stems and browsed stems. 2) Annual micro-mapping since 2004 in 7 quadrates 1 × 1 m, since 2015 in 17 quadrates to embrace all habitats in which the species occurs. Outside the plant position, the number of stems, their length, length of inflorescence, bitten or dried inflorescences, total number of leaves and length of the longest leaf were recorded. There were a maximum of 62 plants per the quadrate (at 2008), in the last 5 years there were on average only approx. 10 plants per quadrate. The majority of the plots decreased in number of plants and other characteristics of the populations changed (less flowering stems, shorter stems, inflorescences, less leaves). This may be the consequences of a changing climate. We rate the population condition as slightly unfavourable.



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Changes of *Pedicularis sudetica* occurrence in the Krkonoše Mountains during the last 200 years

Keywords: herbarium sheets, 19th century, recent occurrence

Recent occurrence of *Pedicularis sudetica* monitored in 1998–2019 is being confronted with its distribution on the base of herbarium collections – mainly from the Herbarium WU & Virtual Herbaria JACQ (Vienna University), The Herbarium of the Natural History Museum in Vienna, The Herbarium of the National Muzeum of Prague, The herbarium collection of the Charles University in Prague (PRC), The herbarium Dresdense (DR), the Herbarium BRNU, The herbarium of Regional Museum in Olomouc. It concerns 450 herbarium sheets with more than 1000 items in total, from both Silesian and Czech part of the Krkonose mountains, mostly from 2nd half of 19th century. These items proof the occurrence of *Pedicularis sudetica* on all of the recently known localities but also at places where we have not found it in last 10 years so far – Čertova zahrádka garden, Kotelní jáma corrie, Kotel Mt., Dvoračky chalets, Brádrlerovy Boudy chalets, south part of Studniční hora Mt., Pudlova bouda chalet, Úpské rašeliniště peat bog and others.

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Carabid beetles of the Krkonoše ridges and cirques in the course last five decades (1969–2019)

Keywords: carabid beetles, long-term monitoring of species, alpine belt, Krkonoše Mts.

Hůrka in the years 1955–1957 had open first systematic research of Carabid beetles in the Krkonoše Mountains. He registered 38 species here. Materna, Vaněk, Kůrka a Vonička in 2004 founded 15 species (415 individuals) at Studniční hora. Martiš in the course of period 1969–2019 recorded with his students 83 species of Carabid beetles in total number more than 15 250 individuals. The research is still continuing. Material was collected using pitfall traps with 4% formaldehyde under the metal roof. The pitfall traps were picked roughly every two weeks. Pitfall traps were located at Kotel, Kotelné jámy, Harrachovy kameny (1969–1971, 1995–1996, 1999–2000, 2013–2015, 2018–2019), Vysoké Kolo (1969–1971, 1995–1996, 1999–2000), Luční hora and Studniční hora and Sněžka (2017), during the whole vegetation period. Special research was taken during winter period 2018–2019 at Harrachovy kameny when pitfall traps were covered by snow. *Carabus sylvestris*, *Carabus linnei*, *Calathus micropterus*, *Cychrus caraboides*, *Nebria rufescens*, *Patrobus assimilis*, *Patrobus atrorufus*, *Pterostichus negligens*, *Pterostichus unctulatus* and *Trechus striatulus* belonged to the most dominant species. Newly present data from Vysoké Kolo Mt. and Labský důl and Sněžka Mt. and Obří důl will be compiled during next weeks an obtained result will be presented partly in my main paper and partly in relevant poster (namely graphics – locations of traps on maps and broadly wider area of investigation. Special classification of 10 Carabid beetles' characteristics (zoogeography, zone, biotope, soil, termopreference, hygropreference, fotopreference, seasonal rhythmic, daily rhythmic, food) was experimentally tested species. Daily and seasonal rhythmic were studied by selected species. It was confirmed that species with hibernating larvae and with nocturnal activity prevail.



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Carabid beetles of Velká Kotelní jáma

Keywords: carabid beetles, Kotelní jámy, pitfall traps

Collections of Carabid beetles from pitfall traps in characteristic biotopes of the Velká Kotelní jáma (by the pond near by the forest, at southern slope below Harrachovy kameny and in avalanche pass (Ostřicová rokle) were assessed in the frame of whole glacial cirque. Unexpected species richness and density of Carabid beetles were found. Finding of *Pterostichus negligens* at the forest border is extremely curious. The obtained results were compared with those from former periods of Martiš research in this glacial cirque (1969, 1970, 1971, 1994, 1995, 1996). In addition, five pitfall traps were installed at the beginning of November 2018, just before the first snow fall. Dataloggers for temperature and moisture measuring were installed too. The Carabid beetles from this pitfall traps were pick out at the beginning of May 2019. It shows that Carabid beetles are relatively active during the winter.

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Carabid beetles of Sněžka, Luční hora a Studniční hora

Keywords: carabid beetles, summits of Eastern Krkonoše Mts., various habitats

Research of Carabid beetles in the area of Sněžka, Luční hora and Studniční hora was going on in 2017 (from May to October). At each of these mountains 7 pitfall traps with 4% formaldehyde was used. All typical biotopes of these mountains were studied. 20 species (more than 520 individuals) of Carabid beetles was recorded in course of vegetation season 2017. The highest species diversity and abundance were recorded in Sněžka (16 species, 426 individuals), Studniční hora (7 species, 65 individuals) and Luční hora (6 species, 35 individuals) seem to be poorer. Several species, characteristic for peak alpine zone in Krkonoše, were not caught, e.g. *Pterostichus negligens* and *Nebria rufescens*.



Carabid beetles of Vysoké Kolo Mt.

Keywords: carabid beetles, Vysoké Kolo Mt. peak plateau, spatial and species distribution

Research of Carabid beetles in the area of Vysoké Kolo was going on in four periods in course of last five decades: 1969–1971, 1994–1996, 2013–2015, 2016–2017). Classical method of pitfall traps with 4% formaldehyd was used. All typical biotopes of this mountain were studied. The assessment of the results shows extreme differences among four specific zones of the locality:

- wetlands around the local spring
- windward zone – west of the peak plateau
- peak plateau of Vysoké Kolo
- leeward zone – east of the peak plateau

About 50 species (more than 2300 individuals) of Carabid beetles was recorded e.g. in the period 2013–2015. All obtained results from this locality will be compared. The peak plateau of Vysoké Kolo is the most valuable part of this mountain. Characteristic species of the peak plateau are e.g. *Pterostichus negligens*, *Nebria (gyllenhali) rufescens*, *Carabus sylvestris*, *Leistus ferrugineus* and *Trechus striatulus*. Generally, in time comparison species diversity and common abundance it seems to be poorer at present.

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Multitemporal satellite data in classification of subalpine and alpine vegetation of Giant Mountains

Keywords: multitemporal data, remote sensing, monitoring, satellite, classification

Satellite remote sensing ensure monitoring of vegetation. European Space Agency Sentinel-2 mission, thanks to high spatial (10–20 m) and spectral resolution (12 spectral bands registered in visible, near and mid infrared spectrum) and short revisit time (5 days) enables to provide reliable and accurate material to mountain vegetation identification. Using Support Vector Machines (SVM) algorithm and reference data (botanical map of non-forest vegetation, field survey data and interpretation of high spatial resolution images) it was possible to classify following vegetation types of Karkonosze Mountains: bogs and fens, deciduous shrub vegetation, grasslands, heathlands, subalpine tall forbs, subalpine dwarf pine scrubs and rock and scree vegetation. The results of iterative classification repeated 100 times were assessed as about 80% median Overall Accuracy (OA) based on multitemporal datasets stacked using four vegetation season dates of acquisition (from late spring to early autumn 2018), better than using a single-date scene (70–72% OA). It confirms a big potential of fully available data for identification of vegetation for their management purposes and protection within national parks.



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Hyperspectral data for vegetation mapping – now from plane to satellite in future

Keywords: hyperspectral remote sensing, mapping, support vector machines, vegetation communities, vegetation types

Mapping plant communities in mountain areas is difficult and time consuming. Field surveys deliver high quality data but often are limited to small-extent areas. Hyperspectral data due to large number of narrow spectral bands allow for detailed vegetation analysis. We applied classification of 22 vegetation communities in the Giant Mountains using Airborne Prism Experiment (APEX) data, registered 10 September 2012 in 288 spectral bands at 3.12 m. The data were corrected atmospherically and geometrically and dimensionality reduction was performed to select the best dataset. As reference we used a non-forest vegetation map of Polish Karkonosze National Park from 2002, orthophotomaps and field data from 2013 to 2014. Support Vector Machines (SVM) algorithm allowed for develop the maps of vegetation communities, lakes and areas without vegetation. Accuracy assessment repeated 100 times was used to obtain the most objective results for each community. Median value of overall accuracy was 84 %. The methodology was transferred to data simulated for German hyperspectral EnMAP (The Environmental Mapping and Analysis Program, 242 spectral bands) mission planned for 2020, but taking into account spatial resolution (30 meters) the classified units were generalized into vegetation types. The overall accuracy was 83%. Aerial data allow for very detailed analyses at communities level, however, forthcoming satellite EnMAP mission will be powerful for vegetation monitoring purposes due to revisit time (23 days). All results can support both Polish and Czech national parks vegetation monitoring purposes.



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What can *Eusphalerum* beetles tell us? Use of rove beetles in monitoring of climate change in the alpine zone in the Giant Mts.

Keywords: high temperature, fauna, alpine zone, Staphylinidae

Beetles from genus *Eusphalerum* Kr. (Coleoptera, Staphylinidae, Omaliinae) are among flower dwelling species and they larva develop in close proximity, in moist soil. Many of those species inhabit mountain areas and subalpine and alpine floors. For the Karkonosze Mountains, a list of species for the Polish and Czech side was prepared. The most abundant species was *Eusphalerum alpinum* (Heer, 1839), in Poland reported only from Sudetes and Carpathians. However, quick observations indicate that number of the most common beetles species is declining. This raises a question if this decline is a direct result of changes in temperature and humidity levels in the highest mountain floors? Following factors make the *Eusphalerum* genus an excellent monitoring subject:

- beetles of this genus are abundant in mountainous environments, especially on herbaceous vegetation in high alpine zone,
- collection of beetles is very simple (entomological mesh),
- identification of beetles does not require to kill them,
- monitoring procedures can be conducted simultaneously in different mountain regions.

The poster presents possibilities of use *Eusphalerum* beetles in research on climate change results in the most valuable natural floors of plants.



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Reconstruction of fauna changes in our territory during the end of the Pleistocene and the beginning of the Holocene

Keywords: Pleistocene fauna, migration, changes of species, climate change, human activities

The fauna from the end of the Pleistocene (30 thousand years) to the beginning of the Holocene was studied and analyzed. Species composition, distribution, migration and palaeoecology are monitored in fauna based on the analysis of carbon, nitrogen and strontium isotopes ($^{13}\text{C} / ^{12}\text{C}$, $^{15}\text{N} / ^{14}\text{N}$ and $^{87}\text{Sr} / ^{86}\text{Sr}$). Fauna was also found to be affected by climate change as a result of human activities. For example, during a climate-favorable period during MIS3, strontium isotope ratios revealed that reindeer did not migrate but lived in small herds and migrated rather vertically. The reindeer began to migrate during the MIS2 cooling period. The same was true for mammoths. In the Holocene, faunal and human communities are more strongly influenced. E.g. for the first farmers, horses and donkeys are heavily hunted as harmful and cattle crossing with aurochs (documented based on mtDNA).

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Vegetation disturbance monitoring algorithm based on Landsat time-series data

Keywords: Landsat, time-series, Tatras, vegetation indices, vegetation disturbance

Remote sensing provides data and processing algorithms to support traditional methods of vegetation monitoring, which is particularly significant in difficult to explore mountain areas. Combination of in-situ and satellite data allows for models development used for environmental change detection. We developed and tested a new remote sensing algorithm for monitoring of abrupt vegetation disturbances in Tatra Mountains, primarily caused by strong winds and bark beetle outbreaks. We used time series of Landsat satellite images (30 meters spatial resolution, corrected geometrically, atmospherically and topographically) acquired in period 1984–2016, and vegetation indices calculated on them and in-situ data collected in 2013 and 2015 (chlorophyll content, Leaf Area Index – LAI, Accumulated Photosynthetically Active Radiation – APAR, and spectral characteristics of non-forest vegetation, dwarf pine and forest stands). The developed algorithm utilizes two approaches: thresholding – indicating where and when disturbance occur, and trend line analysis, presenting general trend in time series. We have tested ten vegetation indices and we found Normalized Difference Moisture Index (NDMI) as the best predictor of vegetation disturbances. Using randomly selected validation points we achieved about 98% overall accuracy of results. We elaborated the maps of vegetation disturbances and we assessed the relationship between the frequency of disturbances and selected biotic and abiotic factors (altitude, exposure, slope, vegetation community type, age and structure of the stand, protection zone and degree of naturalness). The algorithm has been tested for detection of vegetation disturbances in Tatra Mountains, however, it can be used for the long-term monitoring in other ecosystems.



Thermal conditions in subalpine belt of Karkonosze Mts. in the light of atmospheric circulation

Keywords: temperature monitoring, atmospheric circulation, Western Krkonoše Mts.

The analysis used the air temperature measurement series from Szrenica from 1961 to 2000, extended to 2015 based on thermal data from Labská Bouda. Daily thermal data was compared with the atmospheric circulation calendar for the Sudetes according to Ojrzyńska. The temperature trend in the period 1961–2015 was $0.32^{\circ}\text{C}/10$ years (statistically significant, p -value <0.01). A statistically significant temperature upward trend ($p < 0.05$) was recorded in April, May, July, August, November and December. The vegetation period lasted on average 141 days, with an upward trend of 5.1 d/10 years ($p < 0.01$). Using the division into four main sectors of atmospheric circulation, the lowest temperature in the period from April to October was brought by circulation from NW, and from November to March from NE. Advection from SW brought the highest temperature from December to March, and from SE from April to October. During the analysis period, circulation from SW occurred in 38.4 % of all days, advection from NW in 26.3 %, NE in 21.8 % and SE in 11.5 % of all days. Situations with no predominant directional sector of atmospheric circulation accounted for 2.0 % of all days. The change in the annual share of individual sectors in the period 1986–2015 compared to the period 1961–1990 did not exceed 2.0 % in any case and was not statistically significant. The average annual temperature increased in all sectors of circulation in the period 1986–2015 compared to 1961–1990. The largest warming was recorded in spring and summer. In September and October the differences were the smallest and for advection from SE and NE a decrease in temperature was noted.



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The prediction of forest development in the Krkonoše Mountains National Park

Keywords: EFISCEN, future scenarios, growing stock, carbon storage,
The Krkonoše Mountains National Park

Forests are one of the most important providers of ecosystem services (e.g. production of timber, sequestration of carbon, retention of water and nutrients in the landscape). Climate change influences all forests - protected or unprotected. The main aim of our presentation is to predict and compare development of growing stock and carbon sequestration in the protection zones of the Krkonoše Mountains National Park. The area of the Krkonoše Mountains National Park covers 363 km² of protected area and 186 km² of buffer zone (total 549 km²). Forests cover more than 80 % of the total area of the National Park. The park territory is divided into three zones and the buffer zone, each utilising a different mode of protection. Three forest scenarios with different intensity of climate change impacts on forests were analysed (i. without impact, iii. low impact and iii. extreme impact). Scenarios differ in the forest management and climate change impacts (changes in growth, cutting, regeneration and natural disturbances). The EFISCEN model (European Forest Information SCENario Model) for prediction of forest biomass production until 2070 was used. The primary forest data about two main tree species (Norway spruce and European beech) are based on the forest management plans and national forest inventories (NFI). According to the most optimistic scenario, the total growing stock and carbon storage would increase until 2070 in contrast to the most pessimistic scenario, where the total growing stock would even decrease. The role of nature protection management in the different zones of the National Park on carbon sequestration will be discussed.



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Current health status of ash stands and spatial distribution of resistant ash with focus on Ash dieback (*Hymenoscyphus fraxineus*) in KRNAP

Keywords: resistance, ash, ash dieback, forest stands, infection

The project was aimed at evaluating the relative proportion of ash individuals with natural resistance to the Ash dieback (ADB) caused by pathogen *H. fraxineus* in ash communities created by the natural regeneration of the original stands or the succession series on non-forest stands compared to the proportion of resistant ash individuals in human artificially planted forest stands. We have planned to demonstrate a greater diversity of natural ash communities with a higher proportion of resistant individuals with the potential to preserve ash in the landscape. The means of assessing the situation is an assessment of the health status of selected stands (communities) in relation to the damage caused by the pathogenic fungus *H. fraxineus* throughout the whole territory of KRNAP. A part of the project was the creation of database and GIS map outputs of selected more resistant individuals, their permanent identification in the field with the possibility of verifying the genetic resistance in the following years and their support in reproduction. There was found only 68 resistant ash individuals in year 2018. This project will contribute as a basis for management in the assessed stands and selected resistant ash trees can be intentionally reproduced firstly in stand by the natural way of replanting (releasing them) and secondly it is possible to take reproductive material artificially (seeds, vegetative cuttings, etc.) and with this planting material to reconstruct communities with ash at habitats where the original populations failed. **ACKNOWLEDGEMENT** The research was supported by the Internal Grant Agency Faculty of Forest and Wood Technology Mendel University in Brno (LDF_VP_2018017 & LDF_TP_2019007).

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The overview of health problems of *Pinus mugo* in Giant Mts.

Keywords: *Pinus mugo*, pathogenic fungi, *Lophodermium corconticum*

In the Karkonosze Mountains, dwarf mountain pines (*Pinus mugo* Turra) play an important part in the protection of the soil from unfavourable environmental conditions and as such, constitute an important part of the subalpine layer. Until now, no extensive research was carried out with regard to dwarf mountain pine diseases caused by pathogenic fungi, even though the mass occurrence of *Lophodermium pinastri*, a fungus which causes Lophodermium needle blight in dwarf mountain pines, was already observed at the end of the 19th century. Scientists have managed to identify four diseases affecting the needles of dwarf mountain pines growing in the subalpine layer of the Karkonosze Mountains: Lophodermium yellow needle blight caused by *L. corconticum*, brown spot needle blight (*Mycosphaerella dearnessi*), rust (*Coleosporium tussilaginis*) and Lophodermium needle blight (*L. pinastri*). *Lophodermium corconticum* Koukol & Pusz & Minter, sp. nov. was recorded first time by Czech and Polish mycologists as the dominant species isolated from the needles still attached to the tree and showing disease symptoms such as yellow spots and premature fall. It seems that Lophodermium yellow needle blight has an extremely detrimental impact not only on the needles, but also on the overall health of the plant. This can affect the deterioration of condition of dwarf mountain pine and decreased resistance to weather conditions. To a lesser extent the mountain's dwarf pine needles were spotted wilt symptoms caused by *Mycosphaerella dearnessi* and causing pine needles rust – *Coleosporium tussilaginis*.



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Nitrogen assimilation abilities of vascular plants from different high-mountain habitats of the Karkonosze mountains

Keywords: nitrogen assimilation, nitrate reductase, alpine ekosystem, Ellenberg numbers, portable water bath

Aims Nitrate is considered as the one of most important soil nitrogen forms for terrestrial plants. The first and regulatory step of nitrate metabolism in plant cell is its reduction by an enzyme nitrate reductase (NR), which activity can reflect actual and potential species abilities for nitrate assimilation. However little is known about nitrate reductase activity (NRA) in high-mountain vascular plants, which grow on acidic, ammonium dominated soils. Good example of such conditions represent habitats located above tree-line in the Karkonosze Mts. Methods: Twenty six plant species of twelve families representing different growth forms were investigated in seven habitat types of subalpine and alpine belts of the Karkonosze Mts., with respect to leaf NRA and mineral soil nitrogen forms. NRA was measured by an *in vivo* assay for the first time directly in the field. Findings Substantial differences among species, families, growth forms and habitats for NRA were found. The differences reflected mainly the taxonomical position and partially ecological preferences. PERMANOVA analysis confirmed that variance component showed enzyme activities were mostly explained by plant species and habitat type. Overall, the high-mountain species from their native habitats were characterized by very low and low abilities for nitrate metabolism. Constantly lowest NRA values exhibited species from Ericaceae family. Many species showed low NR activities even under increased nitrate availability. Otherwise the highest NRA values were observed in Polygonaceae and Urticaceae families. We also compared NRA values with actual Ellenberg's N values for the studied plants. Using a regression equation, N values of some species were corrected and calculated for the first time for the others.



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The principles of the effectivity of tree microinjection as a method of individual tree protection against the important fungal pathogen of ashes

Keywords: resistance, ash, ash dieback, forest stands, infection

Hymenoscyphus fraxineus (T. Kowalski) Baral, Queloz & Hosoya (hereafter *H. fraxineus*) is an invasive alien fungus in Europe and the causal agent of ash dieback (hereafter ADB). There are a lot of methods for elimination of influence of this pathogen, but research and practise show a little effectiveness. Therefore, the aim of this research was to test the efficiency of tree injections as a method of individual protection of woody plant species against the most destructive pathogenic organisms on ashes (ADB) not only for Europe conditions. The research methodology was as follows: First step of the research was the capture collections of *H. fraxineus*. Inoculation medium was grown from the cultures obtained. In the next step was carry out the micro-injection treatment of the trees (forest stand – 49.1567328N, 16.8213444E; 210 m a. s. l. with 100% presence of ash trees). We used several variants of fungicidal agents (systemically acting substances of both organic and inorganic nature). The inoculations test on mature ash trees (injected and control non-injected trees) in the selected experimental plot were the next step. Research parts were performed in the summer of 2019. After treatment and inoculation of the woody species, the extent of underbark necrosis was measured at regular intervals. The results of the research are still in process but it is already shown that this method is applicable in the management of tree care in the status of *H. fraxineus* infectious pressure, or more precisely under the condition of ADP. The effect of microinjection is determined by the amount of substance that is injected into the tree by microinjection and also by the frequency of the injection holes. Furthermore, the selection of a fungicidal substance with a systemic effect is essential.



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How educational paths in Krkonoše Mts. National Park (don't) work

Keywords: information schedule, interpretation natural heritage, educational paths, Krkonoše Mts. National Park

Many different information schedules by many different authors, with different designs, messages etc. were prepared in Krkonoše Mts. NP. Schedule about comic Vlasta Burian whereabouts was installed too. Why is it communicated by Administration of Krkonoše Mts. NP? The new PR and envi education conception was developed in 2010. It defines messages of info-schedules (and not a word about Mr. Burian). The graphic studio 2123design developed woody info-schedules manual. The wood was chosen therefore it's natural material and Administration has technology for woody info-schedules production by engrave machine. The manual determines shape and size of tables, fonts and head of them. The characters have to be bigger than 10 mm and gaps have to be wider than in printed text. Smaller characters and gaps are break out and readability felt down. This means, there is a space for max. 600 characters. Author has to think twice about the text! Short texts = attractive info-schedule. Info-schedules attractivity (number of visitors who goes around / number of them who read it) was about 31 %. It's quite enough. But what they get from them? Advantages of info-schedules:

- could be prepared by profiteam and could be tested
- they are cheaper than guide who says the same

Disadvantages of info-schedules:

- errors are badly repaired
- multi-language problem
- weathering, destroying by movement, vandalism
- not suitable everywhere

But... KPN Administration has multi-language problem solution, and eliminate their disadvantages. Visit posters The Invisible information schedules and The Translation application Multilingua.



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The Invisible information schedules

Keywords: information schedule, natural heritage interpretation effectivity, smartphone application, Krkonose Mts. National Park

Administration of Krkonose Mts. National Park has a smart solution, how to offer to the visitors cheap information everywhere and any time, and without information schedules. „The Invisible information schedules“ is smartphone application, which is downloaded to smartphone at home or in infocentrum. It works in field independently on mobile phone operators signal (which is very problematic in mountains) with switch gps on. Visitor controls the number and frequency of short information, similar to SMS, about topics on his trip. Advantages of application The Invisible info-schedules:

- the source of application is possible to edit everywhere and any time
- traditional schedule, which is not installed in field, is not possible to destroy by men or weather
- it is possible to go back to read infos
- no multi-lingual problems...

On the second hand, disadvantages: display of large smartphone is (and will be) much more smaller, than info-schedule in field, somebody hate electronic technology in nature and not everybody has a smartphone.



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The Translation application Multilingua

Keywords: multi-lingual information schedules, translation, smartphone application, Krkonose Mts. National Path

Attractivity and effectivity of information schedules depends on the design, quantity of text and their localization. The ideal info-schedule has not any (many) text, has omnipresent picture or iconography and it is installed on the spot, where visitors make stop naturally and wait for something. But it is very difficult to develop the ideal info-schedule and to find the right place for it. Smaller problem is to control each attribute of ideal info-schedule. Text has to be very visually short and understandable. Long text with many scientific terms discourage potential readers, therefore info-schedule doesn't fulfill the purpose. The same problem is, short text, but in several different languages. This multilingual text looks like a long monolingual text. Solution should be in smartphone application Multilingua, which is downloaded by foreign visitor before (or during) his trip. Visitor points smartphone's camera to the info-schedule. The device immediately and automatically translates text to foreigner's language. Translated texts aren't downloaded instantly from the internet, but these are taken from smartphone memory. It means, that translation is independent on internet connection. Application Multilingua recognizes different text as a QR code – because its system of dark and light points (organized to letters). Multilingua was developed by Administration of Krkonose Mts. NP and UNITY for The Tree Top Walk in Krkonose in 2014 and there is no problem to try it over here.



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S

Morphological characteristics of one-years seedling of *Pinus mugo*

Keywords: *Pinus mugo*, dimensions of seedlings, mineral and peaty soils

Seeds from 8 dwarf pine populations were seeded in controlled conditions. Morphological characteristics were evaluated on one-year old seedlings. Growth and quality characteristics of different populations differed according to the original population background (mineral soil, peat) and altitude. Population from peat locations had lower above part biomass dimensions, but share of fine roots were higher. Dimensions of seedlings decreased with the growing site altitude, populations from higher locations had higher root share on the total biomass.



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Dwarf-pine cones morphology in Czech part of the High Sudetes

Keywords: dwarf pine cones, morphology, variability

Differences were determined in cone morphological characteristics of dwarf pine (*Pinus mugo*) populations. Each population was represented by at least 20 individuals, for every individual 10 cones were examined. Morphology of cones differs according to the site conditions (peat and mineral soil), altitude and stand origin (autochthonous, allochthonous). Traits have also great variability within population and years (repeated measurements for some populations).

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Research of forest and non-forest springs in the Krkonoše Mountains

Keywords: springs, Krkonoše Mountains National Park, vascular plants, bryophytes.

The poster deals with the research of forest and non-forest springs in the Krkonoše Mountains National Park. On selected springs basic floristic research (inventory of vascular plants and bryophytes) and record of plant communities using phytosociological relevés with the use of Braun-Blanquet scales took place. Concurrently other characteristics of the habitat was recorded (location, altitude, spring area, character of the continuing vegetation). The springs was compared and categorized according to their similarity. The results were compared with researches on contemporary data published on springs in comparable areas in Czech Republic, eventually in Central Europe.



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Plant communities dominated by *Pinus mugo* s. l. from a European perspective

Keywords: plant communities, vegetation, krummholz, subalpine belt, distribution, geographical variability

My contribution deals with the dwarf-pine shrubs shaping subalpine communities creating distinguished krummholz zone in nemoral mountains of Central Europe, Balkan and Apennines. *Pinus mugo* s.l. is generally considered to be a heliophilous pioneer species, frequently found on extreme sites such as peatbogs or rocky outcrops where it has been dislodged by other competitors. It summarizes the most recent knowledge and new point of view on the classification, ecology, dynamics and geographical variability of dwarf pine stands. Based on the floristic differences, soil characteristics and altitudinal distribution, the *Pinus mugo* scrubs can be divided into 5 groups reflecting main ecological types: i) a dry, rocky type on basiphilous bedrock; ii) a moist type on nutrient-rich soils on basiphilous, as well as silicate bedrock; iii) an acidophilous, oligotropic, species-poor type; iv) an oligotropic, windswept type at the transition between the subalpine and alpine belt on silicate bedrock, and v) azonal oligotrophic shrub-communities on raised bogs and bog margins. Considering the occurrence of individual floristic elements, geographical variability can be reflected at various hierarchical levels such as distinct alliances, associations, or even a subassociations.



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Growth strategy of the Mountain Pine (*Pinus mugo*)

Keywords: Mountain Pine, clonal growth, layering, polycormons,
Pinus mugo vs. *Nardus stricta*

Mountain Pine (*Pinus mugo* Turra) and Bog Pine (*Pinus rotundata* Link) represent two taxonomically intricate species aggregates. From the point of view of Quaternary history, these two species of pines, either in the form of shrubs or trees, settled some mountain ranges of Hercynids, Alps, Apennines, Carpathians and Pyrenees. The paper deals only with the *Pinus mugo* aggregate. This shrubby pine forms spacious stands above the alpine tree limit in the High Sudetes, the Carpathians and in the Alps. Soil, climate and hydrological importance of *P. mugo* stands is undoubted. The age and spatial structure of *P. mugo* is significantly influenced by the clonal growth strategy this woody plant. Vegetative propagation significantly prevails over generative reproduction. Creeping branches are easily rooted and over time a complex system of daughter shrubs (polycormones) is formed. Clonal growth rate of *P. mugo* depends on site conditions. Conversely, generative reproduction is observed only in a certain type of cryogenic disturbed habitats. The growth parameters of the *P. mugo* differ significantly in the minerotrophic and organotrophic sites. The age structure of stands is very diverse and is also reflected in various resistance of individual shrubs to abiotic and biotic disturbances (frost, cryo-processes, creeping snow, snow avalanches, herbivorous insects, human). The contact of people with Mountain Pine in the last millennia has been very significant in the Krkonoše Mts. Thus resulted especially recently in the highly controversial philosophy of how and where the *Pinus mugo* stands protect, where new reforestation activities are not appropriate, why and what type of *P. mugo* management is the best for tundra habitats of the Krkonoše Mts.



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Edge of the Karkonosze Foothills in the light of geomorphometric analysis

Keywords: Karkonosze Foothills, GIS, geomorphometry

The edge (escarpment) of the Karkonosze Foothills is the northern boundary of the Karkonosze massif. The main rivers, flowing down from the Main Karkonosze Ridge, divide the Foothills escarpment into three sections: western (W), middle (M) and eastern (E). Based on the analysis of DEM with 10×10 m resolution, carried out in the QGIS and SAGA GIS programs, the morphometric features of the Foothills escarpment sections were determined. The boundary of the escarpment has generally a straight course, but the M section being distinguished by a greater sinuosity – 1.124, for comparison, the value of the coefficient for other sections are 1.043–1.062. The relative height of the escarpment is the highest on the W section and reaches a 235 m, but for the section M and E it does not exceed 150 m. These differences are emphasized by the Relief Energy (RE). The average RE for the W section is 73 m, and 62–59 for M and E. The average slope values for all sections are similar and are 14–15°. The degree of edge fragmentation by the valleys for all sections are comparable. Statistically for each of the 1000 m length of the escarpment, are account 8 (W), 9 (M), and 7 (E) valleys, which cut directly the side of the escarpment. The average bottom inclination of these valleys is for 197 ‰ for the section W, 156 ‰ for M, and 181 ‰ for the section E. In some of these valleys there are short, strongly inclined sections with a height of 5–15 m. These values correspond to the height of erosion undercuts and the height of the edges of high terraces in the main river valleys. These studies confirm previous reports indicating the Pleistocene tectonic activity of the Foothills escarpment. Probably after the Saale Glaciation period, the amplitude of tectonic uplift in this area was 10–15 m.

Impact of snowmaking on the change in stream flows in the Krkonoše Mts.

Keywords: impact of snowmaking, water consumption, snow covered and snow-free ski slopes, snow physics, snow chemistry

The paper analyses the impact of snowmaking on the change in stream flows (as well as the change in hydrological balance) and the effect of snowmaking on water pollution. Discharge, conductivity, and water temperature have been measured in 22 catchments located in the Krkonoše Mountains. The catchments represent a wide range of physical-geographic conditions, natural and anthropogenically affected streams. The mix of different catchment characteristics allows for a detailed analysis of the impact of snowmaking on discharge and groundwater levels during snowmaking and snowmelt periods. Changes in discharge have been observed directly by continuous measurements, and indirectly by using a hydrological model. Further, changes in soil properties were analyzed, both on the snow-covered and snow-free ski slopes and outside of ski slopes. The snow physics and chemistry (with respect to the use of additives) were analyzed as well. The measured data have been compared with information provided by the state administration and the operators of individual ski resorts. We aim to propose measures to be adopted for eliminating the negative effects of snowmaking on the stream environment. A set of recommendations on how to proceed with the permission of water consumption for snowmaking has been prepared. Conditions of the permission should reflect the requirements for long-term optimal development of biota in streams, and should allow efficient and long-term use of water resources. The development of a software tool for modeling the effects of snowmaking on the change in discharge is also planned.



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Morphological and molecular differentiation of *Allium sibiricum* L. in Southern Poland

Keywords: *Allium sibiricum*, morphology of populations, Sudetes, Carpathian

Allium sibiricum is one of the rarest plant species in the Sudetes and Carpathians. Analysis based on molecular markers (ISSR) and on morphological analyses were conducted to study the biogeographical relationships between geographically disjunctive populations of *A. sibiricum* in the Carpathians and Sudetes. The results clearly differentiated the Carpathian and Sudetes populations, but also showed a relatively high level of genetic similarity in specimens within certain groups of the Sudetes and Carpathian populations. The plants collected in Karkonosze probably belong to a mountain form of *A. schoenoprasum* morphotype C which inhabits natural sites in Karkonosze. In contrast, the study found morphologically and genetically different plants inhabiting Mt. Pilsko in the Carpathians. The plants from the Carpathians were present in scattered sites probably due to the activity of Vlach shepherds and the formation of large pastures. The species enlarged its local range due to this type of anthropopressure and likely hybridized with the cultivated *Allium* plants introduced by the shepherds. This may indicate that the populations on Mt. Pilsko (Carpathians) are of a partly anthropogenic character.

Ground beetles (Coleoptera: Carabidae) of mires in the Karkonosze and Iżera Mountain

Keywords: faunistics, montane species, tyrphobionts, indicator species

The main scope of the project was to find out which environmental factors influence arthropod assemblages in the mires of the Giant and Iżera Mountains. The material was sampled in 21 montane peat bogs and fens using pitfall traps in two successive years. Only results on spider assemblages have been presented so far, however pitfall traps are also appropriate for sampling some groups of beetles (Coleoptera). In this presentation we focus on one of the most important beetle families, which are often considered as good indicator organism – the ground beetles (Carabidae). These animals were often studied in different regions of Poland and Czech Republic, however every new data are very valuable especially as they come from endangered habitats. Montane mires of the Karkonosze and Iżera Mountains host numerous ground beetle species. Among the dominant carabids there are *Agonum ericeti* and *Pterostichus rhaeticus*, which are characteristic for mires. Among the most dominant beetles there was also a more common species – *Pterostichus diligens*. We observed a few carabids that are characteristic for montane habitats, such as *Carabus linnaei*, *Patrobus styriacus*, *Pterostichus burmeisteri* or *Trechus amplicollis*. Some of them are very rarely found. Apart from presenting the species list and comparing the dominance structure of the ground beetles in different mires we will analyse some basic environmental factors that may shape their assemblages. We will also summarize knowledge on the carabid fauna of mires in Central Europe to show our data from the Karkonosze and Iżera Mountains in the broader context.



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Mountain hawkweeds of subgen. *Hieracium* in Krkonoše Mountains

Keywords: *Hieracium*, hawkweed, endemic, gene bank

Krkonoše Mountains are rich in endemic species of hawkweeds. There are about 40 species of *Hieracium* subgen. *Hieracium*, 20 of them are endemic taxa in the mountain range. Most of them belong to endangered species. A monitoring of selected species was done during years 2017–2019, and some new interesting localities of rare and/or endemic taxa were discovered, namely localities of *Hieracium albinum*, *H. glandulosodentatum*, *H. hypochoeroides*, *H. pseudalbinum* and *H. schustleri*. There are three actually missing species on Czech side of the mountain range: *H. chlorocephalum*, *H. inuloides*, and *H. nigratum*. Present conservation status of some endangered taxa of hawkweeds is not satisfactory and they are potentially endangered by various threads. There are also some taxonomically complicated and still unclear taxa in this group of plants. A creation of Ex situ collection of all hawkweed species occurring in Krkonoše was initiated in the Genetic Bank of Krkonoše Mountains National Park Administration. This collection will represent a basis for collecting of seeds for gene bank, and eventually for an action plan in the future.

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***Pulsatilla vernalis* var. *alpestris* in Krkonoše Mountains: Condition and progress of the population**

Keywords: *Pulsatilla vernalis*, gene bank, reintroduction

The population of *Pulsatilla vernalis* var. *alpestris* in Krkonoše Mountains was found in 1827. It is the only occurrence of the taxon in Czech Republic. Long-term monitoring of native population in Čertova zahrádka locality shows dramatic decline of plant micropopulations as well as of total counts of individual plants from 90' years of 20. century. In the summer 2019 were found just 20 native plants on the last microlocalities. The population was a few times strengthened between years 1982 and 2008 using autochthonic plants, planted in the Genetic Bank of Krkonoše Mountains National Park Administration. In years 2018 and 2019 was done new monitoring on their sites, showing declining counts of surviving plants too. Possible factors threatening the native population as well as the implanted plants are browsing by animals and change of conditions (drought). The population is vanishing and needs new action plan in the future to prevent extinction.



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History of non-indigenous dwarf pine at Jeseníky Mts. – eastern High Sudetes

Keywords: Hrubý Jeseník, afforestation, non-indigenous dwarf pine, clear-cutting of artificial shrubs

The first traces of human influence in the highest area of Hrubý Jeseník Mts. were recorded close to Praděd hill from the 1st century BC. It is followed by records of fires from the early Middle Ages in the vicinity of Petrovy kameny hill from the 7th and 8th centuries. Charcoal assemblages reveal the rapid onset of medieval colonization of the (sub) alpine areas of the mountain ridge from the turn of the 13th and 14th centuries. The whole area was, like all most peripheral mountains of the Czech Republic, part of the boundary forest, to which man began to infiltrate to a greater extent in 12–14th century. Man started to manage the massif of Hrubý Jeseník Mts from 15–16th century, especially hunting, wood production, pasturing, and hay making evolve. In the highest altitudes of Jeseníky, especially in sites of Praděd, Vysoké hole, Kepník, mountain forest free area enlarged that were rimmed by sparse mountain forest at its bottom border. Forest free area was used for cattle grazing at the turn of the 17th and 18th centuries and sheep grazing became popular throughout the area for 200 years from the beginning of the 18th century. The first unsuccessful experimental afforestation of forest free areas close to forested border took place at the end of the 18th century and subsequently at Mravenečník and Praděd between 1800 and 1805. The forest free areas were afforested by non-indigenous dwarf pine (*Pinus mugo*) from 1874 to 1928. The reason for afforestation was the effort to raise the forest border and prevent water erosion, to limit pasture above forest border, and to protect forest stands against avalanches. The last dwarf pine afforestation took place in the 1970s. After the declaration of the PLA Jeseníky in 1969, the strategy of dwarf pine removal was proclaimed. Small experimental plots were clear-cut at the area of Velká kotlina (1975–1976), Malá kotlina (1988), Petrovy kameny (1994–2009), Sněžná kotlina (1998), Tabulové kameny (2004), and Kepník (2009–2010). Dwarf pine should be continued and done in more places and on larger areas because its area increases at 2 % per year in Hrubý Jeseník Mts.



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Giant trouble with dwarf pine at eastern High Sudetes

Keywords: none-native dwarf pine in Hrubý Jeseník, negative effects, microrelief, alpine zone

In the Hercynian (sub) alpine mountain area, dwarf pine (*Pinus mugo*) is part of the natural vegetation only above the treeline in the Giant Mountains. The historical absence of dwarf pine in the (sub) alpine zone of Hrubý Jeseník Mts. is associated with specific postglacial vegetation immigration, so unique ecological conditions were formed in the treeline ecotone and alpine zone there. The non-native species was used for afforestation at the 19th century and the plantations expanded. The presence of dwarf pine significantly modifies some environmental parameters in mountains with small (sub) alpine areas in Central Europe: microclimatic as well as soil conditions, microrelief structures, including the thickness of soil organic layers, their acidity and nutrient content, and snow conditions. The negative effect of dwarf pine stands on the community structure of montane invertebrates (Carabidae, butterflies and moths) was also apparent in changes of functional diversity. Dwarf pine expansion has formed three distinct habitats (alpine grasslands, dwarf pine plantation, and gaps) that differ in their beta and gamma diversity. That pattern is sensibly reflected by most of (sub) alpine heliophilous plant species that commonly missed under dense pine canopy. Much more, it can support recruitment and dispersion of some other strong competitors by the nurse effect. Small-scale experimental removal of dwarf pine was performed in the (sub) alpine zone of Hrubý Jeseník Mts. On the clear-cut area, the highest species diversity was documented, invasive species were missing there, but plant composition remained transitional even after 6 years however. Dwarf pine should be considered a strong plant competitor and invader of subalpine area that possesses recovery potential and can gradually spread at expenses of alpine grasslands in the future. The immediate reduction or removal of non-native dwarf pine stands is recommended in the (sub) alpine zone of Hrubý Jeseník Mts.



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