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Wetland restoration

Study tour in the Czech Republic 06.10.14 – 11.10.14

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Title

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Summary

The group visited several areas for wetland restoration during the study tour in Czech Republic. Wetland restoration is of major importance for conserving biodiversity and for mitigating climate change. A large amount of wetland has been exploited in several ways for many hundred years, both in Czech Republic and in Norway. One of the major focuses during the study tour was to learn about restoration of different mires areas with different topics for restoration issues. Many challenges has to be coped with depending of what kind of exploitation they have been used for, but one common feature is to restore the water level up to a level that are good enough to restart the ecological process in wetland areas. Restoration of rivers was also one topic of interest, and two different rivers and streams systems were visited. In Sumava National Park, an example of river remeandering with the aim to restore the hydrological regime within the riverbed and its surroundings was visited. In Bystřice river there was a project to regain fish migration that was destroyed due to establishment of several erosion dams.

Key words

The Czech Republic, wetlands, restoration, bogs, mires, streams

Photo – front page

Artifical pound in Boží Dar Peatland. Photo: Mia Husdal

Preface

The Norwegian Environmental Agency and the Ministry of the Environment of the Czech Republic, Department of Species Protection and Implementation of International Commitments, have agreed upon a cooperation on management of wetlands in Czech Republic under the EEA agreement in the period 2014-2016. The project title is “Conservation, Research and Sustainable Use of Wetlands of the Czech Republic”.

The joint program should contribute to follow up the Czech Republic’s commitments under the Ramsar-convention. The project shall also contribute to exchange knowledge between the two countries in order to manage wetlands in a better way. As a part of this, a Norwegian delegation with participants from several Norwegian institutions were in the Czech Republic on a study tour in October 2014. The main goal for the trip was to look at wetland restoration projects, including mires, bogs, ponds and streams.

In 2015, there is planned a revisit from the Czech Republic, coming to Norway to see and learn about what is done in Norway concerning nature guidance, public awareness, conservation and management of wetlands.

Trondheim, February 2015

Kjell Tore Hansen
Senior Advisor, Section for Natural Heritage

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1. Introduction

In the Czech Republic the natural character of wetlands and streams has to a large extend been modified. As an example, a quarter of agricultural land in the country is drained by subsurface pipes. In the 1950s about 1 300 000 ha of wetland were recorded and in 1995 only 350 000 ha remained. The importance of restoration of the natural character of wetlands and streams is connected to loss of natural values and biodiversity and hydrological conditions like flood risk, reduced groundwater and nutrient wash-off.

The main goal of the study tour was to experience different challenges and solutions connected to wetland restoration. The main study areas were in connection to the Doupovské hory in northwest (day 1 – 3; Krušné hory (day 1-2), Slavkovský les (day 3)) and in the Šumava National Park in the southwest (day 4 -5). Both regions are close to the German border (fig. 1).

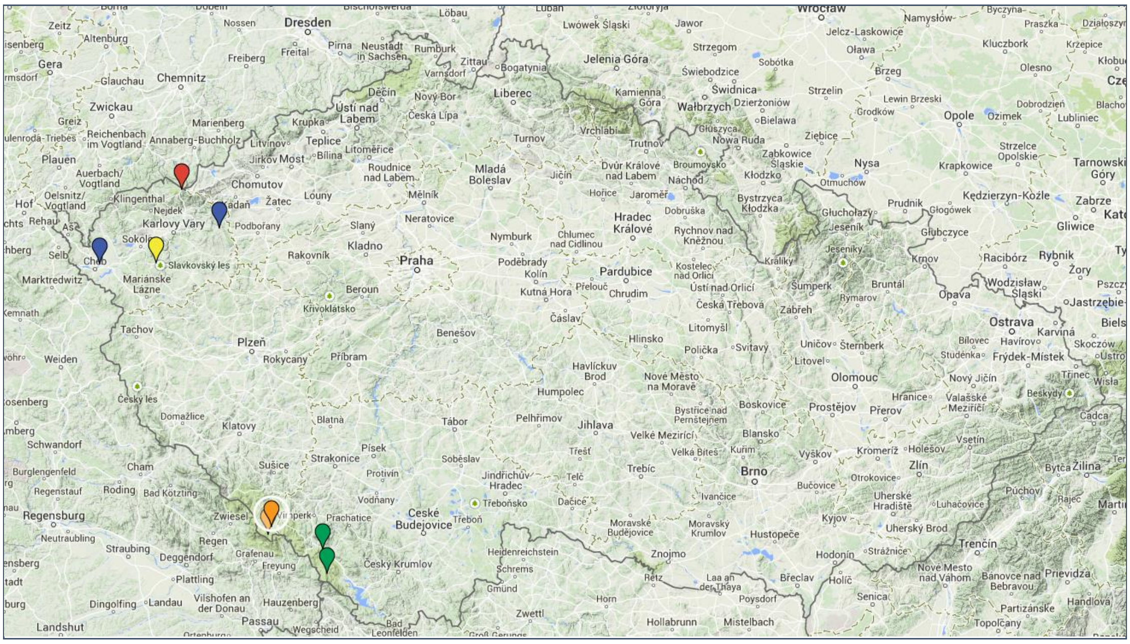

Figure 1 Overview of the study tour. Day 1 – blue, day 2 – red, day 3 – yellow, day 4 – orange and day 5 – green.

2. Day 1

Guides: Martina Eiseltová, Jan Květ and Vít Tejrovský
Referees: **Stein Byrkjeland** and Astrid B. Skrindo

2.1 Bražecké hliňáky- Doupovské hory

2.1.1 Challenges

The Bražecké hliňáky in the Doupovské hory is an area proposed as a National Nature Monument. Research is conducted on the best management methods of the area.

2.1.2 Nature qualities

This is a region of volcanic bedrock and at the northern limit for several biotypes and species. The area is in a former military army training site, but the pollution and destruction were fortunately limited. The wetlands consist of a system of traditional fish ponds and surrounding wetland biotypes with rare aquatic vegetation, fragments of ash-alder carr, water-locked forest and grassland with high ground water level.

The site is considered the most important site for the threatened butterfly Marsh fritillary *Euphydras aurinia* (fig. 3), a priority species for conservation effort in several countries. The caterpillars were numerous in a small part of the site.

Many amphibian species live in this area. We recorded Moor frog *Rana arvalis* and Common toad *Bufo bufo*. The area is also important for birds. Among other species we recorded Common crane *Grus grus*, Kestrel *Falco tinninculus* and Common Buzzard *Buteo buteo*. As the ponds are dominated by various *Potamogeton* species, they also function as good feeding sites for dabbling ducks. Artificial nesting boxes for ducks are placed in some of the ponds.

Figure 2 *Man – made ponds in Bražecké hliňáky*

Photo: Astrid Brekke Skrindo

2.1.3 Restoration project

Management in this area is differential, ranging from zones with no intervention to zones with extensive management. The fish ponds are man-made and shallow, and already influenced by expansion from nearby vegetation. Grazing by cattle has ceased in the whole area.

Parts of the former hayfields are now being mowed, to improve conditions for butterfly caterpillars. Different management methods are tested and monitored.

Figure 3 *The rare butterfly Marsh fritillary in Bražecké hliňáky. Monitoring will start this fall*
Photo: Astrid Brekke Skrindo

2.1.4 Experiences

The management methods are being monitored and no conclusions exist so far. However, the mowed parts of the hayfields definitely seem attractive for the Marsh fritillary, as good numbers of caterpillars were found there.

2.2 Ohře river

2.2.1 Challenges

In the Ohře river several dams have been built in the 1980'ies, to enhance sedimentation of silt, reduce erosion and to slow down the current. The dams represent obstacles for fish to move upstream. This has made some spawning grounds inaccessible for parts of the brown trout population, and also limits reproduction for other fish species.

2.2.2 Nature qualities

This far upstream only four fish species occur naturally. Brown trout *Salmo trutta* is the most significant species, another one is Minnow *Phoxinus phoxinus*. Along the riverside, at least two invasive plant species were recorded: *Impatiens glandulifera* and *Fallopia japonica*.

2.2.3 Restoration project

The old alternation due to silt sedimentation and soil erosion was improved by adding large rocks and establishing fish ladders.

The impact of invasive plant species is so far not a focused issue. An invasive species-project started this summer, but priority is given to conservation areas, so this river is not on the list, yet.

2.2.4 Experiences

The fish ladder is effective. Only one ladder is so far completed, so the fish are trapped further upstream. We did see some fish succeed to jump where no improvements were made, but we also observed several that did not make it.

Figure 4 *Two of the dams built in the 80`ies. The dam to the right has been successfully restored for migrations of fish during the latest years*
Photo: Astrid Brekke Skrindo

3. Day 2

Guides: Martina Eiseltová, Jan Květ, Vladimír Melichar and Vít Tejrovský
Referees: Ola Betten, Oddny Gudmundsdottir and Magnus Johan Steinsvåg

3.1 Boží Dar Peatland

The National Nature Reserve Boží Dar Peatland was proclaimed as a National Reserve in 1965. With an area of 930 ha this reserve is among the largest protected areas in the Czech Republic. Nature trails was created in 1972 by building a 3.2 km long boardwalk that runs partly through the peatland.

Figure 5 *Boardwalk through the peatland (left) and Boží Dar Peatland (right)*
Photo: Oddny Gudmundsdottir

The majority of the soil has acid character as peat lands and mineral soils. However, some places there is found some small island of basalt minerals in Krušné Mountains.

3.1.1 Challenges

This mountain region was highly influenced by acid rain in addition to mining, peat-extraction, drainage and forestry. Conifers and Purple moor grass (*Molinia caerula)* invades the disturbed peatlands. The goal is to raise the water table and restore the peatlands, including a raised bog.

The populations of Red deer (*Cervus elaphus)* and Sika deer (*Cervus nippon*) are so large that the deciduous trees hardly manage to survive. The goal is to enhance the growth of deciduous trees.

3.1.2 Nature qualities

The peatlands includes a waterlogged forest and a raised bog. In the forest edge, there was a mix between meadows and shrub land inhabited by a rare lichen species (50 % of the known Czech population). The lichen needed iron-rich soil on disturbed areas. The area inhabits the largest population of the rare black grouse (*Tetrao tetrix)*. In the bog there was a spring with nutrient-rich water, and plant species that preferred such nutrient-rich habitats.

Figure 6 *Rare iron – demanding lichen species and the guide Vladimír Melichar*
Photo: Mia Husdal

3.1.3 Restoration project

Wooden dams were built in the existing drainage ditches, to prevent the water leaving the ditch and to raise the water table. Some places the ditches partly were filled with branches and peat. This is the most used restoration method in drainage ditches in the Czech Republic.

To enhance deciduous forest, both newly planted and already existing trees were fenced in to keep the deer from eating.

For the lichen a small disturbance was made at the site just by the park ranger walking at the site.

2200 wooden dams of five different types were made between years 2010-2012. Some were simple wooden constructions and others were more advanced; including geotextiles and also filled with branches and stems from trees.

There was no restoration project addressing the lake. The lake is man-made, but has its ecological functions and will remain a part of the area.

3.1.4 Experiences

The wooden dams were established 10 years ago and today the water table has increased, but there have been no monitoring to address the succession so far. Even the raised bog shows signs of succession towards it natural stage. The areas with former peat-extraction were visible and contributed still to the drainage of the preserved peatlands.

Sixty of the 2200 wooden dams are not functioning and will be replaced due to the agreement made with the contractors.

Figure 7 *The gap between the area with former peat extraction (to the left) and the natural peat lands (to the right). The difference in level is negative for the water level in the remaining peatlands. The person in the photo is Kjell Carm. Photo: Mia Husdal*

The cooperation between local forestry and conservation authorities is good, but in some areas they were not allowed to cut the trees from the land-owners.

There was no monitoring of the growth of the trees, but the method used has been successful in other areas.

Figure 8 *Different measures were made to enhance growth of deciduous trees; singel-tree fences, group-tree fences and white-anti-deer-painting (painting every year for 15 years). Wooden dams made to increase the water table. Notice the metal string on each end of the wooden structure. It prevents the deer from crossing the dam and thereby destroying the structure. Picture at right shows the "anti-deer" painting on Sorbus aucuparia Photo: Magnus Johan Steinsvåg.*

Figure 9 *Landscape of Boží Dar Peatland* *Photo: Magnus Johan Steinsvåg*

4. Day 3

Guide: Přemysl Tájek
Referees: Janicke Haug, Ragnhild Skogsrud and Trond Vidar Vedum

4.1 Krasenske peatland

4.1.1 Challenges

The challenge of this location is to restore an area of mires where there was historical hand cutting of peat in earlier days. Since 1980's there was mechanized peat cutting in this area, and this continued into the 1990's. The purpose of the draining was being able to take out peat to heat people's houses and for medical use, and more recently peat has been exploited for horticultural use.

4.1.2 Nature qualities

The area lays at 800 m.a.s.l. and consists of a mire complex covering some 152 ha and consisting of the raised bog V borkách (76 ha), adjacent mires and waterlogged spruce forest. The area appears with different succession levels, from wet forest with typically bog-species like *Drosera rotundifolia, Vaccinium*- and *Betula*-species, to *Calluna vulgaris* dominated areas and to almost open areas without vegetation.

The forest consists mainly of spruce. The rare species *Pinus rotundata* is still present. This species is endemic to the Czech Republic. The mire inhabits trivial and rare species of dragonflies, butterflies and beetles. This area is also used as a nesting area for different birds, for instance snipe.

Figure 10 *Wooden dam in old ditch in the Protected Landscape Area Slavkovsky les. The area was earlier an important era for peat extraction. The water level was still too low to prevent drainage of the peatlands.*

Photo: Magnus Johan Steinsvåg

There`s been extraction of peat since the 1500-1600 century for fuel to households. The peat were removed manually and then dried in the sun. In the 1960's there was a lot of trees in the bog, but they have later been felled. In the 1980's the peat was drained by digging ditches. The ditches were numerous, and the harvesting of peat went on, mainly for balneology use (medical use in the Spa's) until the 1990's. Now there is one area that still is exploited, but the peat can be taken out wet so no ditches are needed. The industrial use of this site is still a goal.

4.1.3 Restoration projects

Today the area is included in the Protected Landscape Area Slavkovsky les, it`s a Ramsar site and a site of Community Importance. The part of the area that is not used by industry, is tried to be restored, mainly by improving the hydrology of the peat by raising the water table. The ditches have also been blocked by wooden dams. The restoration started in 2003-2004.

As walking trough the peatlands, we were shown a pond of unknown origin. This area was of well-developed peatlands. The pond is of great importance to the dragonflies. From the edges, one could see the beginning of a succession gradient. Even though, the overall ground water level has not risen sufficiently. The goal is to raise it to about 30-40 cm below ground.

Figure 11 *Revegetation of the remaining peatlands has proved difficult. This is partly due to surface temperature during summer up to about 60ºC. The peat surface does not absorb water, but develops a hard and sustainable surface*

Photo: Mia Husdal.

Some of the ditches have been "seeded" with *Sphagnum*-species to enhance the succession of the ditches, which seemed to have some effect.

4.1.4 Experiences

There are some difficult challenges to the restoration, because the peat is now only 0,5-2 m deep. The peat depth was about 7 m before the exploitation. A huge area is almost without vegetation and in the summer, the surface becomes very dry, hard and warm. It can reach about 60ºC on the surface. The peat surface does not absorb water, but develops a hard and sustainable surface.

In the start the restoration goal was to make a peat pond to raise the water level. The restoration measure has also been difficult because the landowners are against the restoration. They want to use the peat for spa, and therefore the restoration group could only carry out some of the measure that was planned.

In the main ditches there were quite much water movements, which should be stopped. In some areas the succession has been faster. The explanation of this is less intensive peat extraction in these areas.

Figure 12 *Water locked forest in Kladská mire*
Photo: Mia Husdal

4.2 Kladská mire

4.2.1 Challenges

There were almost no challenges in this big peatbog today - the peat is quite intact.

4.2.2 Nature qualities

This peatland covers an area of 93 ha. Earlier there was, and still is, a lot of deer in this mire forest. The deer grazed the young *Pinus rotundata* earlier, but the trees have been protected by fences or chemicals and are now big enough to cope with the grazing of the animals.

4.2.3 Restoration projects and experiences

The small draining of the bog has been stopped by blocking the ditches, and a great part of the bog is without other human impact. Lynxes (*lynx lynx)* pass through these forests. It is also a hope that the black grouse to re-establish in the area. Actually the study-group observed two individuals from the bus nearby the bog (Hansen and Skrindo pers. comm.). It had not been observed in the area since 1997.

5. Day 4

Guide: Ivana Bufková
Referees: Kjell Carm, Eldfrid Engen and Ragni Nordås

Indoor presentation of peatland restoration projects in Šumava National Park by **Ivana Bufková,** Botanist, Administration of Šumava National Park

In Sumava NP around 20 % of the area is wetland, 1/3 of this is mires. Almost 70 % of the mires are influenced by drainage. They estimate that 2000 ha of mires need to be restored, and 590 ha of these have been restored. The most important restoration measures are to raise the water table to requested target level by damming of drainage channels and infilling them by soil and other natural material. In some areas appropriate mire species like sphagnum mosses or sedges are used to enhance terrestrialization of blocked channels. The work are done mostly manual, but machines are used especially in much degraded and well accessible areas. Volunteers, including NGOs have participated: "People for mires".

There is a monitoring project to study the effects of the restoration in specific routes in the mire. The registration starts three years before restoration and includes studies of water table, water chemistry, microclimate and vegetation.

This day was spent in Sumava National Park. The park is situated in the southwest part of the Czech Republic, on the German border. This is a forestry-landscape with mires that range from typical raised bogs to forested or open fens fed mainly by the ground water. The Sumava peatlands have been a Ramsar site since 1990.

The forest in higher elevations consists mainly of spruce. In 1998 there was a storm which resulted in a plenty of windthrow. This again resulted in a severe attack by bark beetles, and for large areas almost all the trees were killed. We asked if acid rain could have weakened the trees, but this area wasn`t strongly influenced by acid rain.

Figure 13 *Most of the spruce forest is killed by bark beetles attack. The path of young, green trees in the middle is the former Iron Curtain. Photo: Mia Husdal*

5.1 Breznik mire

Figure 14 *Dam and old ditch in a raised bog in Breznik peatlands* *Photo: Eldfrid Engen*

5.1.1 Challenges and nature qualities

Breznik peatlands consists of both raised bogs and fens supplied by upwelling springs. The mires had been drained to improve conditions for the forestry.

5.1.2 Restoration projects

There were built several dams to block drainage ditches in 2006. The work was done manually. The material for the dams where carried from the nearest road and the holes were dug by hand.

5.1.3 Experiences

The water table has been raised, and botanical studies show an expansion of natural mire species. An interesting experience was that there were fewer damages from the bark beetle attack in the waterlogged forests than elsewhere. Because of several natural barriers including severe microclimate, slow growth and released tree canopy, these forests have developed better resistance against disturbances like bark beetle attacks.

Figure 15 *The guide Ivana Bufková shows examples of species living in the raised bogs. The photo shows one of the longest dams that was particularly difficult to construct.* *Photo: Magnus Johan Steinsvåg*

5.2 Cernohorsky mocal mire

5.2.1 Challenges

It is a complex of mountain mires with a total area of 90 ha at the altitude of approx. 1100 m.a.s.l. The wetland types in the area are ombrotrophic peatbogs (in the late successional stage), bog spruce forests and waterlogged spruce forests. The wetland is surrounded mainly by spruce forest.

The mires have been drained in the past, both to increase timber production and also to give way to the Iron Curtain.

In the 19th century the mires were drained by hand dug shallow ditches that had a modest impact on the mires. Later, in the second half of the 20th century there was dug a systematic and deeper network of ditches by usage of modern diggers, which had a far larger impact on the area.

In the 1950s the line of the Iron Curtain was cut through the area in a completely strait line, regardless of nature qualities or other obstacles. All vegetation was removed from the route of the Iron Curtain, and on both sides it was dug a wide and deep drainage ditch. This drained the wetland on both sides of the Iron Curtain, and cut off the natural network of springs and small capillar streams, and caused massive vertical erosion on slopes.

5.2.2 Nature qualities

Several endangered plants grow in the sphagnum spruce mires, amongst them the orchid Lesser Twayblade (*Listera cordata*). These mire forests are priority habitats of Natura 2000, and are described as “relic mire vegetation with rare and relic fauna and flora”. Also capercaillie *(Tetrao urogallus*) still lives in this area.

5.2.3 Restoration projects

The drainage ditches have been blocked by a network of wooden dams. To enhance the terrestrialisation of the ditches they have been filled with masses of natural material and clusters of four different species of *Sphagnum* able to grow floating on water.

Figure 15 *Ditch eroded 3-4 m deep and 6-7 m wide.* *Photo: Ragni Nordås*

Terrestrialisation of the ditches is a particularly difficult challenge along the Iron Curtain where the gradient of the slope is quite steep and the vertical erosion has been massive.

It has been calculated how long the space between each dam should be on steep

gradients to rise water table to a target level, stop erosion and to achieve terrestrialisation of the ditches.

Figure 16 *The dam is built with a double wall with a membrane in the middle to make it waterproof.*

Photo: Ragni Nordås

The dams along the Iron Curtain are built by usage of heavy machines as there is access by road and by the Iron Curtain itself. The digger digs a perpendicular space for each dam across the ditch, and the workers build the dam manually using horizontal wooden boards.

Along the Iron Curtain the peat which was dug was not removed from the site and could therefore be used to infill the ditches. Usually peat has been removed during ditch construction in the past so refilling ditches with peat is impossible. Also bundles of branches are made to be used in the ditches on the slope, to make fine sediments.

Old capillary streams have been restored to let water return into original water courses within the wet forest and across the Iron Curtain.

Figure 17 *Also bundles of branches are made to be used in the ditches on the slope, to make fine sediments accumulate.*

Photo: Ragni Nordås

5.2.4 Experiences

On the top of the hill where the gradient is quite flat one can clearly see that there is terrestrialisation of the ditches in progress.

It is early days in the project, and along the difficult parts of the Iron Curtain the dams are still under construction. There has been no monitoring of the restoration jet, only of the pre-restoration phase.

Figure 18 *Restored stream crossing the Iron Curtain.*

Photo: Ragni Nordås

Figure 19 *(left) Ditch dammed in 2006 with almost no open water surface due to terrestrialisation*
Photo: Ragni Nordås

Figure 20 (*under left) New dams (2014) with blocked channel along the Iron Curtain.*
Photo: Ragni Nordås

Figure 21 *(under right) Contractors building dams along the Iron Curtain.*
Photo: Magnus Steinsvåg

5.3 Rokytecké slatě mire

5.3.1 Challenges

In the early 50ties, the Iron Curtain was established by cutting down all trees in an approximately 20 m wide line through the mire. The removal of the vegetation led to the creation of surface erosion and artificial runoff. During the years to follow this led to the formation of a ditch that drained the surrounding mire. Part of the mire is intact with no measures.

5.3.2 Nature qualities

The ombrotrophic peatbog habitat are priority habitats of Natura 2000, and are described as “relic mire vegetation with rare and relic fauna and flora”. The mire habitat consists of a mosaic of stands of pine (some very dense), small pools and hollows and open areas with mostly grass, sedges and sphagnum species.

Figure 22 *Intact part of the mire.*

Photo: Kjell Carm

5.3.3 Restoration projects

To re-establish the water level the artificial surface runoff has been blocked by building lots of wooden dams. The dams were built manually with help of volunteers in 2011.

5.3.4 Experiences

No peat or other masses were added to the ditch. As can be seen from the picture above the regeneration might take some time, but in some of the small pools the terrestrialisation has started.

Figure 23 *Dams built to re-establish water level.* *Photo: Kjell Carm*

6. Day 5

Guides: Ivana Bufkova and Eva Zelenkova (hydrobiologist)
Referees: Michael Eklo and Astrid B. Haavik

6.1 Hučina stream

6.1.1 Challenges

The Hučina stream was regulated in the 19th century when the stream was channelled for transportation of logs from traditional logging. Originally the river meandered over a floodplain and through spruce mire forests. Forests along the channel were drained. The drainage system and the channel were reinforced in the 20th century, by deepening of the channel which led to an increased drainage of the area.

Biodiversity and stream heterogeneity was strongly reduced. Floodplain, riverine and mire habitats were influenced by the drainage. The floodplain became dominated by *Carex brizoides* (which frequently grows on drained fens), also a results of reduced agricultural activity.

6.1.2 Restoration projects

The main goals for the restoration have been:

1. Restoration of the original stream course with its natural geomorphology, dynamic and flood pulses
2. Restoration of natural hydrology and improvement of water retention in landscape
3. Enhancement of biodiversity

And several considerations had to be taken before restoration:

- Prevent flooding of railway and roads downstream
- Keep historical monument of log floating channel
- Prevent damage to river mussel populations downstream (control over runoff sediments)

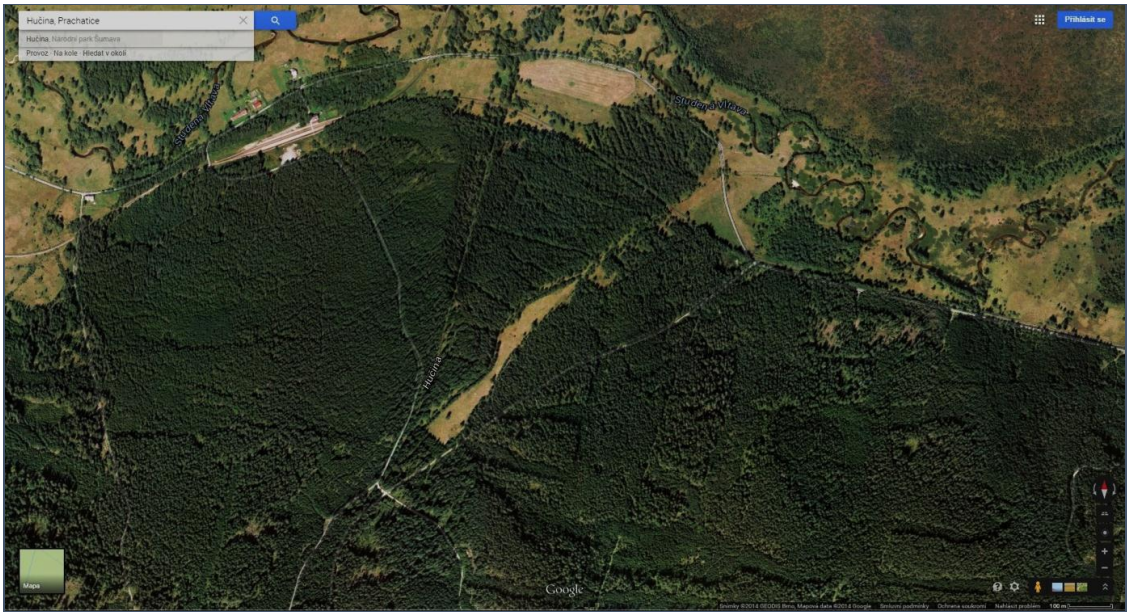

Figure 24 *Aerial photo of the project area. The floodplain and surrounding drained forests are easily seen in the centre of the picture.*

Figure 25 *Eva Zelenkova, Martina Eiseltová and Ivana Bufkova show an aerial photo of the restoration process.*
Photo: Astrid Bakke Haavik

In 2006 2,8 km of drainage ditches were blocked and in autumn 2013 the restoration of the river started. The river was restored by digging out a new meandering course for the river. When planning the course of the river they looked for sediments from the old stream. One of the goals was to prevent vertical erosion (digging down in to the sediments) and to encourage horizontal erosion (meanderings). They also added some woody debris to river course to enhance habitat diversity (for instance; the trout finds places to hide) and enforce natural development of river morphology.
There were several important points to success:

- Keeping a natural river morphology
- Using light machines to reduce negative impact of the digging.

6.1.3 Experiences

The river has responded extremely well to restoration and only a year after there is few signs left to tell that the river had been constructed.

- Because there was no big flooding spring 2014, the dug-out river had a chance to recuperate and stabilize. This is believed to have had a very positive effect on the restoration
- The remains of the channel (not historic monument) were filled with masses from the channel sides and from the dug up riverbed
- Limnological fauna has been quick to return to the restored river
- Part of the wood-floating channel is today protected as a historic monument, and some of the water from the river is diverted to this channel. This works as a flood diverter to protect the railway and roads downstream of the river.

Figure 26 *A section of the restored river in alluvial meadows in Hučina river system. Notice the woody debris in the photo to the left. They will enhance habitat diversity*
Photos: Magnus Steinsvåg

6.2 Soumarsky most

6.2.1 Challenges

The only industrially harvested peat bog in Sumava NP. The area was harvested by machines from 1960's to 1998. Peat was extracted from a total area of 75 ha. NP administration stopped peat mining in 1998 after negotiations with the private owner to restore the area as a wetland. There is normally an obligation by law to restore a peat-mined area after extraction, but either as agricultural land or forest. The peat was exposed on the surface. The local town restituted ownership of the bog and thus many negotiations were made to convince it about the benefit of the restoration process.

Figure 27 *Aerial photo of Soumarsky most. The areas with former peat extraction are easily seen in the photo*

6.2.2 Restoration projects

Project started in 2000-2004. The main goals were restoration of a mire wetland almost completely destroyed by industrial peat mining and the establishment of wetland communities and peat forming vegetation. They planned for possible return of relict peatbog species in parts with high water table and low nutrient contents.

To reach the goals ditches were blocked and mulch from adjacent mire meadows was added to the bare peat to reduce extreme

Figure 28 *View from the observation tower in Soumarsky Most peatland. The bare peat is slowly being colonized by plants, especially Eriophorum tussocks*

Photo: Astrid Bakke Haavik

Figure 29 *A small pool in Soumarsky most peatland is a results of the increased water table caused by blocking drainage ditches. These pools are important habitats for several groups of insects including dragonflies.*

Photo: Astrid Bakke Haavik

temperature fluctuations and evaporation from the peat surface. This also enhanced colonization in to bare peat because of seeds of sedges and spores of sphagnum from the mulch. Spagnum mosses were reintroduced into shallow basins. In addition tufts of *Eriophorum angustifolium* and *Carex rostrata* were planted in the peat to increase plant cover and recolonization. It took10 years to raise enough money to start stage two of the restoration process.

6.2.1 Experiences

The main factor facilitating successful regeneration of peatbog vegetation was the restoration of the water regime. The colonization process was strongly accelerated by experimental planting of *Carex rostrata* and *Eriphorum angustifolium*. Common cotton grass spread very successfully. Margins of flooded areas and shallow basins were colonized by reintroduced Spagnum species. Dry parts of the site were mostly colonized by trees as *Betula pubescens* and *Pinus sylvestris*. Today 2/3 of the surface area is covered with vegetation. Cover of sphagnum increased from 1 % in 2002 to 8 % in 2007.

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Figure 30 *The participants (from left): Katarina Slabeyova, Astrid Bakke Haavik, Magnus Steinsvåg, Stein Byrkjeland, Mia Husdal, Eldfrid Engen, Kjell Tore Hansen, Trond Vidar Vedum, Michael Eklo, Kjell Carm, Astrid Brekke Skrindo, Přemysl Tájek, Ola Betten, Ragnhild Skogsrud, Janicke Haug, Pavla Trachtova, Oddny Gudmundsdottir and Ragni Nordås*

Photo: Libuše Vlasáková

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