Restoration of drained and mined mires

in the Sumava National Park

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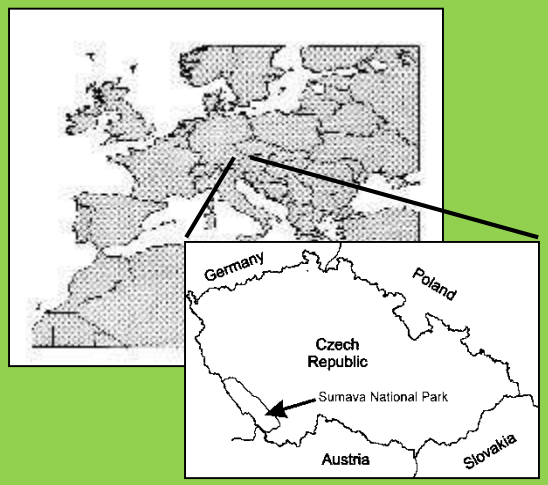
Mires and wetlands in the Sumava NP



Code	Habitat* (abbr.)	Area (ha)
7110*	Active raised bogs	373
7140	Transition mires and quaking bogs	959
7120	Degraded raised bogs	83
91D0*	Bog woodland	3001
(9410 part)	Waterlogged spruce forest	6739
6410	Molinia meadows	120
91E0*	Alluvial forests with Alnus	155
3260	Water courses	76

ŠUMAVA NP (70 000 ha)	Area (ha)	% NP
Mires	6 566	**10**
Other wetlands	14 930	**21**
All wetlands - total	20 536	**31**

Distribution of mires in the Sumava NP

valley raised bogs
with bog pine forest

minerotrophic mires

(mainly spruce mires and poor fens)

upland mountain raised bogs

valley raised bogs

- ❑ **more than <u>6000 ha of mires</u>**
- ❑ **in altitudes 700-1200m a.s.l.**

1990 – Ramsar Site Sumavska raseliniste peatlands

Mires (NP total)	**6 566 ha**	**10 %**
bogs	**1 587**	**2 %**
minerotrophic mires	**4 982**	**8 %**

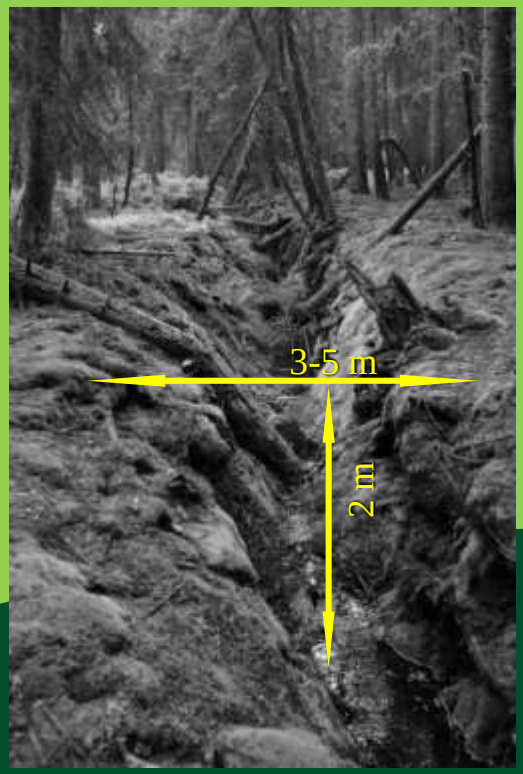
Human impacts – changed hydrology

Past drainage

- about **70% of mires** have been **drained** in the past
- and more than **50% of other wetlands**

- mostly **open ditches**
- **subsurface drainage** ca 230ha
- regulated small streams – ca 20km

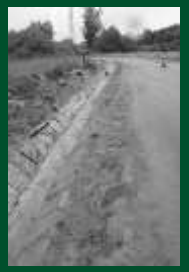
Fens drained for agriculture



Bog forest drained by use of explosive

- for timber production, agriculture, accessibility and peat cutting
- in the 19th and second half of 20th century
- about **2000 ha of mires** and **7000 ha of other wetlands** have a problem

Subsurface drainage



Drainage along road network

Peat extraction

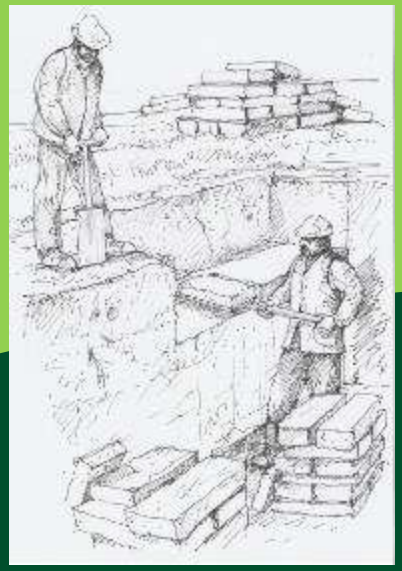
Manual peat extraction

- in 18. and 19th centuries, adjacent to settlements
- about **38 sites** with estimated area of **510ha**

Industrial peat cutting

- in the second half of 20th century (up to 2000)
- 1 mined bog inside the **Sumava NP (50ha)**
- **4 sites** (ca 200ha)
- impossible spontaneous regeneration

Manually cut bog – Jezerní slať



Mined peat bog Vlčí Jámy

Mined peat bog Soumarský Most

Restoration Programme on Mires and Wetlands

- **long-term** programme
- **pilot project in 1999** (Kamerální slať)
- **drained and mined** mires and **other wetlands, regulated streams**

Main approach **:**

- **Restoration of abiotic condition – rewetting** for restarting peat-forming processess, ecological functions and biodiversity
- **One-off measures** (restored sites are left to spontaneous development)
- **Holistic approach**: hydrological units, from upper to lower catchment, stated priorities, linked to monitoring and communication
- **Long-term conception** (since 2004, updated 2012)

Main Restoration Goals – changing with time:

biodiversity → **landscape hydrology** and **water retention** → **climate change** impacts

Restoration in montane condition

- ***sloping gradients***
  - increasing of WT along the **sloping ditches**
  - **high risk of erosion**
- ***small vulnerable habitats***
  - **high risk of damage**
  - **lack of peat** for infilling of ditches
- ***low accessable areas***
  - limited use of technique
  - limited transport of material, equipment

Different technology
from flat lowland or boreal landscapes

Restored sloping montane mire

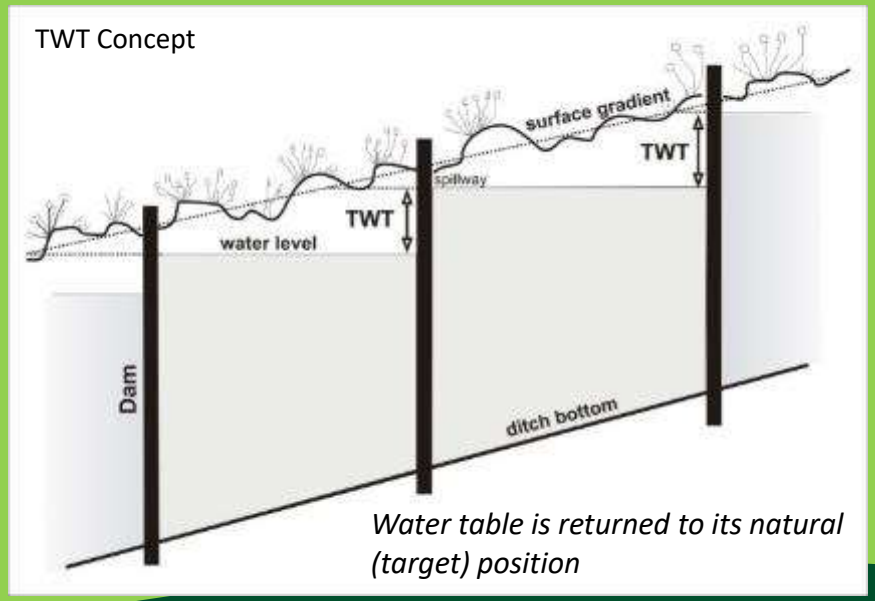
Flat boreal landscape – paradise for mire restoration

Stikliklani - Latvia

Main restoration methods

- „rewetting“ of wetlands
- blocking of drainage ditches
- cascade of woody dams and infilling of ditches

Target Water Table Concept



- **Target Water Table (TWT)** corresponds to natural WT table
- TWT is different for distinct mire types
- TWT together with surface gradient determine number and distribution of dams along the channel

Instalation of woody dams

Vertical plank dam

Horizontal board dam

- **manually** in most valuable sites
- **light excavators** on dry disturbed sites

Various types of dams

- vertical **plank dams** (deep peat layer, peaty bottom, bogs)
- horizontal **board dams** (shallow peat, mineral bottom)
- **peat dams** (flat valley sites, peaty bottom, alternately with woody dams)
- combined **double dams** (large channels)

Infilling of dammed ditches – important phase of restoration

- **Prevention of erosion**
- Enhancing **terrestrialisation**
- Enhancing **peat-forming processess**
- **Competition with time** (and decomposition)
- Upper shallow water (30-50cm) left

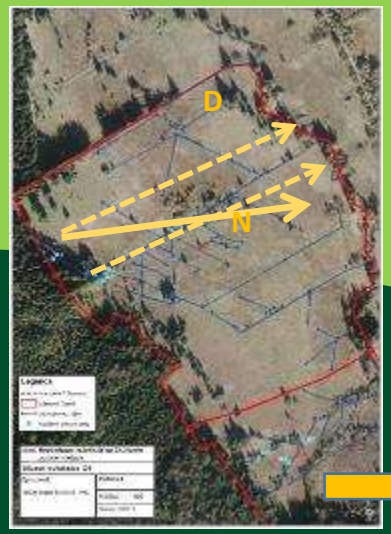
- **Peat** (optimal but lack of material)
- **Mineral soil, vegetation tussocks** (outside of bogs)
- **Hedges** (clustres of branches) – well used
- **Vegetation**

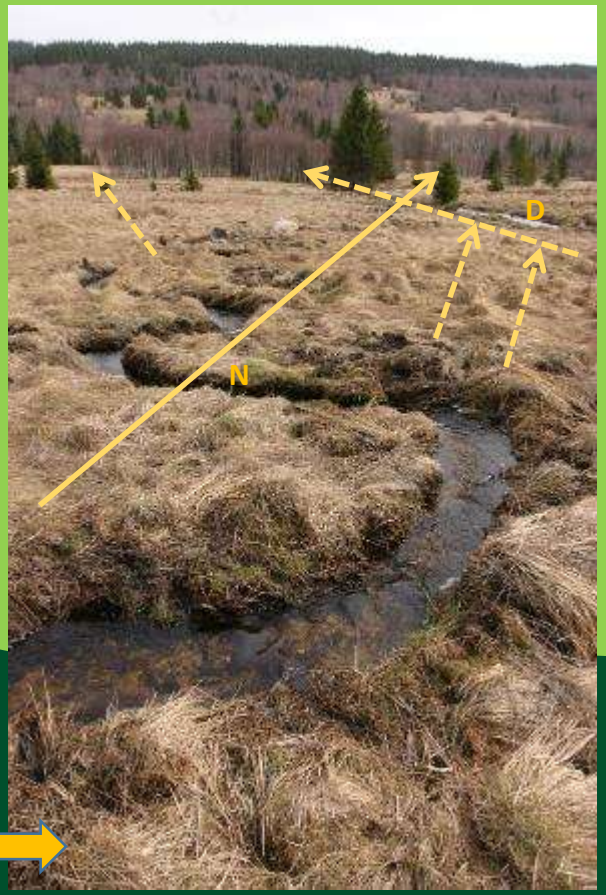
- **Shallow ditches** are able of quick spontaneous terrestrialisation
- **Large and deep channels** need support
- **Re-vegetation** by *Sphagnum* clusters and other mire and wetland species

Nine years after restoration (2015)

Re-establishment of natural water flows!!

- **Natural movement of water** – subsurface, surface
- **To divert water back onto the mire/wetland**
- **Restoration of springs and capillar streams** (usually incorporated into drainage system)
- **Interlinking with restoration of regulated streams**

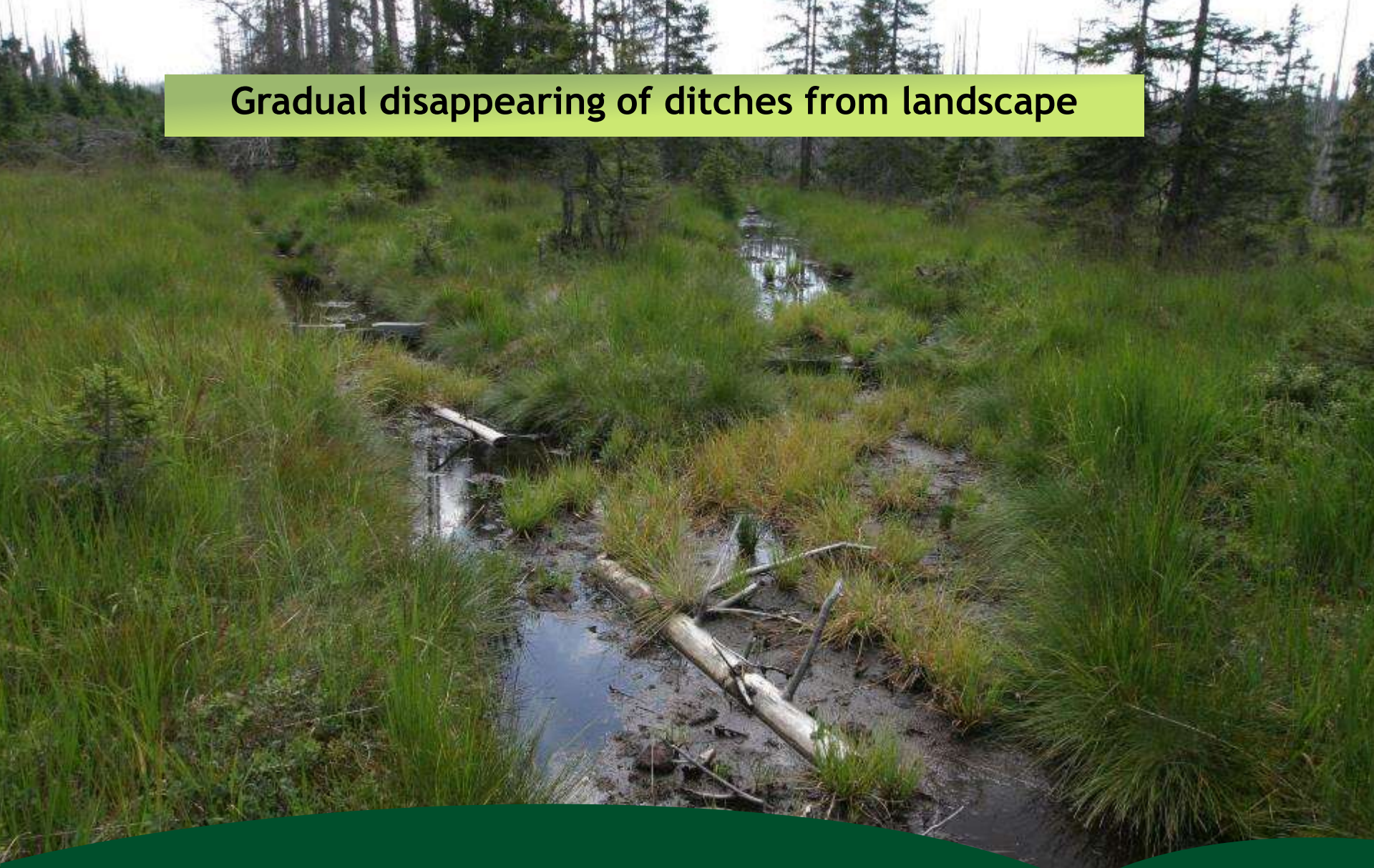




Use of machines wherever possible

- Shift from manual work towards using of light machines
- **Limits**: risk of damage (peat subsidies, mechanical damage, surface erosion tracks)
- **Advantages**: more stabile and effective ditch damming and infilling, lower risk of erosion, restoration of capillar streams

Gradual disappearing of ditches from landscape

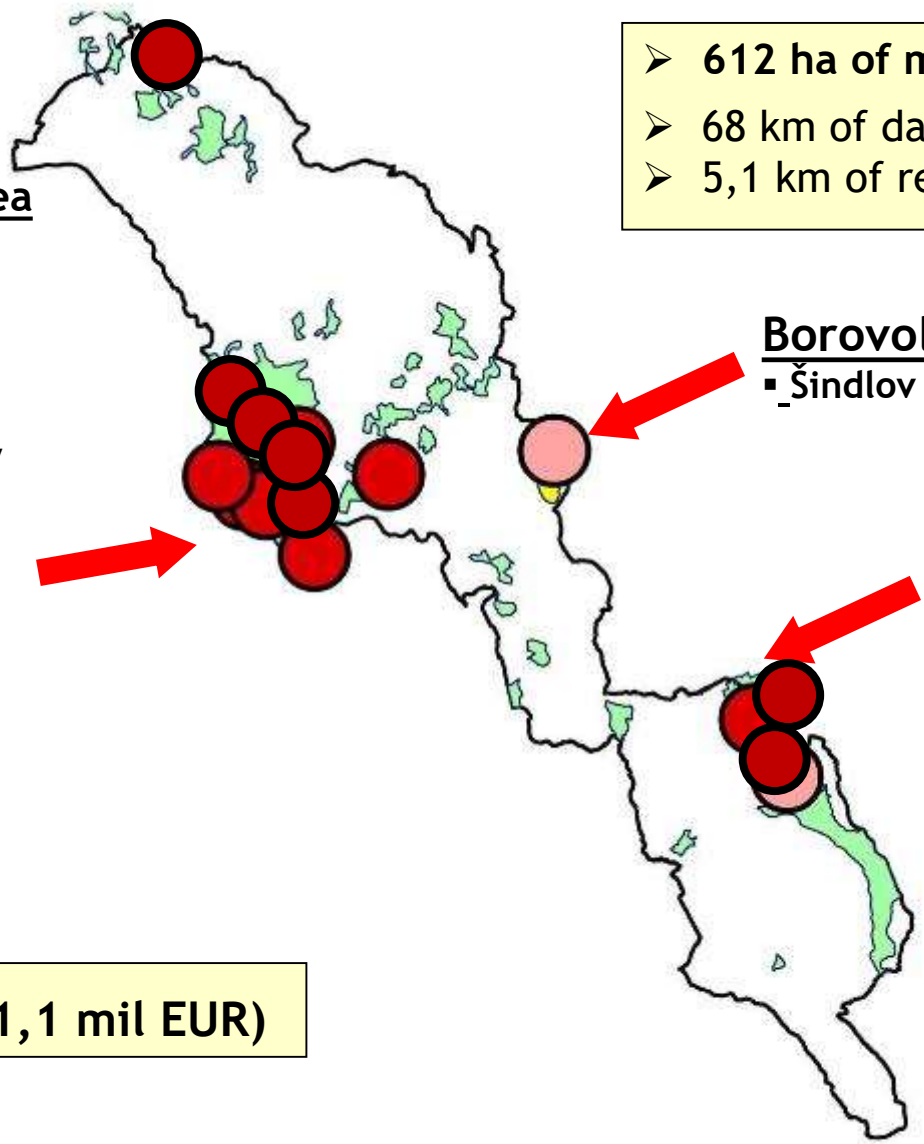


- about 612 ha of mires was restored until 2016
- more than 68km of drainage ditches were blocked

„People for mires“

- **involvement of public** into mire restoration
- **volunteer** events („**Days for mires**“)
- regularly since **2008**
- **restoration work** combined with the guided **excursion**
- contrast of disturbed and natural sites
- about **680 people** participated at total
- easy **registration via web** http://www.npsumava.cz/

- **612 ha of mires and wetlands**
- 68 km of dammed ditches
- 5,1 km of regulated streams



central upland area Modravské slatě

- Kamerální slať
- Černohorský močál
- Vrchové slatě
- Novohuťské močály
- Cikánské slatě
- Blatenská slať
- Luzenské údolí
- Ptačí nádrž
- Nad Rybárnou
- Schachtenfilz
- Na Ztraceném
- Zhůří-Hadí vrch
- Rokytecké slatě

Borovoladsko

- Šindlov

Vltavský luh

- Soumarský Most
- Malý luh
- Hučina
- Žlebský potok
- Jedlový potok

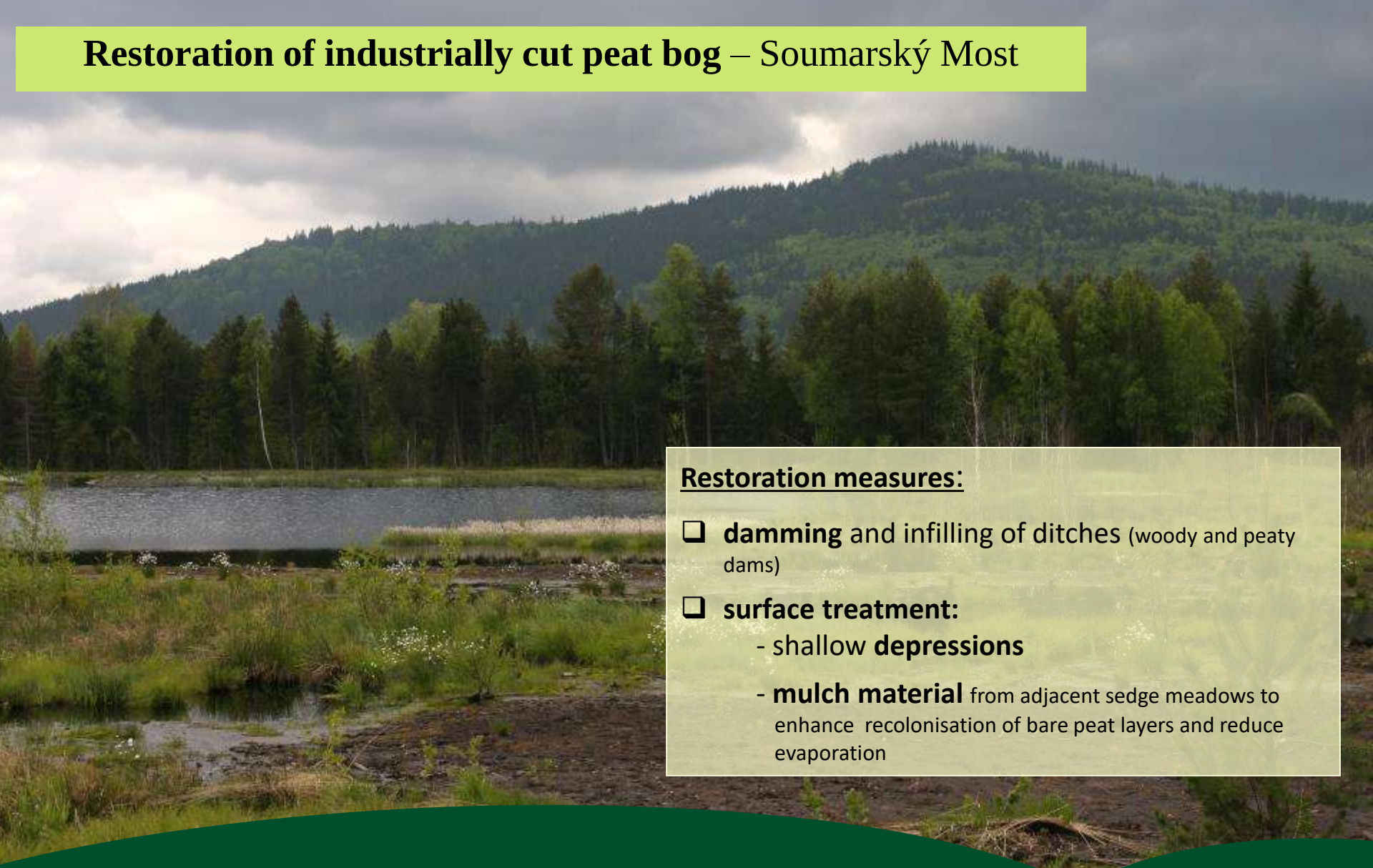
- **29 mil CZ (1,1 mil EUR)**

8 years after restoration

Drainage along former „Iron curtain“ – Černohorský močál mire II phase

- 80ha
- 2013-2014
- 1,8km of blocked ditches
- restored small stream
- 115 000 EUR

Restoration of industrially cut peat bog – Soumarský Most



Restoration measures:

- **damming** and infilling of ditches (woody and peaty dams)
- **surface treatment:**
  - shallow **depressions**
  - **mulch material** from adjacent sedge meadows to enhance recolonisation of bare peat layers and reduce evaporation

total area: 70ha

valley raised bog with bog pine forest

implementation: 1999-2006

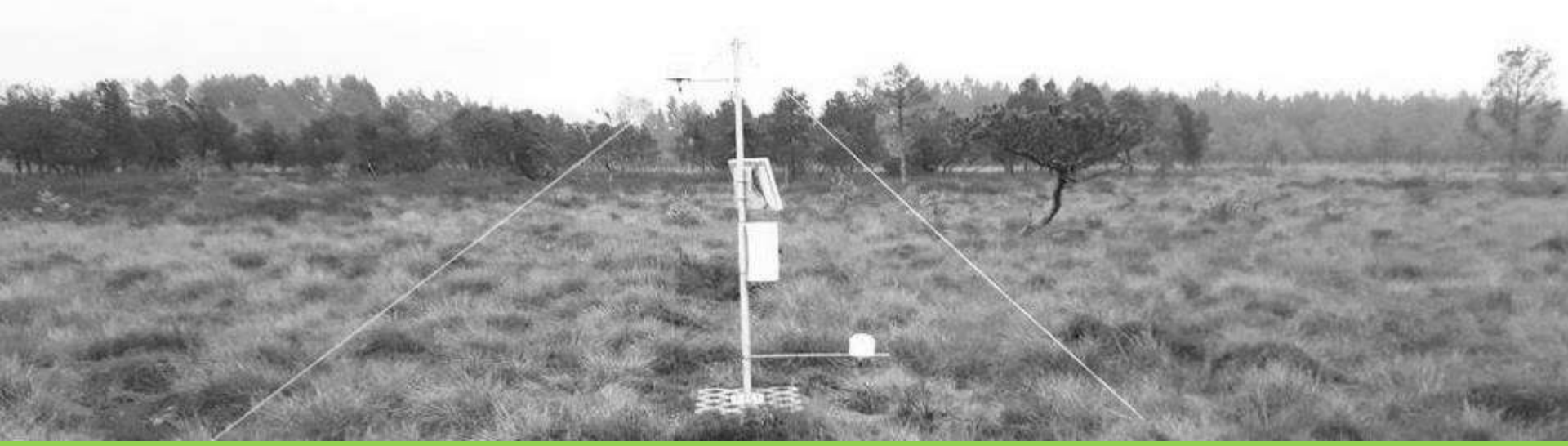
Best practices for mire and stream restoration: Hucina – holistic approach

Best practices for stream restoration: Hucina - return of the stream

Mire monitoring – evaluation of restoration success

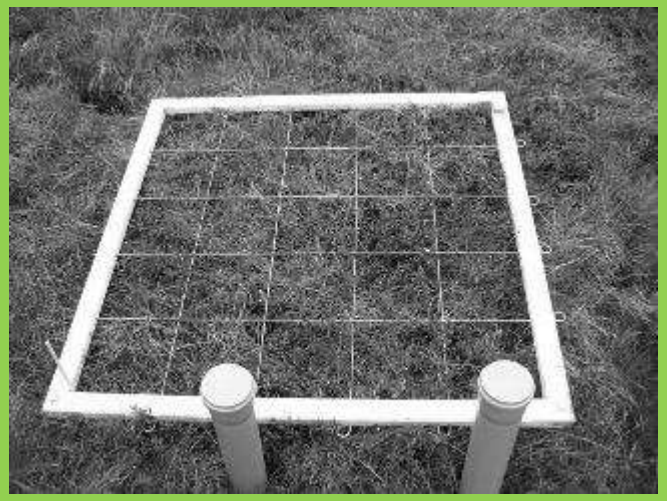
– restoration is closely linked to mire monitoring

- What are impacts of restoration on hydrology and microclimate?
- Could restoration influence water quality and runoff?
- Is re-starting of peat forming processess possible?
- How restoration is reflected in biodiversity?
- Do different mires respond to restoration in the same way?



Monitoring of restoration impacts

1. Impact on **water retention and quality**
2. Impact on **water table**
3. Impact on soil processess, **peat accumulation and decomposition**
4. Greenhouse **gas emission**– CO_2
5. Impact on **vegetation** and rare species
6. **Microclimate** conditions – cooling effects
7. **Socio-economic impacts**



- **118 boreholes with adjacent permanent plots**
- **pre-restoration phase – 3 years**

Transboundary monitoring of mires CZ and GER

Common monitoring design
NP Sumava and NP Bavarian Forest

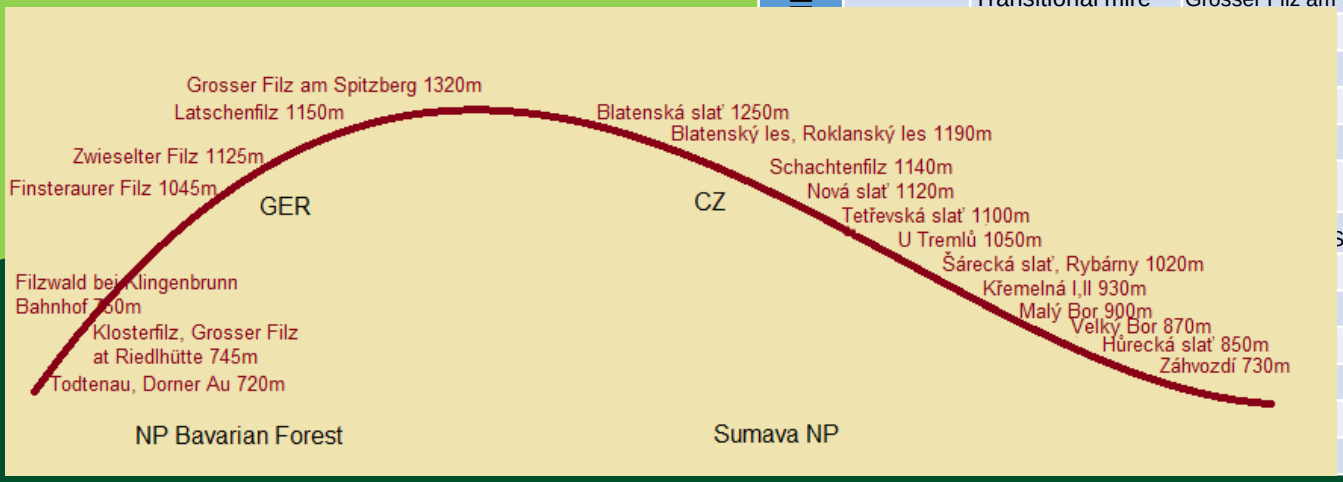
Interreg project: „Silva Gabreta Monitoring – Implementation of cross-border monitoring of biodiversity and water regime"

- **37 mire sites** (22 CZ/ 15GER)

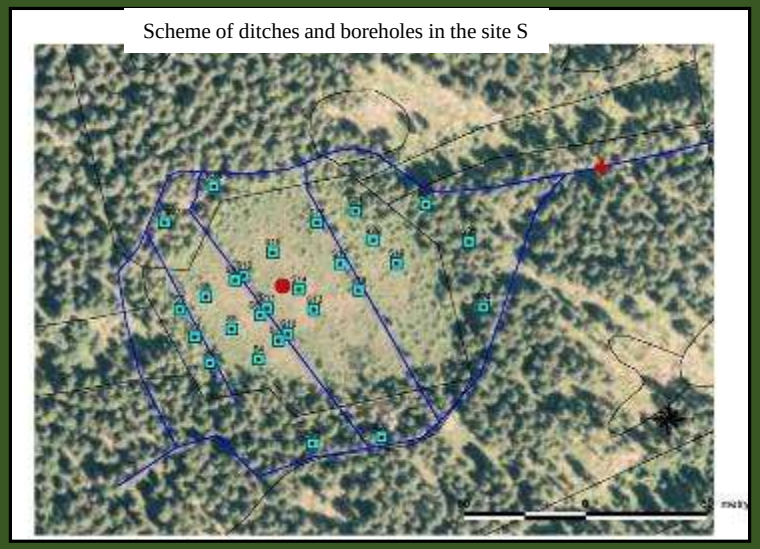
Key measured variables:

- **WATER TABLE**
- **HYDROCHEMISTRY** (pH, konduktivita, DOC, SO4, NO3, NH4, PO4, Ca, Mg, Al, Fe)
- **VEGETATION**
- **MICROCLIMATE** (air and soil temperature and moisture)

Site			Name	Code	State	Altitude	Start
OMBROTROPHIC BOGS	Control	High raised bog	Grosser Filz am Spitzberg	1	GER	1320	2017
			Zwieselter Filz	Z	GER	1125	2017
			Blatenská slať	B	CZ	1250	2005
			Šárecká slať	SAR	CZ	1020	2008
		Valley raised bog	Klosterfilz	KL	GER	745	2017
			Todtenau	TA	GER	720	2017
			Dorner Au	DA	GER	720	2017
			Záhvozdí	ZAH	CZ	730	2015
			Hůrecká slať	HS	CZ	850	2017
	Disturbed	High raised bog	Finsterauer Filz	F	GER	1045	2016
			Schachtenfilz	SCH	CZ	1140	2005
			Rybárny	R	CZ	1020	2005
			Křemelná I	KI	CZ	930	2008
			U Tremlů	UT	CZ	1050	2017
		Valley raised bog	Großer Filz at Riedlhütte	GR	GER	745	2017
	Control	Spruce mire	Latschenfilz				
RES			Filzwald bei Klinge Bahnhof				
			Tetřevská slať				
			Blatenský les				
			Hůrecká slať				
		Transitional mire	Grosser Filz am Sp				
				Spi			
				KII	CZ	930	2008



Methods - monitoring design

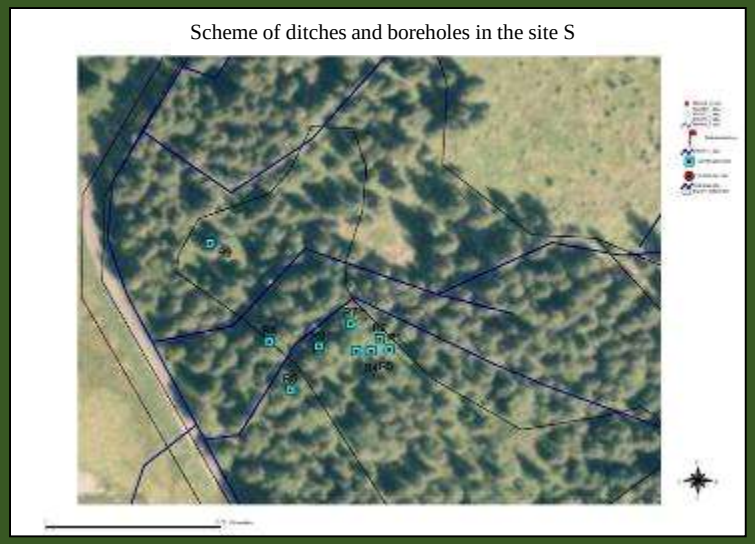


drained → before restoration (3 years) → after restoration

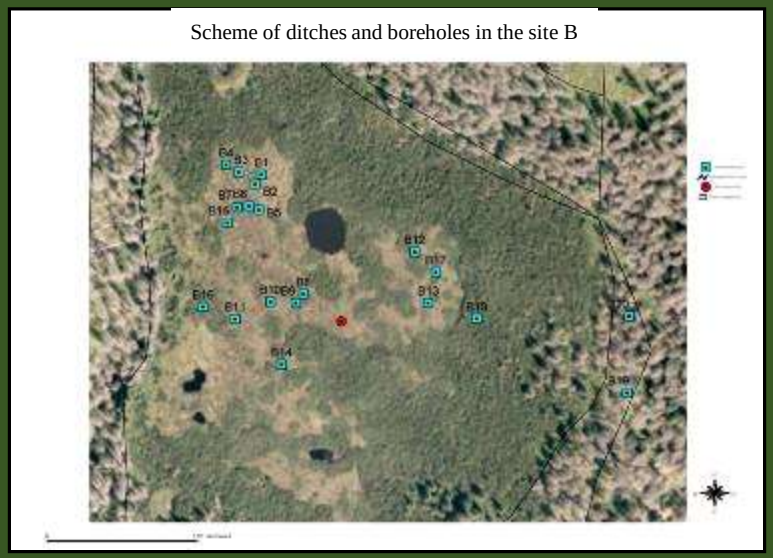
drained → intact

habitats: - bogs, spruce mires, poor sedge fens, mire meadows

2008 – restoration of drained sites

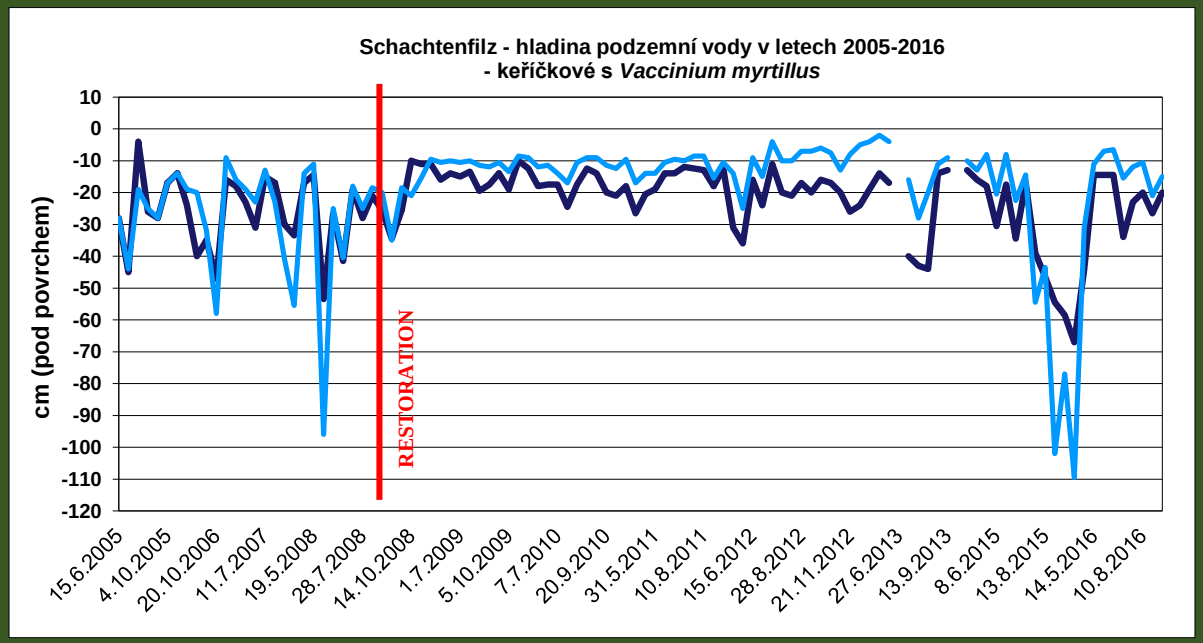


Nad Rybárnou – heavy drained



Blatenská slať - intact

Hydrological response of different mires to rewetting

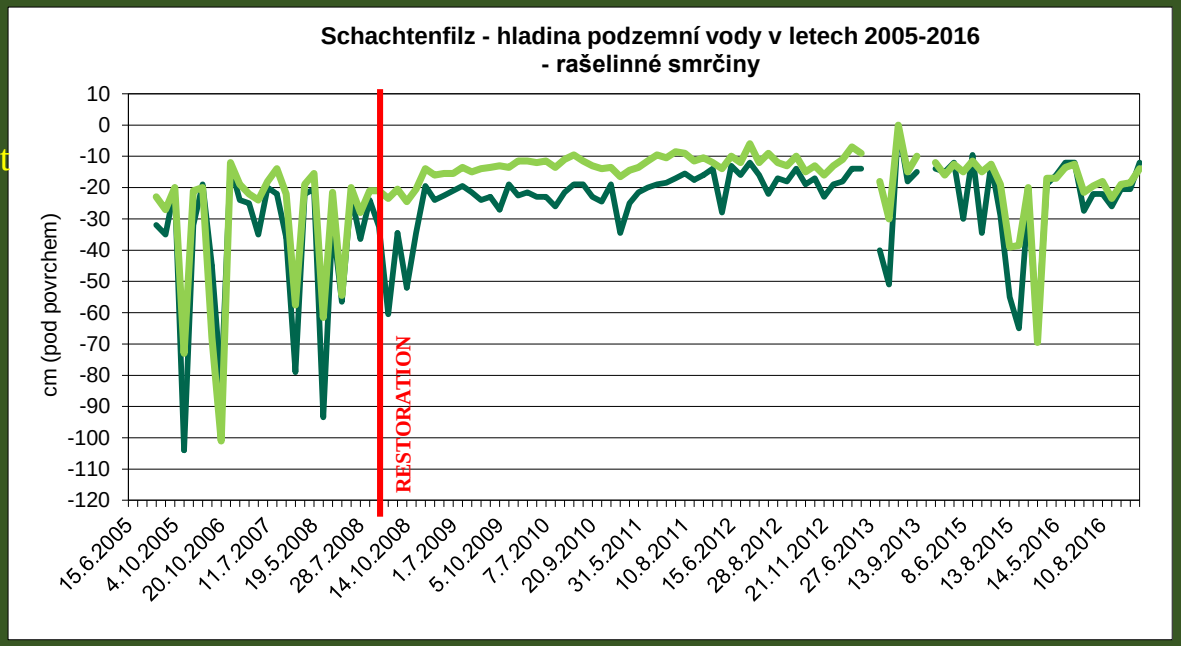


Ombrotrophic bogs

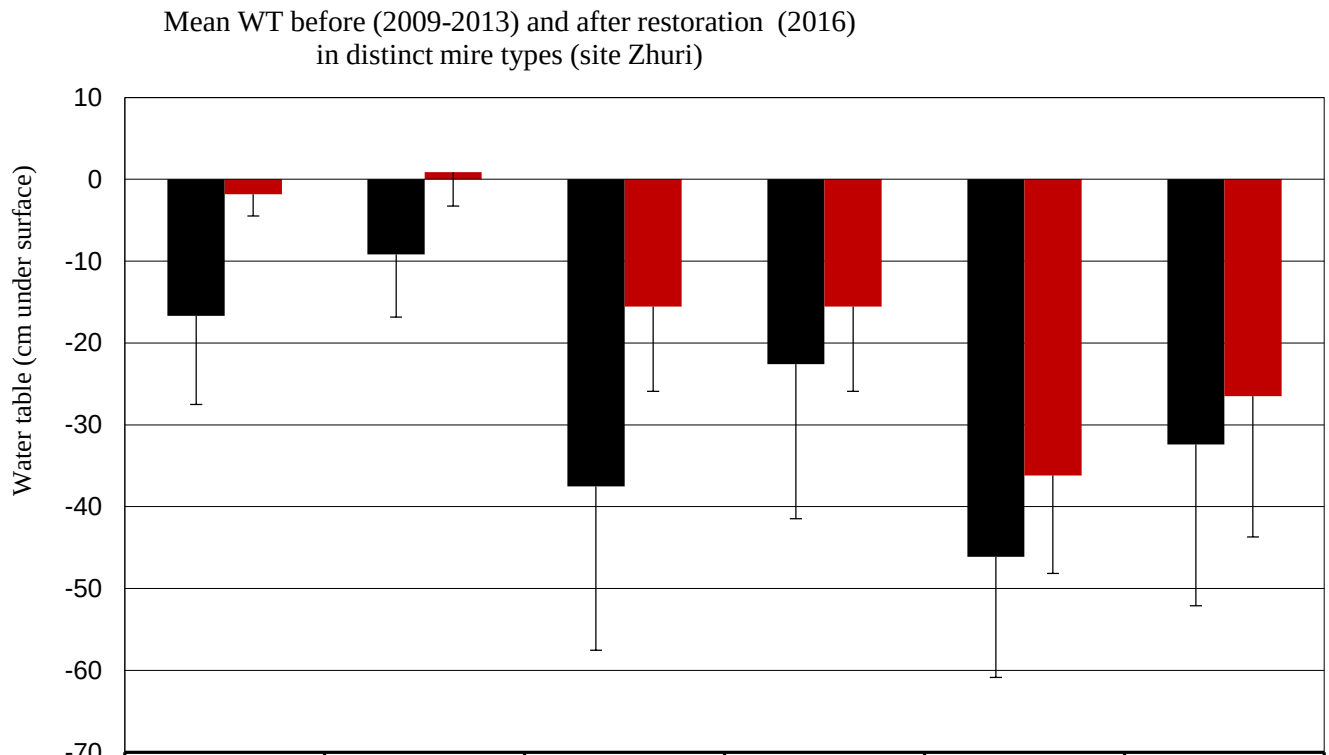
- immediate quick response
- water table raised up
- amplitude of WT fluctuation decreased

Bog forest

- similar to raised bogs
- more stabile WT during extreme drought



Minerotrophic sedge mire - blocked ditches and restored capillar outflows

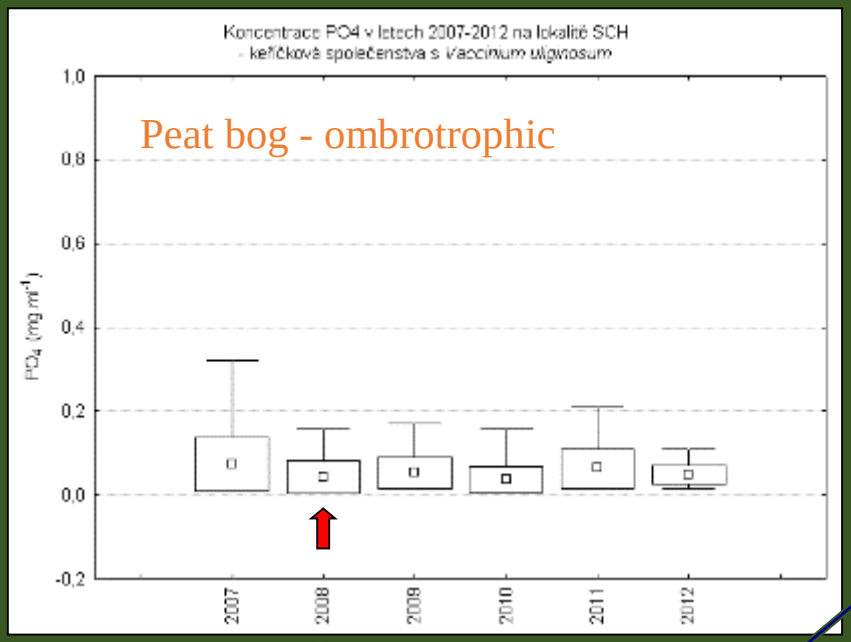


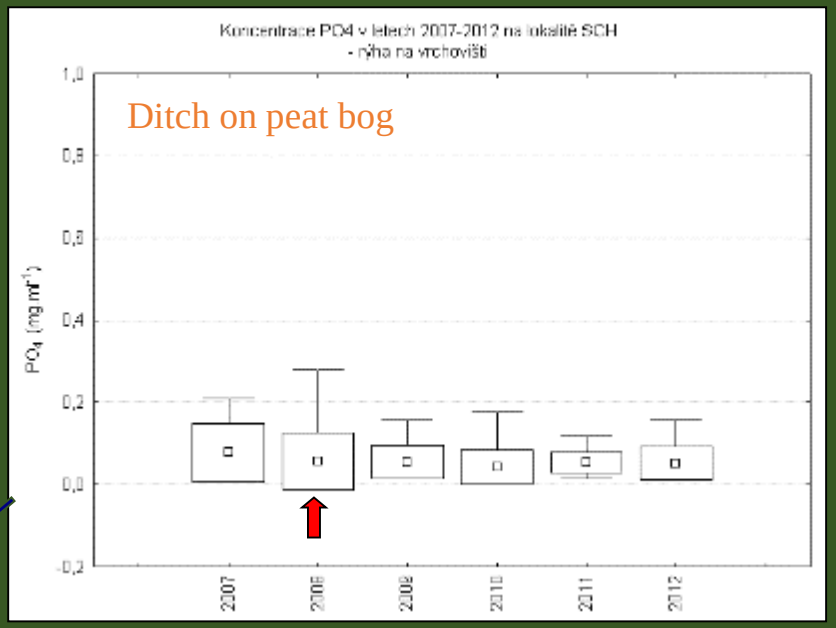
	poor fen near ditch	poor fen ditch 20m	bog near ditch	bog ditch 20m	mire meadow near ditch	mire meadow ditch 20m
2009-2013 pre	-17	-9	-38	-23	-46	-32
2016 post	-2	1	-16	-16	-36	-27

- Restoration 2014-2015 (blocking ditches and restored capillars)
- Best hydrological response
- MAX values of WT during dry year 2015

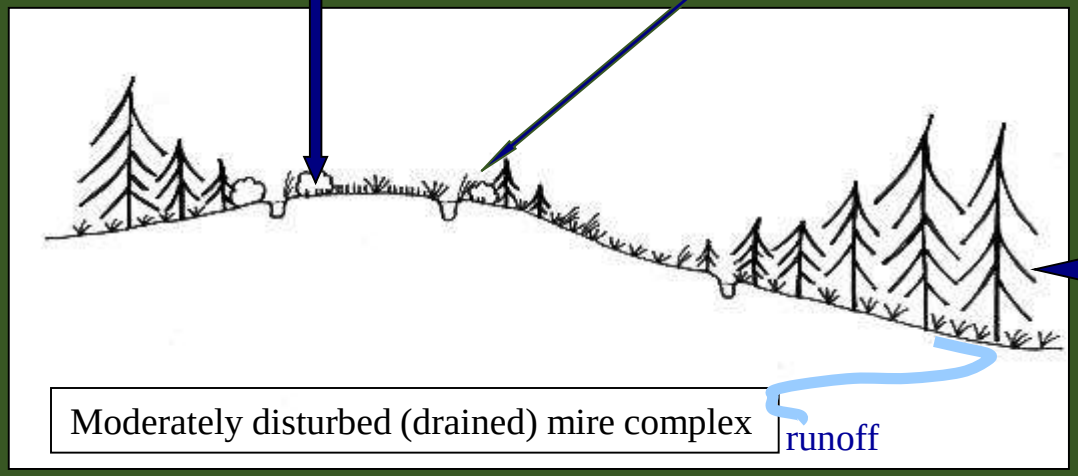
Different hydrochemistry response of different mires!

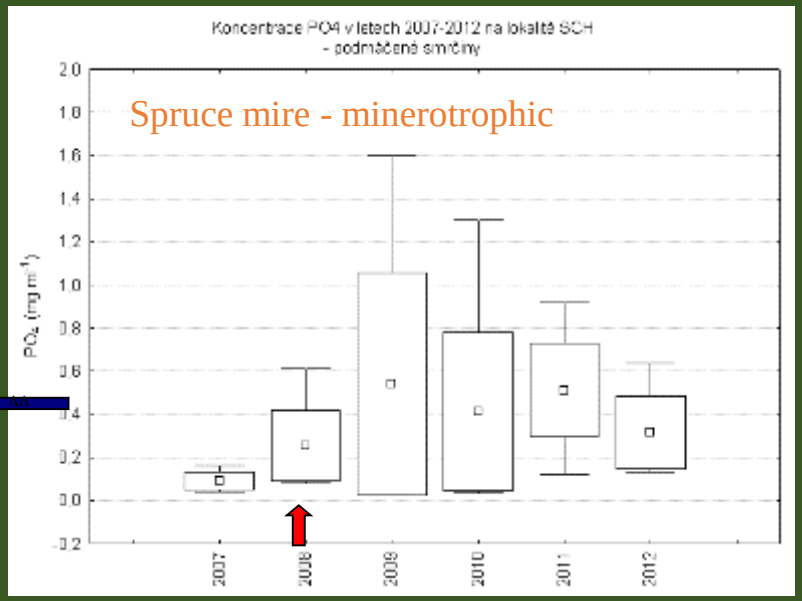
Phosphates - PO4





RESTOR





Positive effect of reatoration on mire vegetation

- spontaneous re-development of **wet** surface features (hollows) 4 years after restoration
- re-development of mire-forming vegetation – proportion of *Sphagnum* mosses
- rare species – *Listera cordata* – 2008 (50 palnts), 2012 (ca 400 platnts)

Conclusions

- **Target Water table Concept** - appropriate for restoration of sloping mountain mires
- Infilling of ditches has to be combined with blocking by woody dams in sloping surface (erosion)
- **About 78% of restoration measures could be assessed as succesful**
- **Land ownership as a key limit** for restoration measures

- **Positive hydrological response** – but still reflects extreme dry periods
- **Hydrochemical response is different for distinct mire types**
- **Response of minerotrophic mires is much pronounced**
- **Early and longterm response can be different**

Prepared next estoration phase (2018-2023) – ca 2000ha of mires and wetlands, applied for LIFE project in September 2017

LIFE Nature and Biodiversity

Third restoration phase started in 2018

Trans-boundary Restoration of Mires for Biodiversity and Landscape Hydrology in Sumava and Bavarian Forest

„LIFE for MIRES“

2018-2024

LIFE for MIRES

Motto: Landscape without wetlands is landscape without water

Transboundary project

- **4 partners:**

  Coordinating beneficiary:
  Administration of the Sumava NP

  Associated beneficiaries:
  Bavarian Forest National Park
  Bund Naturschutz Bayern e.V.
  University of South Bohemia

- **Project activities – 3 main blocks:**

  - **Restoration almost 2000ha of mires and wetlands**
    - Drained mires
    - Mined peat bog
    - Bog woodlands
    - Tetrao terix
    - Hydrological links
    - Mires in vicinity of human residences
  - **Monitoring**
    - water, vegetation, species, soil, climate, socio-economic impacts, ecosystem services, performance indicators
  - **Communication**
    - Awareness raising, project promotion
    - Involvement of public
    - Local stakeholders
    - Networking
    - Replicability, transferability

Thank you for your attention

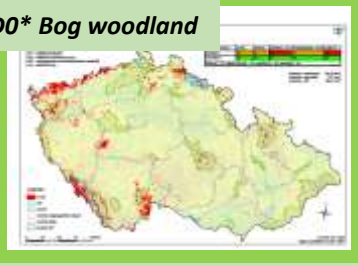
Landscape without wetlands is landscape without water

Restoration team: Ivana Bufková, Eva Zelenková, Franišek Stíbal, Jan Mokrý

Wetlands in the Czech Republic

91E0 Alluvial forests with Alnus*

91D0 Bog woodland*



7140 Transition mires and quaking bogs

Code	Habitat* (abbreviated name)	Area (ha)
3150	Natural euthrophic lakes	6970
3260	Water courses	1896
6410	Molinia meadows	8571
7110*	Active raised bogs	852
7120	Degraded raised bogs	599
7140	Transition mires and quaking bogs	5167
7150	Rhynchosporion	16
91D0*	Bog woodland	16649
91E0*	Alluvial forests with Alnus	31112
(9410 part)	Waterlogged spruce forest	30205
91F0	Riparian mixed forest of Quercus	22979
	Springs	1095
	Wet meadows	82628

selected habitats only

320 000 ha of wetlands in total
(4% of the area)

Alarming state of wetlands in the Czech Republic

- even in marginal and protected areas
- not only heritage from the past

MIRES:
total area has been reduced from ca 31 000 ha in 19th century to only 15 000 ha (2015)

DRAINAGE OF WETLANDS IN THE CZECH REPUBLIC

- subsurface pipe drainage = 1,5 mil ha of agriculture land (1/4)
- additional surface drainage – 12 000 km of surface ditches on agricultural land
  - unknown extent but many thousands km of ditches in forests
- **only 350 000ha wetlands left from original more than 1,3mil. ha**