



# FORRISK

Cross-border forest risk management

BOKU/MENDELU/BAB





## **FORRISK Output T1.2 – Manual for risk management**

- **Identifikation gemeinsamer Probleme und Synthese der besten forstwirtschaftlichen Praktiken/ Identifikace společných problémů a syntéza příkladů dobré praxe v lesnictví**
- **Handbook: Manual for risk management**  
-> preliminary results - status



*Folgende NUTS III-Regionen gehören zum Programmgebiet:*

**Österreich:**

Mostviertel-Eisenwurzen, Sankt Pölten, Waldviertel, Weinviertel, Wiener Umland-Nordteil, Wien, Innviertel, Linz-Wels, Muhlviertel, Steyr-Kirchdorf

**Tschechische Republik:**

Jihočeský kraj, Kraj Vysočina, Jihomoravský kraj

The damage situation in the forests of the border region, which has persisted for years poses major problems and challenges for forest owners, authorities and stakeholders at the cross-border region Austria and Czech Republic.

In the FORRISK project, operational and administrative procedures for dealing with the bark beetle crisis situation are identified.





Region	mean annual temperature [°]	mean annual precipitation [mm]
Jihocesky Kraj [SB]	7,1 - 8,1	650 - 710
Vysocina Region	7,2 - 8,2	650 - 680
Jihomoravsky Kraj [SM]	8,3 - 9,6	540 - 560
Mühlviertel	6,2 - 7,3	700 - 1000 (1100)
Waldviertel	6,6 - 8,9	500 - 700 (1000)



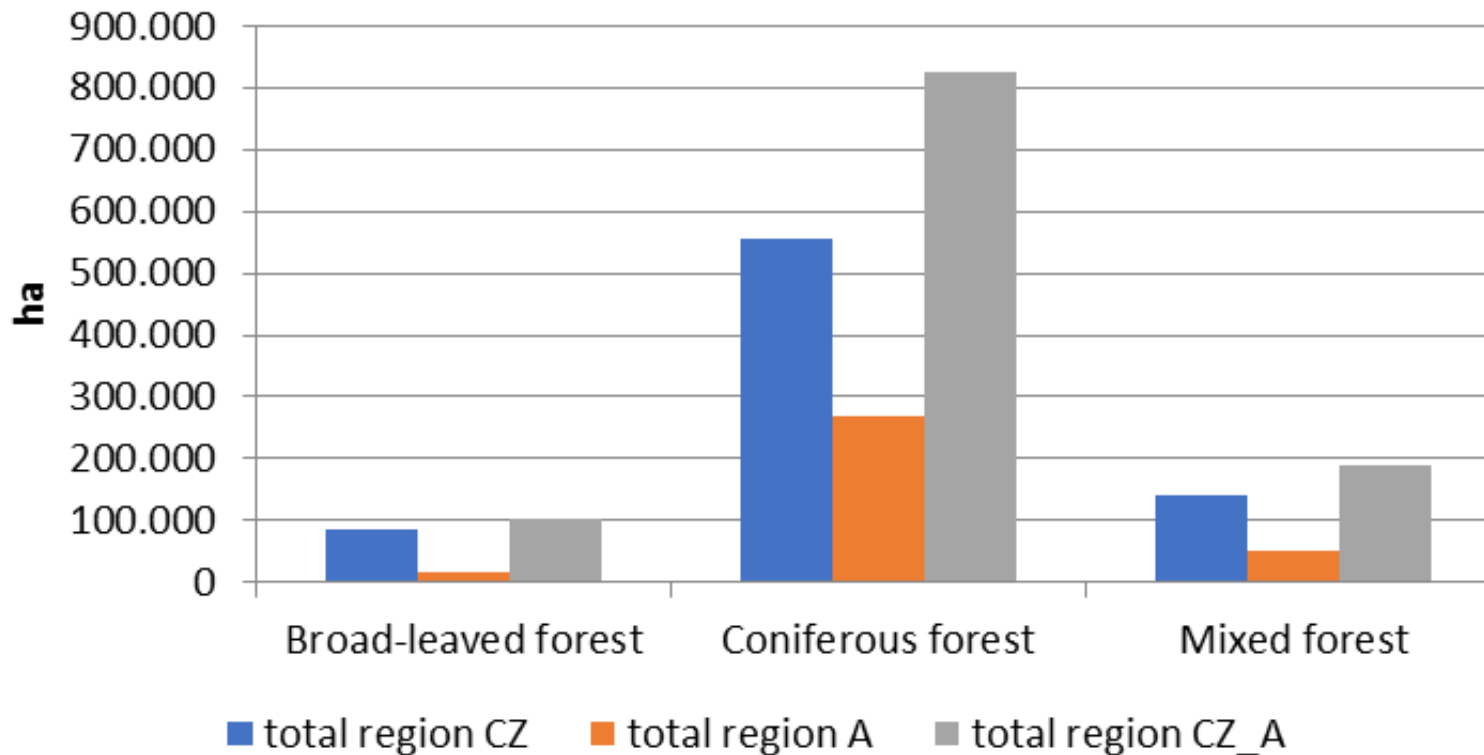
Region	total [ha]
<b>Jihocesky Kraj [SB]</b>	<b>368.800</b>
<b>Jihomoravsky Kraj [SM]</b>	<b>189.700</b>
<b>Vysocina Region</b>	<b>201.100</b>
<b>Mühlviertel</b>	<b>127.000</b>
<b>Waldviertel</b>	<b>127.000</b>
	<b>1.013.600</b>



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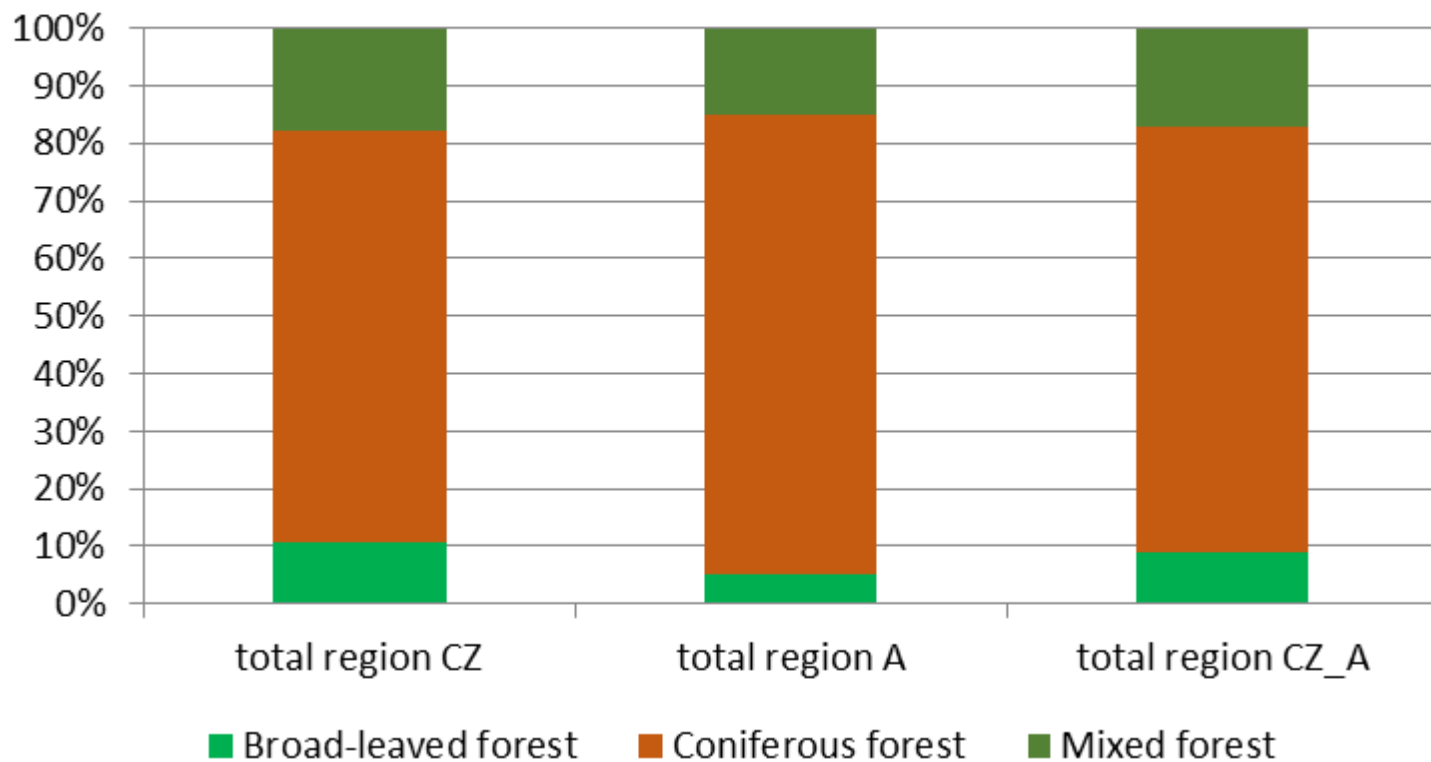
## Bestandestypen/stand types





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## Bestandestypen/stand types





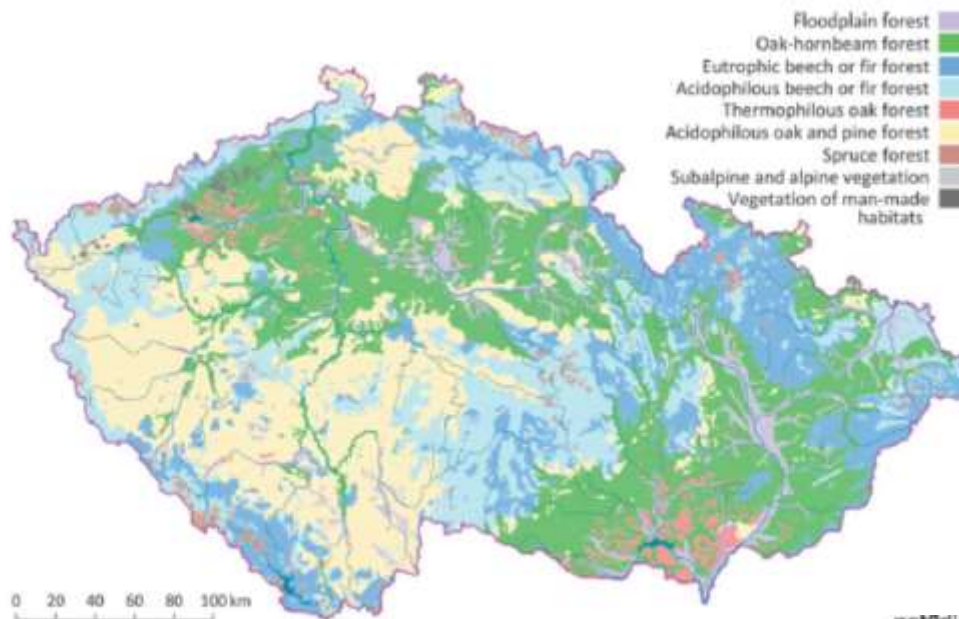
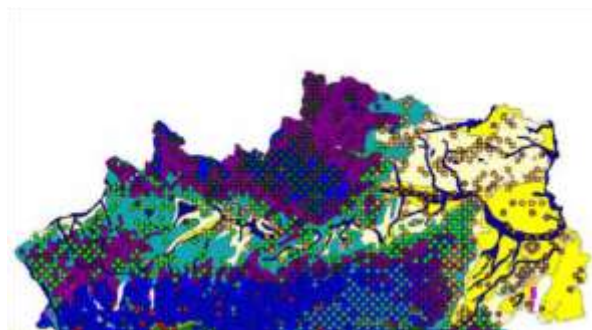


Fig. 12. – Potential natural vegetation according to Neuhäuslová et al. (1997).



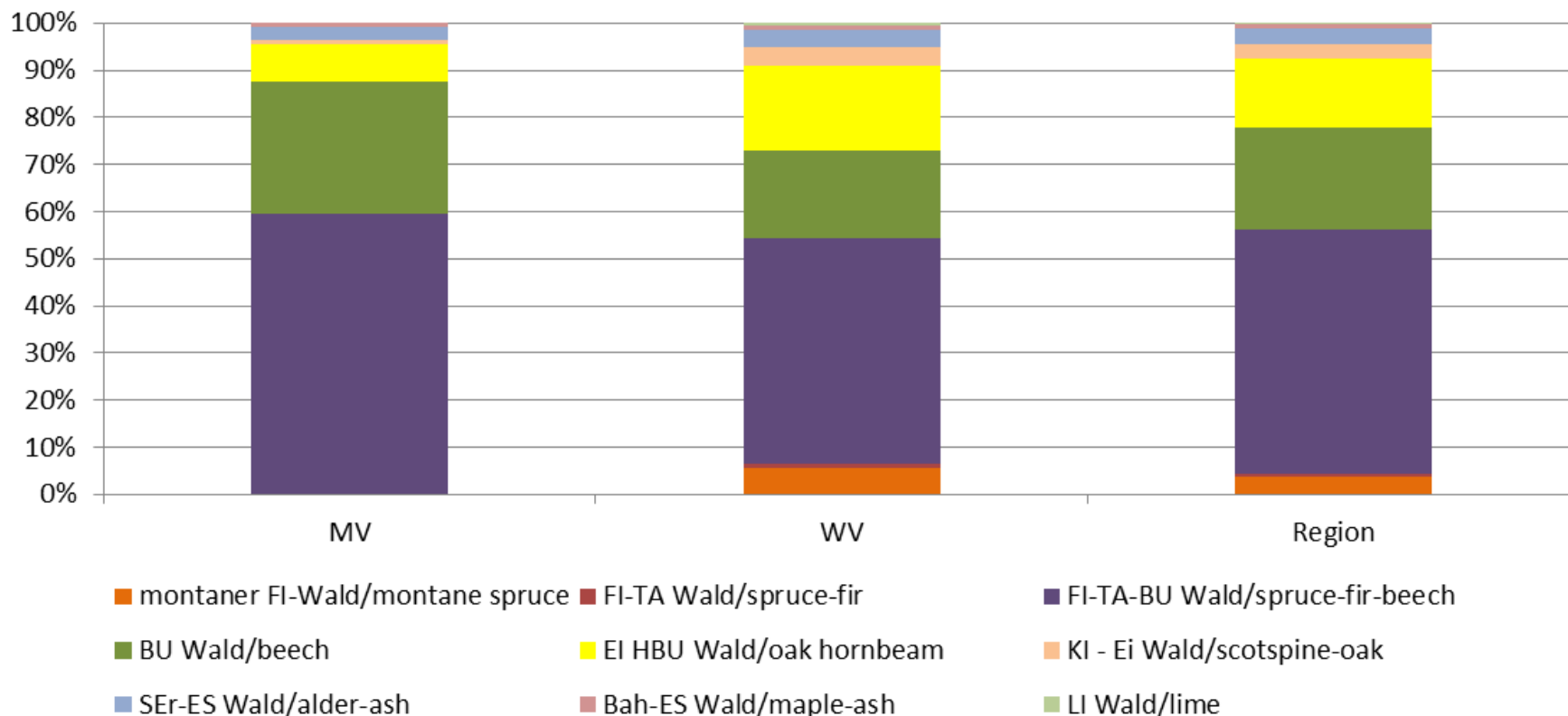
### natürliche Waldgesellschaften

- No Data
- Nivale Stufe
- Alpine Schuttfuren und Grashaiden
- Hochsubalpiner Lärchen-Zirbenwald
- Subalpiner Legföhrengbüsch-Lärchenwald
- Tiefsubalpiner Fichtenwald
- Montaner Fichtenwald
- Montaner Fichten-Tannewald
- Montaner Fichten-Tannen-Buchenwald
- Montaner Buchenwald
- Tief- bis Submontaner Eichen-Buchenwald
- Eichen-Hainbuchenwald
- Bodensaurer Eichen- und Kieferneichenwald
- Flaumeichenwald
- Subkontinentaler Eichenmischwald
- Waldkiefernwald
- Außeralpiner Auenwald
- Flach- und Hochmoore
- Seen





**potentiell natürliche Waldgesellschaften/  
 potential natural forest community**



Data source: ÖWI 07/09



CZECH REPUBLIC	AUSTRIA
<p><u>Bark beetle calamities</u></p> <p>2003–2011 South Bohemian Region (Norway spruce)</p> <p>2015–2020 all three regions (Norway spruce + Scots pine), mainly <i>Ips typographus</i>, <i>Ips duplicatus</i> and <i>Pityogenes chalcographus</i> (on small dimension; Norway spruce) and pine bark beetles (<i>Tomicus</i> spp., <i>Ips acuminatus</i>, <i>Ips sexdentatus</i>)</p>	<p>Main source: <a href="#">Dokumentation der Waldschädigungsfaktoren (DWF)</a> conducted by the Institute of Forest protection of Austrian Research Centre for Forests (BFW) with aid of the Austrian and Provincial Forest Services</p> <p>1992–1997 various regions in Austria (Lower and Upper Austria were severely affected); mainly <i>Ips typographus</i> on Norway spruce</p> <p>2003–2011 various regions in Austria (Lower and Upper Austria were severely affected); mainly <i>Ips typographus</i> on Norway spruce</p> <p>2015–2020 Waldviertel (Lower Austria), Mühlviertel (Upper Austria); mainly <i>Ips typographus</i> on Norway spruce, to some degree also <i>Pityogenes chalcographus</i> (on Norway spruce) and pine bark beetles (<i>Tomicus</i> spp., <i>Ips acuminatus</i>, <i>Ips sexdentatus</i>)</p>

Region
Jihocesky Kraj [S]
Vysocina Region
Jihomoravsky Kraj

aged area [% of forst area]

Mühlviertel	2015 - 2020	3,0	14.500	127.000	11,4
Waldviertel	2015 - 2020	10,3	54.100	232.000	23,3
		25,3			



CZECH REPUBLIC	AUSTRIA
<p><u>Salvage felling due to bark beetle attacks</u></p> <p>2015-2020</p> <p>South Moravian Region – 5.6 mil. m<sup>3</sup></p> <p>South Bohemian Region – 7.6 mil. m<sup>3</sup></p> <p>Vysočina Region – 12.8 mil. m<sup>3</sup></p>	<p>2015-2020</p> <p>Mühlviertel (Upper Austria) – 2.2 mil. m<sup>3</sup> (9700 hectares damaged area)</p> <p>Waldviertel (Lower Austria) – 9.6 mil. m<sup>3</sup> (45800 hectares damaged area)</p>
<p><u>Number of generations of <i>Ips typographus</i></u></p> <p>2016 – 3 swarming periods</p> <p>2017 – 2 swarming periods</p> <p>2018 – 3 swarming periods</p> <p>2019 – 2 swarming periods</p> <p>2020 – 2 swarming periods</p>	<p>Due to an increase of temperature there has been a clear tendency that <i>Ips typographus</i> has 2 or 3 generations per year in many parts of Austria. This is also the case for the project region.</p>

Region	period	damaged volume (Mio m <sup>3</sup> )	damaged area (ha)	forest area	damaged area [% of forst area]
Jihocesky Kraj [SB]	2015 - 2019	4,0			
Vysocina Region	2015 - 2019	5,0			
Jihomoravsky Kraj [SM]	2015 - 2019	3,0			
Mühlviertel	2015 - 2020	3,0	14.500	127.000	11,4
Waldviertel	2015 - 2020	10,3	54.100	232.000	23,3
		25,3			



CZECH REPUBLIC	AUSTRIA
<p><u>Monitoring of bark beetles</u></p> <p><i>Ips typographus</i>, <i>Ips duplicatus</i>, <i>Pityogenes chalcographus</i> – pheromone traps</p> <p>KŮROVCOVÉ INFO – <a href="http://kurovcoveinfo.cz">kurovcoveinfo.cz</a></p> <p>Analysis of satellite data (death standing tree, felling)</p> <p>KŮROVCOVÁ MAPA – <a href="http://www.kurovcovamapa.cz">www.kurovcovamapa.cz</a></p>	<p><b><i>Ips typographus</i></b>, <b><i>Ips duplicatus</i></b>, <b><i>Pityogenes chalcographus</i></b> (on Norway spruce), <i>Ips cembrae</i> (on European larch), <b><i>Ips acuminatus</i></b>, <b><i>Ips sexdentatus</i></b>, <i>Tomicus piniperda</i>, <i>Tomicus minor</i>, (on pine species), <b><i>Pityokteines curvidens</i></b> (on silver fir); monitored bark beetles species vary between years; those monitored in 2021 are highlighted in bold font – pheromone traps</p> <p>Österreichisches Borkenkäfer-Monitoring – <a href="http://www.borkenkaefer.at">www.borkenkaefer.at</a></p> <p>Spatio-temporal simulation of the development and phenology of <i>Ips typographus</i> – PHENIPS and PHENIPS plus – <a href="http://iff-server.boku.ac.at">iff-server.boku.ac.at</a></p>
<p><u>Monitoring of forest damaging factors</u></p> <p>Forestry and Game Management Institute (VÚLHM)</p> <p><a href="#">Zpravodaj ochrany lesa. Supplementum</a></p> <p>Zpráva o stavu lesa a lesního hospodářství (Information on forests and forestry <a href="#">in the Czech Republic</a>)</p> <p><a href="#">Data of Czech Statistical Office – Forestry</a></p>	<p>Department of Forest Protection of the Austrian Research Centre for Forests (BFW) with the support of the Austrian Forestry Authorities and Provincial Forest Services – <a href="#">Dokumentation der Waldschädigungsfaktoren (DWF)</a></p> <p>Austrian Forest Authority – summarized annually in the document “Holzeinschlagsmeldung” provided by the Austrian Federal Ministry of Agriculture, Regions and Tourism (BMLRT)</p>





## Forest

CZECH REPUBLIC	AUSTRIA
<ul style="list-style-type: none"> <li>All windfall, windthrow and wood attractive for the development of insect pests incurred before March 31<sup>st</sup> must be removed or decontaminated by May 31<sup>st</sup> (beyond 600 m above sea level by June 30<sup>th</sup>) at the latest, of the current year. (Decree No. 101/1996 Coll.).</li> <li>Further details for species causing calamities are determined by Annex No. 2 to Decree No. 101/1996 Coll.</li> </ul>	<ul style="list-style-type: none"> <li>The forest owner and its forest and forest protection personnel must pay attention to the risk of the occurrence of forest pests and must report perceptions of an impending dangerous calamity of forest pests immediately to the Forest Authorities (§43, Forstgesetz 1975/2016)</li> </ul>
	<ul style="list-style-type: none"> <li>The forest owner is obliged in an appropriate and proportionate manner to (a) prevent dangerous damage to the forest by forest pests and (b) effectively control forest pests that are already reproducing in a dangerous manner (§ 44, Forstgesetz 1975/2016)</li> <li>It is illegal to promote an impending dangerous calamity of forest pests due to actions or omissions (§ 45, Forstgesetz 1975/2016); this refers particularly to salvaging and sanitation (as mentioned above), two major elements of bark beetle management</li> </ul>



## Selected macroeconomic data and public finances to support forest management

<u>Forest products production (in total) / round timber (in mil. €)</u>	<u>Production value of the forestry industry (in total) / sawmill and industrial roundwood (in mil. €)</u>
2010 – 1424 / 560	2010 – 2094 / 874
2016 – 1928 / 697	2016 – 2104 / 855
2017 – 2073 / 762	2017 – 2183 / 903
2018 – 2003 / 831	2018 – 2242 / 953
2019 – 1868 / 846	2019 – 1967 / 796
<p>The data characterize the basic value of forestry production and the main share of the main product - saw logs.</p> <p>Source: Czech Statistical Office, national accounts for forestry and logging.</p>	<p>2020 – 1704 / 644</p> <p>The production value of the forestry sector consists of the net increment of forest trees, forest tree plants, production of raw wood for material and energy use, as well as forestry services, ancillary activities and other products (e.g. secondary uses).</p> <p>Source: Statistics Austria. Economic Accounts for Forestry.</p>



## Forest management act/guidelines

### Contributions to forest management based on:

- Act No. 289/1995 Coll., on forests (including mandatory expenditures, services)
- Annex No. 9 to Act No. 455/2011 Coll., On the state budget of the Czech Republic
- Regional rules for the provision of contributions to forest management ("regional rules")
- Community guidelines for State aid in the agriculture and forestry sector

Recommendations for tree species choice and forest management at regional and/or enterprise level:

„Tree species choice for Mühlviertel“ (Forest administration Upper Austria)

„Silvicultural guidelines for the forest management in Lower Austria“ (Forest administration Lower Austria)

„Silvicultural Handbook“ of the Austrian Federal Forests (Österreichische Bundesforste AG)



Obligatory expenditure / Services to forest owners / Contribution to forest management (operational funds) in mil. CZK

2018 – 240 / 87 / 380

2019 – 264 / 89 / 695

2020 – 306 / 66 / 1059

Payment under the responsibility of the Ministry of Agriculture, national resources.

Contribution to bark beetle calamity mitigation (mil. CZK / mil. €)

2019 – 980 / 38.13

2020 – 7019 / 273.11

Payment under the responsibility of the Ministry of Agriculture, national resources.

Contribution to bark beetle calamity mitigation

Co-funded grants under the Austrian Rural Development Program.

Purely national federal funding in connection with the containment of the bark beetle calamity only from 2021 within the framework of the Forest Fund („Waldfonds“).

Compensation contribution rate for bark beetle damaged wood (€/m<sup>3</sup>)

IV/2017 – 0.99

I/2018 – 5.93

II/2018 - 9.98

III/2018 – 14.63

IV/2018 – 19.89

2019\* – 15.50

Compensation for the loss of value caused by bark beetles according to the guidelines of the Forest Fund (“Waldfonds”): 3.500 €/ha

\*Since 2019 not only private forest owners, but also forest enterprises can apply for this contribution





Ongoing

CZECH REPUBLIC	AUSTRIA
Transformation of even-aged, monospecific forest stands (i.e. leave age-class forest structures) to mixed, uneven aged, structurally rich forest stands.	Due to the high proportion of young and medium-old spruce-dominated stands (age class 20 - 60 (80) years) in the regions Mühlviertel and Waldviertel, a target-oriented silvicultural treatment for immediate risk reduction is of particular importance.
Close-to-nature forestry approach application, minimize clear cuts, keep more less permanent forest cover	
Supporting of natural regeneration	Supporting of stand conversion by natural regeneration and/or artificial reforestation
Long-term evidence and feedback of realised forest interventions.	Long-term evidence and feedback of realised forest interventions.
Maintaining and improving the net of extraction tracks and roads.	Maintaining and improving the net of extraction tracks and roads.
Diminishing of damages (browsing, fraying, bark peeling) inflicted by game by hunting and protecting seedlings and saplings (fencing, individual protection). Keep the game population in an equilibrium with nature, considering an appropriate “bearing capacity” of the habitat.	Diminishing of damages (browsing, fraying, bark peeling) inflicted by game by hunting and protecting seedlings and saplings (fencing, individual protection). Keep the game population in an equilibrium with nature, considering an appropriate “bearing capacity” of the habitat.



**Ongoing Activ**

CZECH REPUBLIC	AUSTRIA
<p>Use for site appropriate, native and also verified introduced tree species; Support of drought tolerant species; Evaluation of nurse crop; combination of succession – pioneer species and artificial regeneration.</p>	<p>Use of site-adapted, more resilient tree species based on thorough site classification (which is not available for most areas in Austria)</p>
<p>Introduction of geographically close tree species, impossibility of planting of invasive tree species, combination of forest afforestation and/or establishment (i.e. natural + artificial regeneration, even use of succession by pioneer tree sp. as preparatory forest)</p>	
<p>Promote the availability of nursery plants of appropriate provenances of various tree species, particularly hardwoods, presently not so frequently used for artificial regeneration.</p>	<p>Promote the availability of nursery plants of appropriate provenances of various tree species, particularly hardwoods, presently not so frequently used for artificial regeneration.</p>
<p>Further test various afforestation and silvicultural concepts concerning original spacing, design and further silvicultural treatment; this is particularly important to initiate mixed-species forests.</p>	<p>Further test various afforestation and silvicultural concepts concerning original spacing, design and further silvicultural treatment; this is particularly important to initiate mixed-species forests.</p>
<p>More intensive forest management of Norway spruce forests managed mainly for timber production: e.g. lowering the rotation period (e.g. to 60-80 years), wide initial spacing, intensive thinning.</p>	<p>More intensive forest management of Norway spruce forests managed mainly for timber production: e.g. lowering the rotation period (e.g. to 60-80 years), wide initial spacing, intensive thinning.</p>
<p>Monitoring of natural succession and evaluation of pioneer crops (“Vorwald”).</p>	<p>Monitoring of natural succession and evaluation of pioneer crops (“Vorwald”).</p>
	<p>Further development/promoting management of deciduous stands</p>



## Needed in

CZECH REPUBLIC	AUSTRIA
Modification of forestry (for easier application of close-to nature approach in practice, realize statistically functional inventory) and hunting law (including especially methodology for game damage evaluation and its	Development of suitable silvicultural concepts and measures i) to stabilize middle-aged spruce stands and ii) for conversion of secondary, unstable spruce and pine stands
compensation, quantification of equilibrium game population status with forest ecosystem)	Improvement of experiences and knowledge about natural succession processes and their integration into forest management
Modification of State Forest Company structure to enhance its operability and enhance and stabilize team of high-quality staff	
Early detection of forest stands at high risk of bark beetle infestation by remote sensing techniques	Early detection of forest stands at high risk of bark beetle infestation by remote sensing techniques
Actual evidence of infested wood (state, position, amount) and its phase of sanitation	Actual evidence of infested wood (state, position, amount) and its phase of sanitation
Logistic of wood transport, storage (environmentally friendly), and final wood processing	Improvement of harvesting techniques (e.g. debarking); wood transport and wood storage techniques (e.g. methods for treatment of stored timber) and/or storage networks



## Needed improvements to reduce risks

CZECH REPUBLIC	AUSTRIA
Training of forest owners (particularly those owning small forests and lacking comprehensive forestry education) in forest management, silviculture and forest protection (particularly bark beetle management) through brochures, educational material, seminars and courses	Training of forest owners (particularly those owning small forests and lacking comprehensive forestry education) in forest management, silviculture and forest protection (particularly bark beetle management) through brochures, educational material, seminars and courses
Developing of robust contingency plans to deal with future calamities in a better manner	Developing of robust contingency plans to deal with future calamities in a better manner
Preparation for payment of forest ecosystem services	Preparation for payment of forest ecosystem services





## Handbook: Manual for risk management

-> preliminary results - status

presentation - discussion - critical analysis - adaptation

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## 3.2 Climatic change

Table x.x: Mean annual air temperature and mean annual sum of precipitation in the past and for two climate projections for the regions Mühl- and Waldviertel, Jihomoravský kraj, Jihočeský kraj and Vysočina.

### Austria








region	past climate 1971-2000 mean	effective measures (rcp 4.5)				business as usual (rcp 8.5)			
		near future		far future		near future		far future	
		climate change signal	mean	climate change signal	mean	climate change signal	mean	climate change signal	mean
<b>Mühl- and Waldviertel</b>									
annual temperature	7.6°C	+ 1.3°C	8.9°C	+2.3°C	9.9°C	+1.5°C	9.1°C	+3.9°C	12.0°C
annual sum of precipitation	729 mm	+5.5 %	768 mm	+9.7 %	798 mm	+7.2 %	781 mm	+12.0 %	816 mm

### 3.2 Climatic

# Meeting

risk scale of climate suitability for Norway spruce  
(with silvicultural suggestions) after Kölling *et al.* 2009)

28. - 29.6.2022

-  very high risk (admixture with very low share possible)
-  high risk (admixture with low share possible)
-  considerably elevated risk (admixture with modest share possible)
-  moderate risk (admixture with medium share possible)
-  noticeable risk (admixture with high share possible)
-  low risk (dominant tree species with adequate admixture of other tree species)
-  very low risk (dominant tree species)

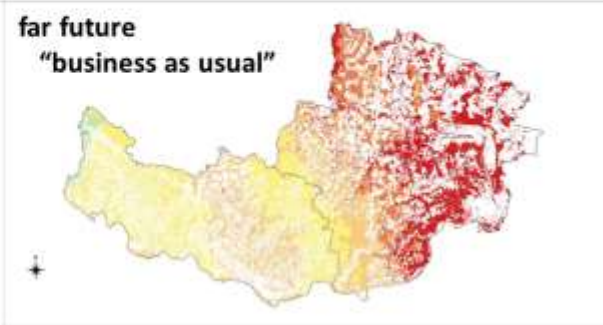
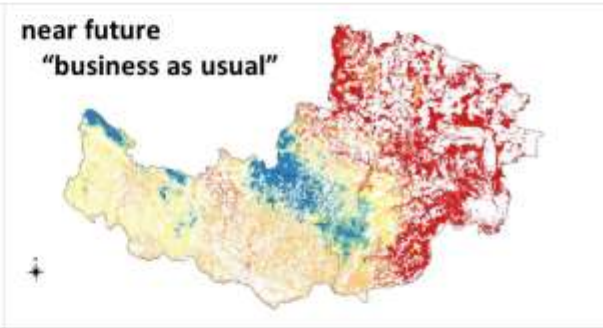
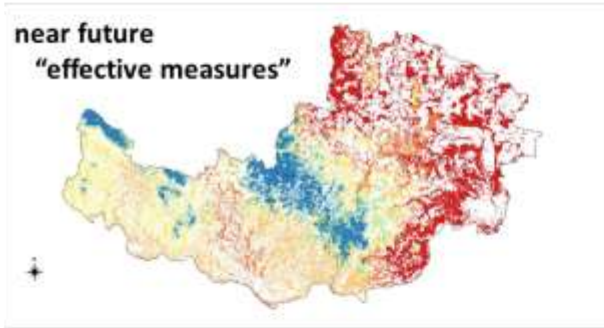
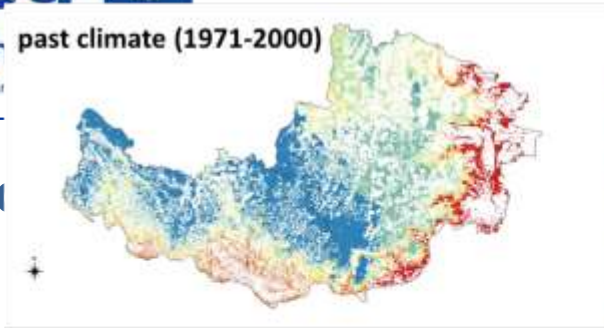
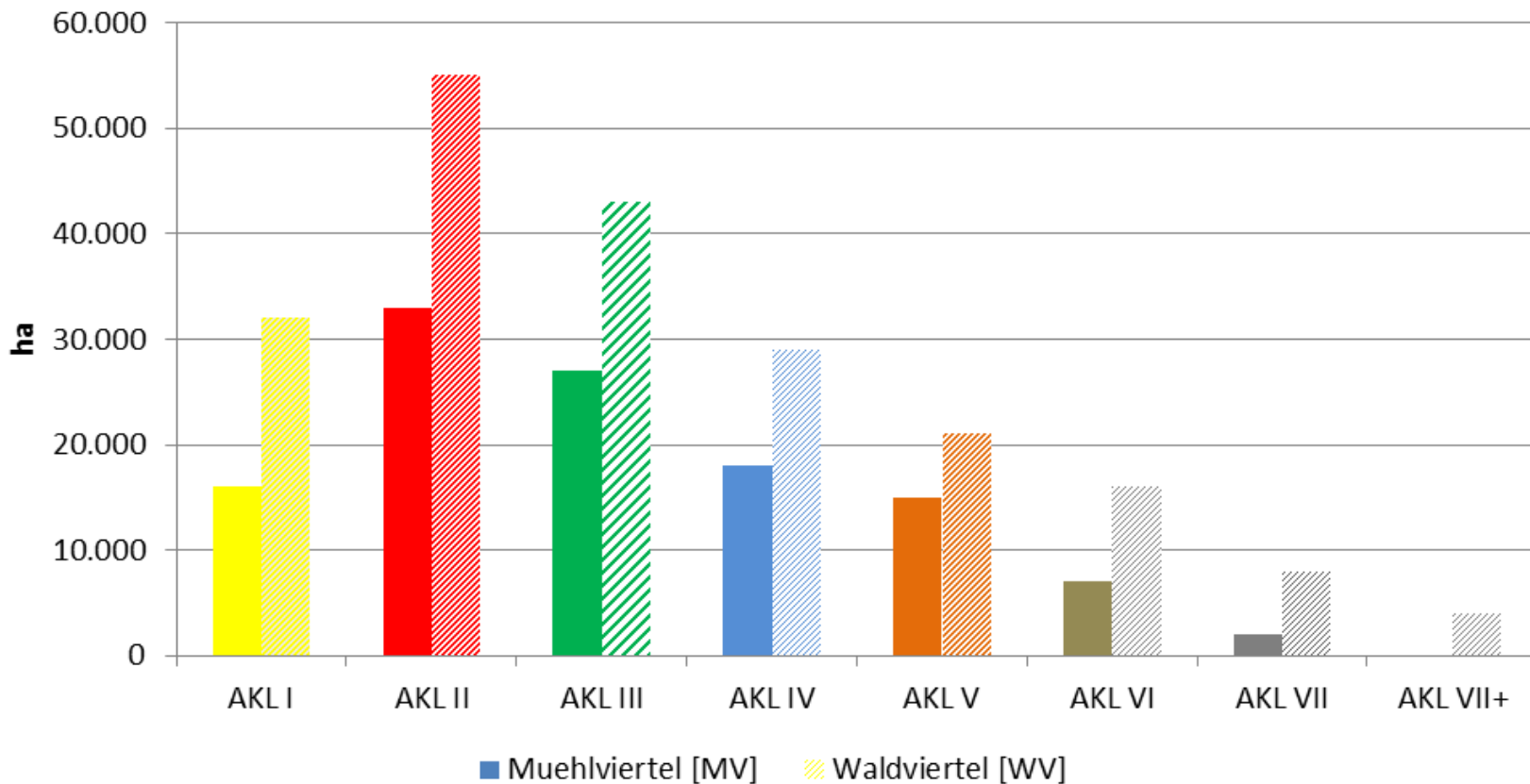


Figure x.x: Climate suitability for Norway spruce (Kölling *et al.*, 2009) in the regions Wald- and Mühlviertel in the past and in the near and far future for two different scenarios ("effective measures": substantial reduction of green-house gas emissions (rcp4.5); "business as usual": further increase of emissions (rcp8.5)).

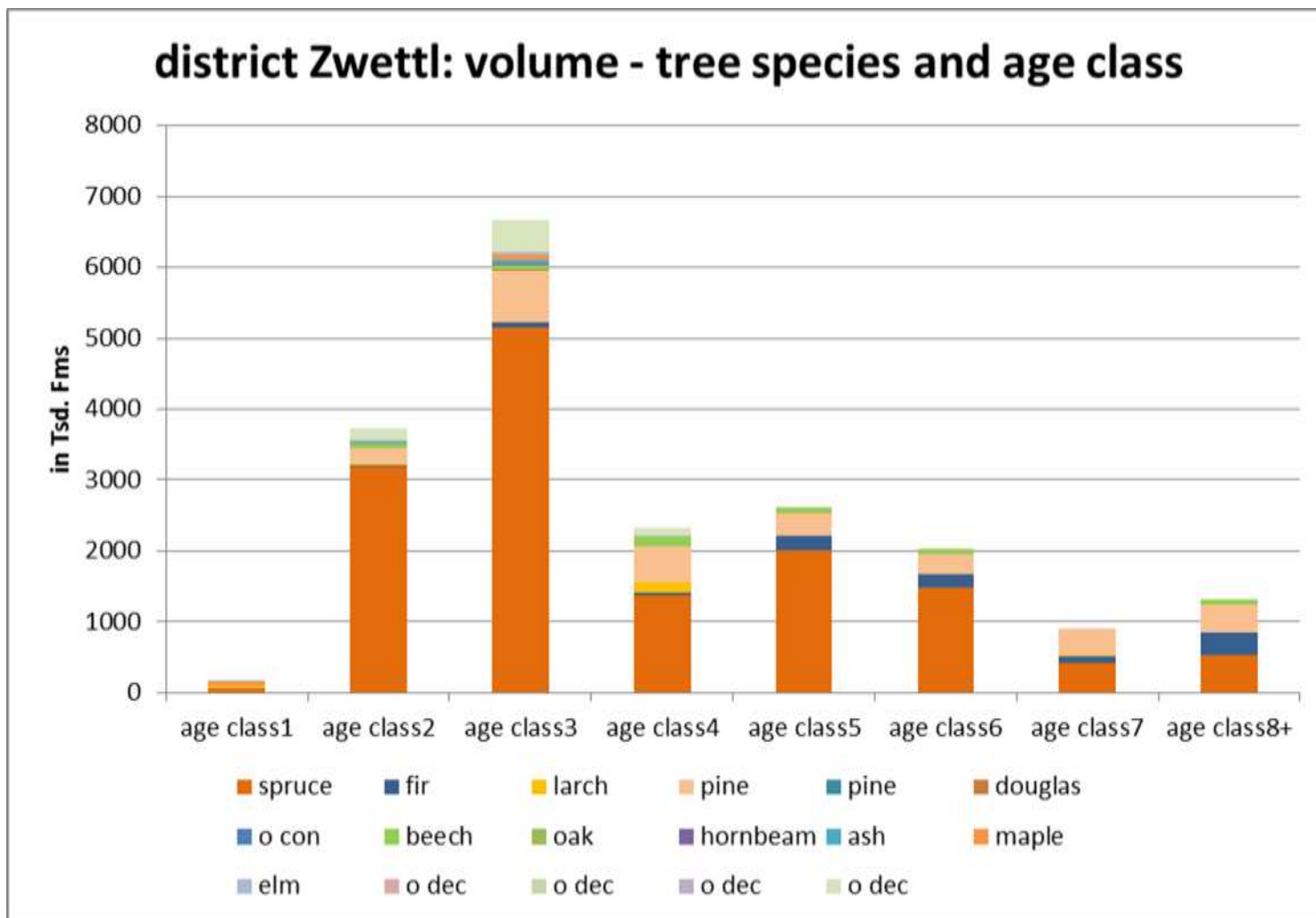


## Altersklassenverteilung/age class distribution



Data source: ÖWI 07/09





Challenges at regional level

Data source: ÖWI 07/09



## 3.11 Major risks factors of the main tree species

### Norway spruce

- Storm
- Snow
- Drought

### European beech

- Game (browsing, bark peeling)
- Storm: on shallow and waterlogged sites, in the growing season when foliated
- Drought: beech decline driven by climatic extremes; signs of death after prolonged periods of drought and heat stress up to extensive failures on a wide variety of sites with infestation by

### Douglas fir

- Douglas fir needle cast (*Rhabdocline pseudotsugae* and *Phaeocryptopus gaeumannii* especially at sites with high humidity and in years with high spring precipitation; particularly young stands are at risk
- Frost (winter and spring frost; Douglas fir is also particularly susceptible to frost desiccation)
- Game (rubbing, browsing)
- Bark beetles: native bark beetles can infest Douglas fir; so far the infestation risk is low, but this may become a greater hazard in the future; in any case, the risk is lower than for spruce



**Table x.x : Hazard rating of tree species to various risk factors**

Tree species	Abiotic factors					Biotic factors							
	Wind	Snow breakage	Frost	Drought	Fire	Degradation	Bark beetles	other insects	Insects	Root rot /Honey fungus	other pathogens	Game	Game damage
Spruce	●	●	●	●	●	●	●	●	●	●	●	●	●
Silver fir	●	●	●	●	●	●	●	●	●	●	●	●	●
Scots pine	●	●	●	●	●	●	●	●	●	●	●	●	●
Larch	●	●	●	●	●	●	●	●	●	●	●	●	●
Douglas fir	●	●	●	●	●	●	●	●	●	●	●	●	●
Beech	●	●	●	●	●	●	●	●	●	●	●	●	●
Oak	●	●	●	●	●	●	●	●	●	●	●	●	●
Sycamore maple	●	●	●	●	●	●	●	●	●	●	●	●	●
Ash	●	●	●	●	●	●	●	●	●	●	●	●	●

**Rating of hazard**

- low
- moderate
- high
- very high



Stand types/altitude level	cz c 350	cz sm 650	cz m >650	a c 300	a sm 500	a m > 500
Secondary pure spruce stands	rare	middle	high	middle	high	high
Scots pine stands	high	middle	low	middle	low	
Mixed oak stands	high	low		low	low	
Oak - noble hardwood stands	low	low				
Mixed noble hardwood stands	low	low				
Red oak stands				low	low	
European beech stand	rare	high	low	rare	low	low
Beech - noble hardwood stands						
beech - fir stands					rare	
Mixed pioneer tree species	rare	low	middle	rare	rare	rare
Mixed Scots pine-oak stands	low	rare		low	low	
Mixed spruce hardwood stands	low	middle	low	rare		
spruce - beech stand						
larch-beech stands					rare	
Mixed European beech, larch, fir	rare	high	low			
Spruce fir beech stands		low	middle		low	middle
spruce- fir stands					low	low
spruce -alder - fir stand				low	low	
Scots pine - spruce stand					middle	low
spruce -larch stand					low	
Natural spruce dominated stands			middle			middle
Mixed Douglas fir - oak stands	rare	rare		rare	rare	rare
Mixed Douglas fir - beech stands				rare	rare	rare

tion

Union



**Table x.x: Tree species suitability**

A	CZ	nutri ent/site typ	water regime	Quro	Qupe	Quce	Qupu	Quil	Cabe	Fasy	Acps	Acpl	Frex	Soto	Sodo	Prav	Algl	Alin	Tisp	Qure	Bebe	Port	Posp	Poni	Soau	
ko 200-300	coll - 350 m		dry	CZ	CZ	CZ	CZ												CZ				CZ			
		nutrient-rich	moderate fresh- fresh																				CZ			
sm 300-500	sm 300-650 m	nutrient-poor	dry	CZ	CZ						CZ										CZ	CZ				
		gley	fresh, wet																			CZ	CZ			
		nutrient-rich	moderate fresh- fresh								CZ										CZ	CZ				
		nutrient-poor	moderate dry-dry																		CZ	CZ				
tm 50-750	m > 650m	nutrient-poor	moderate fresh- fresh																		CZ	CZ			CZ	
		gley																				CZ	CZ			CZ
		nutrient-moderate	moderate fresh- fresh								CZ											CZ	CZ			CZ
		gley	gley																			CZ	CZ			CZ
mm 750 - 1000		gley	wet																							
mm 1000 - 1100		nutrient-moderate	fresh, wet																							
		gley	wet																	CZ			CZ	CZ	CZ	
	Flood plain			CZ																						





**Table x.x: Tree species suitability**

A	CZ	nutri ent/site typ	water regime	Pisy	Piab	Lade	Abal	Psme
ko 200-300	coll - 350 m		dry					
		nutrient-rich	moderate fresh- fresh				CZ	
sm 300-500	sm 300-650 m	nutrient-poor	dry	CZ				
		gley	fresh, wet				CZ	
		nutrient-rich	moderate fresh- fresh		CZ	CZ		
tm 50-750	m > 650m	nutrient-poor	moderate dry-dry					
		nutrient-poor	moderate fresh- fresh					
		gley						
		nutrienrt-moderate	moderate fresh- fresh		CZ	CZ	CZ	
mm 750 - 1000		gley	gley					
		gley	wet					
mm 1000 - 1100		nutrienrt-moderate	fresh, wet					
		gley	wet					
	Flood plain							



**Table x.x: Tree species composition and tree species shares (%) for defined MGTs (Management goal types)**

<b>Management goal types [MGT]/altitude level/tree species share [%]</b>	<b>cz - c 350</b>	<b>cz - sm650</b>	<b>cz - m&gt;650</b>	<b>a - c300</b>	<b>a - sm500</b>	<b>a - tm750</b>	<b>birch</b>	<b>Oak sp.</b>	<b>black alder</b>	<b>noble sp.</b>	<b>other Deciduos sp</b>	<b>poplar sp</b>	<b>beech</b>	<b>red oak</b>	<b>Scots pine</b>	<b>spruce</b>	<b>fir</b>	<b>larch</b>	<b>Douglas fir</b>
Mixed oak stands								70-90			10-30								
Oak - noble hardwood stands								20-60	20-60		10-30								
Mixed noble hardwood stands										70-90	10-30								
Red oak stands											10-30			70-90					
Beech stand													>90						
Beech - noble hardwood stands										40-60			40-60						
Beech - fir stands													50-70				30-50		
Mixed pioneer tree species							> 90					>90							
Mixed Scots pine-oak stands								10-40							60-90				
Mixed spruce hardwood stands																			
Spruce -beech stand													40-80			20-60			
Larch-beech stands													30-40					60-70	
Beech - larch - fir stand													20-40				20-40	20-60	
Spruce fir beech stands													20-40			20-60	20-40		
Spruce - fir stands																50-70	30-50		
Spruce -alder - fir stand									20-50							20-50	20-50		
Scots pine - spruce stand											10-20				30-50	30-50			
Spruce -larch stand																50-70		30-50	
Natural spruce dominated stands																>90			
Douglas fir - oak stands								20-40											60-80
Douglas fir - beech stands													20-40						60-80



Table x

Recommended frame values (n/ha) and spacing						
Tree species	Share (%)	Normal spacing (without pruning)		Wide spacing (with pruning)		Remarks
		n/ha	spacing	n/ha	spacing	
Oak sp.	100 %	4.400 – 5.000	2*1,1 m	2.000 – 2.500	3*1,3 m; 4*0,9 m	Cluster planting: 80 cluster with 25 plants per cluster [2000 n/ha]
		8.000 – 10.000				
Maple sp., ash	100 %	3.500 – 4.200	2*1,2/1,4 m	1.100 – 1.600	3*3 m; 6*1,5 m	
Wild service tree, wild fruit tree sp.	100 %	3.500 – 4.200	2*1,2/1,4 m	2.000 – 2.500	3*1,3 m; 4*0,9 m	
Walnut, blacknut	100 %	----- 2.000 – 2.500	----- 2*2 m	600 – 800 600 – 800	6*2,5 m; 4*3 m	
Wild cherry	100 %	-----	-----	600 – 800	6*2,5 m; 4*3 m	
				400 -1000		
Birch	100 %	-----	-----	1.100 – 1.600	3*3 m	
Black alder	100 %	-----	-----	1.100 – 1.600	4*2 m; 3*3 m	
Red oak	100 %	2.500 – 3.500	2*2 m; 2*1,4 m	1.100 – 1.600	3*3 m; 3*2,5 m	sonst. Laubholz aus Naturverjüngung
Beech	100 %	8.000 – 10.000	1*1,3 m	----	---	
Scots pine	100 %	8.000 – 10.000	1*1,3 m	---	---	
		8.000				
Larch	100 %	1.600 - 2.000	2*2,5 m	---	---	
		500 -2.500				
Spruce, fir	100 %	2.000 - 2.500	2*2 m	---	---	
		3.000 - 4.000				

spacing



## 5. Stand level - site class – Management type

5. Stand level - site class – Management type .....	<b>27</b>
5.1 Secondary pure spruce stands .....	27
5.2 Secondary Scots pine stands .....	33
5.3 Natural spruce dominated stands .....	37
5.4 Mixed spruce hardwood stands .....	41
5.5 Mixed oak stands .....	45
5.6. Mixed Scots pine-oak stands .....	49
5.7. Spruce fir beech stands .....	54
5. 8 Pure Douglas fir stands and/or mixed Douglas fir stands .....	59
5.9. Mixed noble hardwood stands .....	63
4.10. European beech stands .....	67
5.11. Mixed European beech, larch, fir .....	70
5.12. Mixed pioneer tree species	74



## 5. Stand level - site class – Management type

### 5.1 Secondary pure spruce stands

#### Risk assessment

RISK FACTOR/STAND DEVELOPMENT	REGENERATION/ YOUNG STANDS			THICKET			POLE STAGE			TIMBER			TIMBER/ MATURE			DAUERWALD PERMANENT TREE COVER		
	C	S	M	C	S	M	C	S	M	C	S	M	C	S	M	C	S	M
Storm	0	0	0	0	0	0	2	2	2	3	3	3	3	3	3	–	1	1
Snow/ice/rime	1	1	1	2	3	2	2	3	2	2	3	2	2	3	2	–	1	1
Drought	3	2	1	3	2	1	3	3	1	3	3	1	3	3	1	–	1	1
Fire	3	2	2	3	2	2	3	2	2	2	1	1	2	1	1	–	3	2
Bark beetles	0	0	0	1	1	1	2	2	1	3	3	2	3	3	3	–	2	1
Game	3	3	3	3	3	3	2	2	2	0	0	0	0	0	0	–	1	1

Vegetation zone: C – colline, S – submontane, M – mountane

SCALE: 0 – no risk... 3 – extreme high risk; – absent (see context with the previous table with current presence of stand tapes in CR)







1 regeneration/  
young stands

1.1 drought

**Respecting vegetation soil and climate conditions** when establishing stand, planting of quality planting material, control and replacement of dead seedlings

- autumn planting
- optimization of weed control practices – only strip reduction (shading), reduction only if necessary (according to height and density of weed and weather condition)

**Maintaining suitable air and soil moisture**

- preservation of the remains of the mother stand – shade
- use of pioneer woody plants – preparatory vegetation

1.2 fire

**Effective fire control** – to identify the riskiest areas, early fire detection, barriers or firebreaks that may limit fire spread

- control and reduction of dry hazardous material
- in period with high risk (heat, drought, wind) frequent control of riskiest places
- in extremely risky areas creation of barriers for wildfire – firebreaks, fuelbreaks, belts with low flammable woody plants (deciduous trees)

1.3 game

**Controlling of game population and damage prevention**

- controlling of population density, reduction of population density of overpopulated game
- game-proof protection (fencing, browsing repellents, biotechnical protection – keeping no-target trees for browsing), increase of environment usability for game (e.g. planting of fruit trees)

2 thicket

2.1 snow/ice/rime

- work with stand density – suitable crown length
- processing of damaged wood (risk of bark beetle outbreak)

2.2 drought (and  
subsequent bark  
beetle calamity)

- frequent control of the stands
- search for trees secondarily infested by bark beetles
- bark beetle monitoring (pheromone traps, trapping trees)
- timely sanitation (larval/pupal stage)
- optimization of stand density (maintaining a favourable stand climate)

2.3 fire

--> see 1.2

## FOREST PROTECTI



## Silvicultural measures

Vegetation zone	colline – submontane
Target of growing stock	Conversion and/or transformation <ul style="list-style-type: none"> <li>• colline: mixed deciduous and/or mixed oak stands</li> <li>• submontane and montane: deciduous and coniferous mixed stands</li> </ul>
Production goal	Timber of high quality (saw timber); target diameter: spruce 45 cm
Rotation period	60 - 80 (100)y;
<b>Growth classes</b>	<b>initial state - measures/action</b>
young stands height	weeding and/or cleaning; promoting of mixed tree species; integrating of pioneer tree species spruce: normal density negative selection; stem number reduction in dense stands mixture regulations
thicket	promoting of mixed tree species; integrating of pioneer tree species spruce: normal density negative selection; stem number reduction in dense stands mixture regulations
pole stage	spruce: positive thinning (future crop tree thinning) maintaining of mixed tree species and promoting mixed tree species of good quality maintain and promote nurse shade tolerant species; <b>treatment of previously managed stands:</b> combination of light thinning from above and selective thinning; maintenance and support of mixed tree species
timber dbh 20 – 50 cm	spruce: further positive thinning activities (future crop tree thinning) <ul style="list-style-type: none"> <li>- release target trees; maintenance and support of mixed tree species</li> </ul> <b>treatment of previously managed stands:</b> combination of light thinning from above and selective thinning; maintenance and support of mixed tree species; with dbh > 30 cm transition to stock maintenance
timber/mature regeneration	<b>Transformation:</b> tree species change by clear cut and reforestation; <b>Conversion:</b> combination of natural and artificial regeneration; shelterwood cut and group-selection cut [target tree diameter harvesting] <b>colline: transformation to mixed deciduous stands</b> Reforestation: normal spacing: spruce (2*2m; 2500 n/ha), oak (2*1m; 5.000 n/ha), maple (2*1,3 m-; 4.000 n/ha), cherry (wide spacing: cherry (4*3m; 700 n/ha) <b>submontane: transformation to mixed spruce hardwood stands</b> Reforestation: normal spacing: spruce (2*2m; 2500 n/ha), oak (2*1m; 5.000 n/ha), maple (2*1,3 m-; 4.000 n/ha), cherry (wide spacing: cherry (4*3m; 700 n/ha) <ul style="list-style-type: none"> <li>- single mixed stands: wild cherry (service trees) + hornbeam, linden, beech.</li> <li>- support mixture species for oak stands (nurse shade tolerant species as linden, hornbeam, beech or field maple)</li> </ul>



## Silvicultural measures

Management type	<b>Secondary pure spruce stands</b>
Silvicultural system	<b>Continuous Cover Forestry [CCF]</b> not recommended ??????
Vegetation zone	colline – submontane



Silvic

Management goal types [MGT]/altitude leve/ silvicultural system	CZ - c 350	CZ - sm 650	CZ - m> 650	cz- age class	cz - CCF	A - c 300	A - sm 500	A - m> 750	a -age class	a - CFF
conversion/transition Secondary pure spruce stands				x	x				x	
conversion/transition secondary pure Scots pine stands				x	x				x	
Mixed oak stands				x	x				x	x CWS
Oak - noble hardwood stonds				x	x				x	x CWS
Mixed noble hardwood stands									x	
Red oak stands									x	
Beech stand				x	x				x	x
Beech - noble hardwood stands									x	
Beech - fir Stands									x	x
Mixed pioneer tree species				x	x				x	
Mixed Scots pine -oak stands									x	x
Mixed spruce hardwood stands				x	x				x	
Spruce -beech stand									x	x
Larch-beech stands									x	
Beech - larch - fir stand				x	x				x	
Spruce fir beech stands				x	x				x	x
Spruce- fir stands									x	x
Spruce -alder - fir stand									x	
Scots pine - spruce stand									x	x
Spruce -larch stand									x	
Natural spruce dominated stands									x	x
Douglas fir - oak stands				x	x				x	
Douglas f ir - beech stands									x	



## 5.6. Mixed Scots pine-oak stands

### Risk assessment

RISK FACTOR/STAND DEVELOPMENT	REGENERATION/ YOUNG STANDS			THICKET			POLE STAGE			TIMBER			TIMBER/ MATURE			DAUERWALD PERMANENT TREE COVER		
	C	S	M	C	S	M	C	S	M	C	S	M	C	S	M	C	S	M
Storm	0	0	–	0	0	–	1	1	–	1	1	–	1	1	–	0	0	–
Snow/ice/rime	1	1	–	1	1	–	1	1	–	1	1	–	1	1	–	1	1	–
Drought	2	1	–	2	1	–	2	1	–	2	1	–	2	1	–	1	1	–
Fire	3	2	–	3	2	–	3	2	–	3	2	–	3	2	–	3	2	–
Bark beetles	0	0	–	1	1	–	1	1	–	2	2	–	2	2	–	1	1	–
Game	3	3	–	2	2	–	1	1	–	0	0	–	1	1	–	1	1	–

Vegetation zone: C – colline, S – submontane, M – mountane

SCALE: 0 – no risk... 3 – extreme high risk; – absent (see context with the previous table with current presence of stand tapes in CR)







## FOREST PROTECTION

stand development	relevant damage factor	measurement / action
1 regeneration/ young stands	1.1 drought	<p><b>Respecting vegetation soil and climate conditions</b> when establishing stand, planting of quality planting material, control and replacement of dead seedlings</p> <ul style="list-style-type: none"> <li>• autumn planting</li> <li>• optimalization of weed control practices – only strip reduction (shading), reduction only if necessary (according to height and density of weed and weather condition)</li> </ul> <p><b>Maintaining suitable air and soil moisture</b></p> <ul style="list-style-type: none"> <li>• preservation of the remains of the mother stand – shade</li> <li>• use of pioneer woody plants – preparatory vegetation</li> </ul>
	1.2 fire	<p><b>Effective fire control</b> – to identify the riskiest areas, early fire detection, barriers or firebreaks that may limit fire spread</p> <ul style="list-style-type: none"> <li>• control and reduction of dry hazardous material</li> <li>• in period with high risk (heat, drought, wind) frequent control of riskiest places</li> <li>• in extremely risky areas creation of barriers for wildfire – firebreaks, fuelbreaks, belts with low flammable woody plants (deciduous trees)</li> </ul>



## SILVICULTURE MEASURES

Management type	Mixed Scots pine-oak stands
Silvicultural system	Age class system
Vegetation zone	colline
Target of growing stock	40 -60 % oak, 40-60 % Scots pine
Production goal	<b>Timber of high quality (saw timber); target diameter: Scots pine and oak 45+ cm</b>
Rotation period	<b>80 -120 y;</b>
Growth classes	initial state - measures/action
Regeneration	<b>Natural regeneration</b> <b>Reforestation:</b> normal spacing: pine (1*1,3; 7000 n/ha), oak (2*1m; 5.000 n/ha) in case of group mixture avoid monoculture larger than approx. 0,1(2) ha;
young stands	weeding and/or cleaning; promoting of mixed tree species; integrating of pioneer tree species Scots pine: normal density negative selection; stem number reduction in dense stands mixture regulations
thicket	promoting of mixed tree species; integrating of pioneer tree species Scots pine: normal density negative selection; stem number reduction in dense stands mixture regulations
pole stage	positive thinning (future crop tree thinning) maintaining of mixed tree species and promotion mixed tree species of good quality  <b>treatment of previously managed stands:</b> combination of light thinning from above and selective thinning; maintenance and support of mixed tree species
Timber dbh > 20cm	further positive thinning activities (future crop tree thinning) - release target trees; maintenance and support of mixed tree species  <b>treatment of previously managed stands:</b> combination of light thinning from above and selective thinning; maintenance and support of mixed tree species  with dbh > 30 cm transition to stock management
timber/ mature	Natural regeneration: combination of shelterwood cut and group selection system



## SILVICULTURE MEASURES

Management type	Mixed Scots pine-oak stands
Silvicultural system	CFF - depends on site conditions
Vegetation zone	colline
Target of growing stock	40 -60 % oak, 40-60 % Scots pine
Production goal	<b>Timber of high quality (saw timber); target diameter: Scots pine and oak 45+ cm</b>
Growth classes	initial state - measures/action
pole stage/timber (20 – 40 cm)	use maximum self-thinning process; girdling, support quality trees, remove wolf trees; <b>structural thinning</b>
timber/mature stand	<b>target diameter harvesting</b> <ul style="list-style-type: none"> <li>• support for natural regeneration;</li> <li>• species composition can be modified</li> </ul>



presentation - discussion - critical analysis - adaptation