IMPLICATIONS OF FOREST MAST SEEDING

for the projected supply of forest seeds and seedlings for the Austrian forest-based sector

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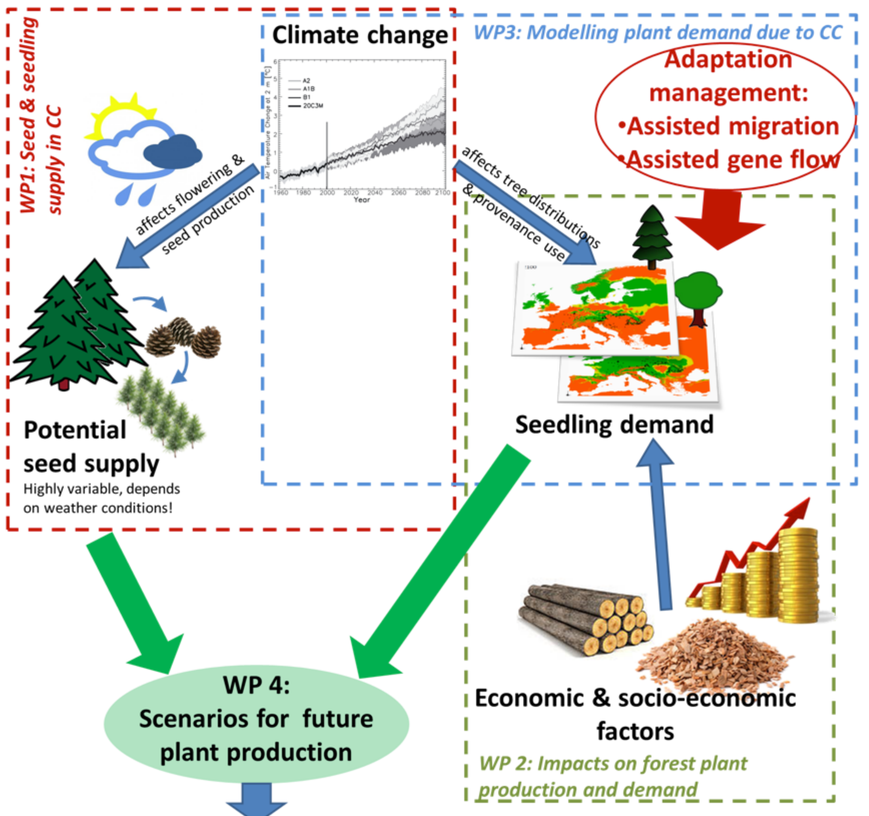
Mast seeding (or masting) is the synchronised and highly variable production of fruits and seeds.

- The synchrony of mast seeding has ecological impacts at the community and ecosystem levels as well as socio-economic impacts.
- Mast directly influences the supply of seeds and seedlings for forest regeneration.

Identification of the key climatic variables affecting the highly variable flowering and seed production of trees in order to model the potential future seed supply.



Adapting forests to climate change

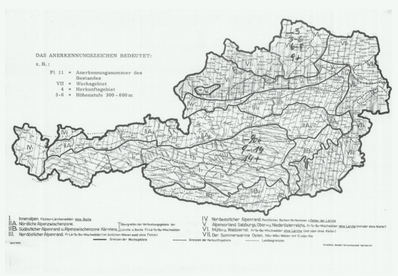
- Planting alternative trees
- Planting trees of different provenances better adapted to, or with a higher potential for adaptation to expected future conditions to mitigate CC-related risks to forests

The seedling demand for the various tree species depends on economic factors that are intertwined with ecological conditions on the one hand and influenced by political framework conditions, actions by decision- and policy-makers, and interdependencies with supranational and global economies on the other.

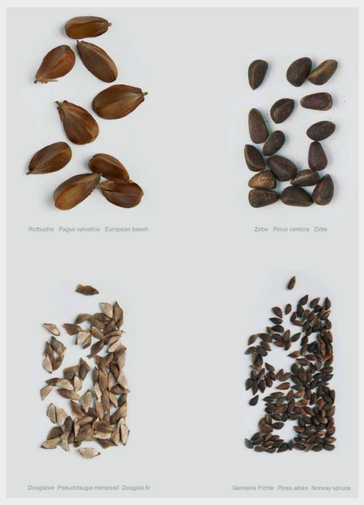
Analysis on how plant production has developed over the past five decades and what impact economic conditions, subsidies, and political framework conditions had on this production.

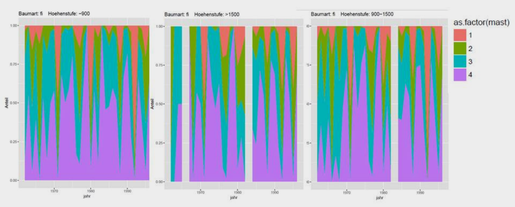
METHODS

1. Historical data on mast seeding and seed harvest from 1960 to 2016 were collected and digitalized for further analysis.

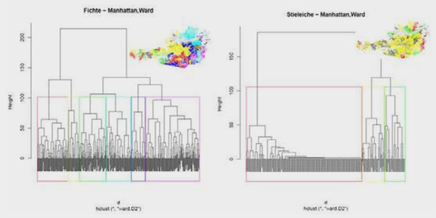


2. All analyses were performed for the currently most important tree species: Norway spruce (Picea abies), **European beech** (Fagus sylvatica), **Silver fir** (Abies alba), **Scots pine** (Pinus sylvestris), **European larch** (Larix decidua), **Pedunculate and Sessile oak** (Quercus robur, Quercus petreae), **and Swiss pine** (Pinus cembra).





Changes of the masting factor by elevation level (< 900m, >1500m, and 900 to 1500m) for the species Picea abies (fir) from 1957 to 1996.



Cluster analysis of mast fruiting of Picea abies (fir) and Quercus robur (oak).

The relationship between seed harvest and (lagged) seedling production shows a higher correlation coefficient for coniferous species than for non-coniferous species across all lags.

correlation results - absolute values								
seedling production	seed harvest	total logwood	coniferous logwood	deciduous logwood	clear cuttings	damaged wood	price fir/spruce roundwood	price beech roundwood
coniferous		0,29	0,29	0,16	0,23	0,23	0,09	-0,24
deciduous		0,09	0,06	0,33	0,04	-0,07	0,18	0,11
norway spruce	-0,23	0,57	0,59	0,09	0,50	0,34	0,33	
silver fir	0,33	-0,54	-0,55	-0,10	-0,43	-0,23	-0,28	
scots pine	-0,18	0,05	0,06	-0,06	0,11	0,12		
european larch	-0,11	0,43	0,43	0,24	0,49	0,25		
oak species	-0,31	0,22	0,18	0,66	0,34	0,13		
common beech	-0,81	-0,51	-0,53	0,02	-0,71	-0,69		0,79
sycamore maple	-0,19	-0,15	-0,16	-0,04	-0,14	-0,21		

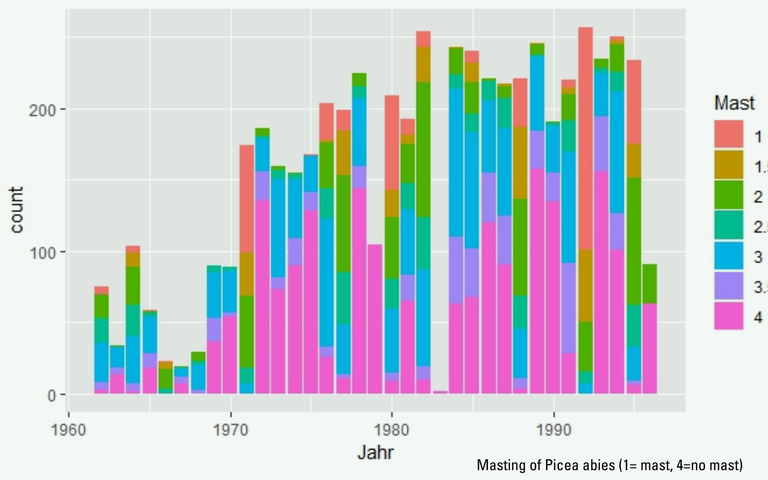
Correlation differenced values

3. The main climatic conditions and regimes affecting the reproductive features of these species were analysed, and the occurrence of mast fruiting in each species was clustered and mapped at the district level in preparation for the application of predictive models for all Austrian regions.

Pearson's product-moment correlation with:

- Daily minimum temperature
- Daily maximum temperature
- Daily average temperature
- Global irradiance
- Daily precipitation

Zielgröße	Zeit/Wuchsgebiet	Art	Gesamt	I-1	I-2	I-3	I-4	I-5	I-6	I-8	I-9
Tagesmin	Jahr	cor	0.015038	0.063456	-0.01821	0.006803	0.016325	0.026304	0.018812	0.052271	0.011884
		p-Wert	0.02413	0.03098	0.5259	0.8921	0.8278	0.5287	0.6244	0.1721	0.6408
		n	22488	1156	1216	400	180	576	680	684	1544
	AM	cor	-0.00814	-0.00703	-0.20281	-0.11835	0.077701	0.017278	0.106449	-0.0933	0.041468
		p-Wert	0.5418	0.9053	0.000373	0.2409	0.6119	0.8371	0.1671	0.2248	0.4165
		n	5622	289	304	100	45	144	170	171	386
	JJAS	cor	0.006658	0.140639	-0.0242	0.08497	0.165778	-0.00472	0.076947	0.052557	0.009354
		p-Wert	0.6177	0.01674	0.6743	0.4006	0.2764	0.9552	0.3186	0.4948	0.8547
		n	5622	289	304	100	45	144	170	171	386
	DJFM	cor	0.068699	0.348768	0.161833	-0.00455	0.034967	0.058784	-0.12477	0.269047	-0.02608
		p-Wert	2.52E-07	1.09E-09	0.004674	0.9641	0.8196	0.484	0.105	0.000373	0.6095
		n	5622	289	304	100	45	144	170	171	386
	ON	*cor*	*0.05259*	*0.131916*	*-0.06027*	*0.076767*	*-0.02538*	*0.191767*	*0.096785*	*0.328309*	*0.106994*
		p-Wert	*7.98E-05*	*0.02492*	*0.2948*	*0.4478*	*0.8686*	*0.0213*	*0.2093*	*1.17E-05*	*0.03561*
		n	*5622*	*289*	*304*	*100*	*45*	*144*	*170*	*171*	*386*



Masting of Picea abies (1= mast, 4=no mast)

RESULTS

Origin of seedlings sold in Austria

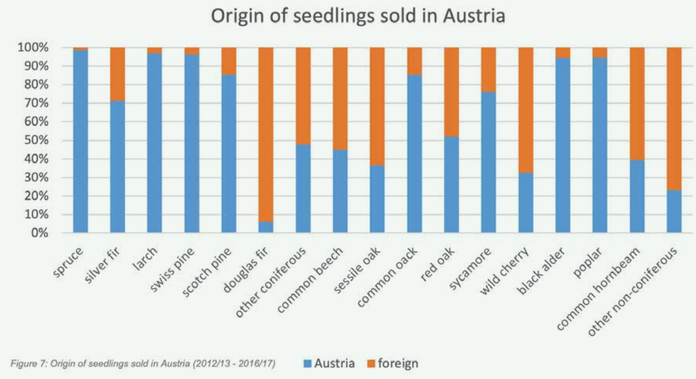
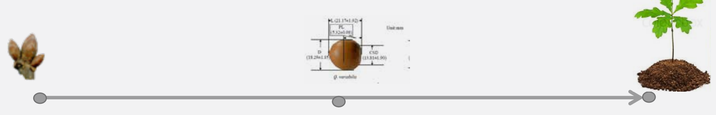


Figure 7: Origin of seedlings sold in Austria (2012/13 - 2016/17) ■Austria ■foreign

Sales quantities between 2012/13 and 2016/17 exhibited a clear trend towards non-coniferous species – especially oak species – as well as other deciduous species which are used to establish mixed forests.

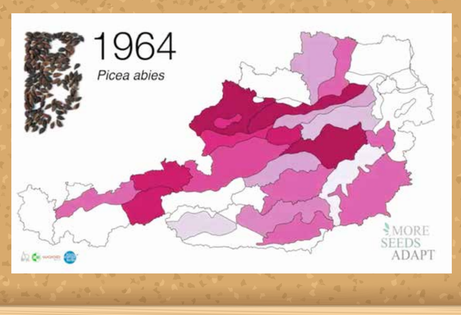
Which climatic influence the reproduction?



THE NEXT STEP

- **Scenarios of future forest seedling production based on potential seed supply and predicted seed demand along with species distribution models incorporating the effects of climate change**
- **Estimations of forest seedling demand for the most important tree species in Austria and Central Europe under different adaptation management strategies**

www.youtube.com/watch?v=2_aFwuh4s2E&t=10s



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MoreSeedsAdapt: Modelling the requirements of forest seeds and seedling provision for sustainable forest adaptation to climate change for meeting future raw material demand