

## Development of Hybrid Poplar Stands in the Donau-Auen National Park (Austria)



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### Abstract

Hybrid poplars (*Populus × canadensis*) are mainly the cross product of the native *Populus nigra* (male) and the North American *P. deltoides* (female). Since the 1860's these trees have been planted in the area of the Donau-Auen National Park. Advantages of *Populus × canadensis* trees are their resistance against diseases, their fast and erect growth as well as their tolerance of water deficiency and their good propagation properties. Certainly hybrid poplars represent a danger for the biodiversity of the national park: Because of the fact that one parent is native in the Austrian flora, hybrids of *Populus × canadensis* and *P. nigra* can occur under natural conditions. Up to ten percent of *P. nigra* seedlings already contain hybrid poplar genes. Other risks are the high infection rate of *Viscum album* and the interspecific competition. Hybrid poplars were introduced to Austria after 1492 and are therefore classified as neophytes.

Usually *Populus × canadensis* are harvested 30 to 40 years after planting, which isn't the case here since the national park was established in 1996. Since then the hybrid poplar stands have been left on their own. The developments of these stands were observed with vegetation relevés (method after Braun-Blanquet) and tree inventories.

In this study 100 plots were observed to describe the development trends of the hybrid poplar stands. The results show that older plantations contain more (native) species and less (invasive) neophytes. The hybrid poplar stands can be classified in two vegetation groups. The second one is richer in species and could be the product of the abolishment of forestry.

This study suggests to leave the hybrid poplar plantations as they are. They seem to develop in the direction of natural forest stands.

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### Keywords

*Populus × canadensis*, hybrid poplar, development, national park, floodplain forest, neophyte

### Introduction

*Populus × canadensis*, family *Salicaceae*, is the crossing product of *Populus nigra* (male) and the North American *P. deltoides* (female) (HEINZE 1998; VANDEN BROECK et al. 2004; ZSUFFA 1973). These plants were firstly cultivated in France (the first description of a hybrid was written in 1775; ZSUFFA 1973). Since 1860 the hybrid poplars were planted in the area of the Donau-Auen National Park (Jelem 1974). In the 1970's the Regelsbrunner Au had a very good reputation as a very excellent hybrid poplar forest enterprise. Usually *Populus × canadensis* were used after 30 to 40 years (EICHELMANN 1995).

Since the establishment of the Donau-Auen National Park the hybrid poplar stands were left as they were. Just some management for a faster re-establishment of native tree species was done. The so called 'Keimzellen' (germination cells) are clear-cuttings with max. 0.5 ha which were planted with native and typical tree species (e.g. *Populus alba*, *Fraxinus excelsior*, *Quercus robur*). Through this method around 20% of the hybrid poplar stands could be eliminated from 2002 until 2010 (OITZINGER & KOVACS 2010).

Today around 13% (Lower Austria) and 11% (Vienna) of the area of the Donau-Auen National Park still contain *Populus × canadensis*.

Problems with this tree species are the fact that they are neophytes, the interspecific competition and the high degree of *Viscum album* growing on them. The largest problem though is the introgression with the native *Populus nigra*.

## Methods

The sampling points were located along the inventory monitoring points of the Austrian Federal Forests (Österreichische Bundesforste – ÖBf). Via GIS (ArcMap 10.3; © Esri 2015) points where the hybrid poplars had a minimum content of 80% of the tree species were selected. Of 119 sampling points in Lower Austria and seven sampling points in Vienna 79 sampling points in hybrid poplar stands were randomly chosen and vegetation surveys were done. The inventory monitoring points of the ÖBf were located via GPS in the field and plots of 20 x 20 meters were surveyed (vegetation with Braun-Blanquet values (TREMPE 2005), tree inventory (height, BHD, vitality) as well as the amount of dead wood). With GIS the distances to the next water body, path and 'Keimzelle' were measured. The same procedure was done with 21 'Keimzellen' in Lower Austria.

The data from the field and the GIS were analyzed using SPSS 22 (© IBM 1989, 2013) and JUICE 7.0.102 (© L. Tichý 1999-2010; Twinspan and indicator values according to Ellenberg).

## Results

In total 79 hybrid poplar stands and 21 'Keimzellen' were surveyed. The division into stand age and percentage of *Populus ×canadensis* content is shown in Table 1.

	0%	80%	90%	100%	sum
<b>0-15 years (Keimzellen')</b>	21	0	0	0	21
<b>20-39 years (AC 1)</b>	0	2	2	8	12
<b>40-49 years (AC 2)</b>	0	3	17	13	33
<b>50-59 years (AC 3)</b>	0	7	8	8	23
<b>60-81 Jahre (AC 4)</b>	0	0	2	9	11
<b>sum</b>	21	12	29	38	100

Table 1: Distribution of the difference age classes (AC) and the percentage of hybrid poplars of the 100 sampling points.

According to the different age classes it could be shown that in higher age classes (age class 2 to 4) more species occur. This increase is due to native plant species. Native species rise from an average value of 13.33 (SD = 4.99) to 17.73 (SD = 7.09). Neophytes increase less (age class 2: 2.85 in average (SD = 1.20); age class 4: 4.18 (SD = 1.40)). If just the age classes 2 and 4 are compared neophytes reduce to a difference of -0.40 (significance proven with a Kruskal-Wallis one-way analysis of variance:  $p = 0.006$ ) and native plant species higher to a difference of +2.23.

This can be shown even better, if you have a look at the coverage of native and non-native plant species. The neophytes in the shrub layer decrease from age class 2 (average: 17.42%, SD = 20.71) to age class 4 (average: 7.55%, SD = 11.59). The development of the neophytes in the different age classes is shown in Figure 1.

The Shannon-Wiener index (diversity index) was calculated and has a significant increase with the age classes (Spearman's rank correlation coefficient = 0.244;  $p = 0.030$ ). The older the plantations the higher was the biodiversity of the forest stands.

The TWINSPLAN analysis divided the *Populus ×canadensis* stands into two groups.

Group 1 (includes 17 sampling points, 6 subdivisions) had only hybrid poplars in the tree layer 1. There is almost no second tree layer and the herb layer had a very low diversity (mainly consisting of *Urtica dioica*, *Rubus caesius*, *Phalaris arundinacea* and *Phragmites australis*).

The second group (Group 2) had often *Fraxinus excelsior* and *Populus alba* in the tree layer 1, the tree layer 2 is more often present. The herb layer is more diverse and also woody plants reproduce here.

The difference in the amount of plant species in the two groups is in average 17.35 and 19.50 in group 1 and 2, but this result was not significant (Mann-Whitney U test:  $p = 0.373$ ).

Significant differences between the two groups can be shown in the different layers: The species amount for example is significantly higher in group 2 (Mann-Whitney U test:  $p = 0.003$ ).

The indicator values according to Ellenberg showed significant difference in the humidity and light parameters. Hybrid poplar stands in group 2 are shadier and drier than the forest stands in group 1. Hybrid poplars from group 2 are less vital (Mann-Whitney U test:  $p = 0.019$ ).

'Keimzellen' were divided into two age classes (established before 2010: 12 sampling plots and after 2010: 9 sampling plots). The most interesting results here are the differences in the amount and coverage of species (native and non-native) and the correlation with the indicator values according to Ellenberg.

'Keimzellen' established before 2010 had a higher number of species (26.67 in average compared to 22.42), but also a higher number of neophytes (4.44 in average compared to 3.67). In the tree layer 2 and in the herb layer these results were significant (tree layer 2: Mann-Whitney U test:  $p = 0.030$ ; herb layer: Mann-Whitney U test:  $= 0.044$ ).

Correlations between the number of native plant species and the indicator values according to Ellenberg showed significant results: The lighter the 'Keimzelle' is, the more neophytes occur (Spearman's rank correlation coefficient  $= -0.526$ ;  $p = 0.014$ ).

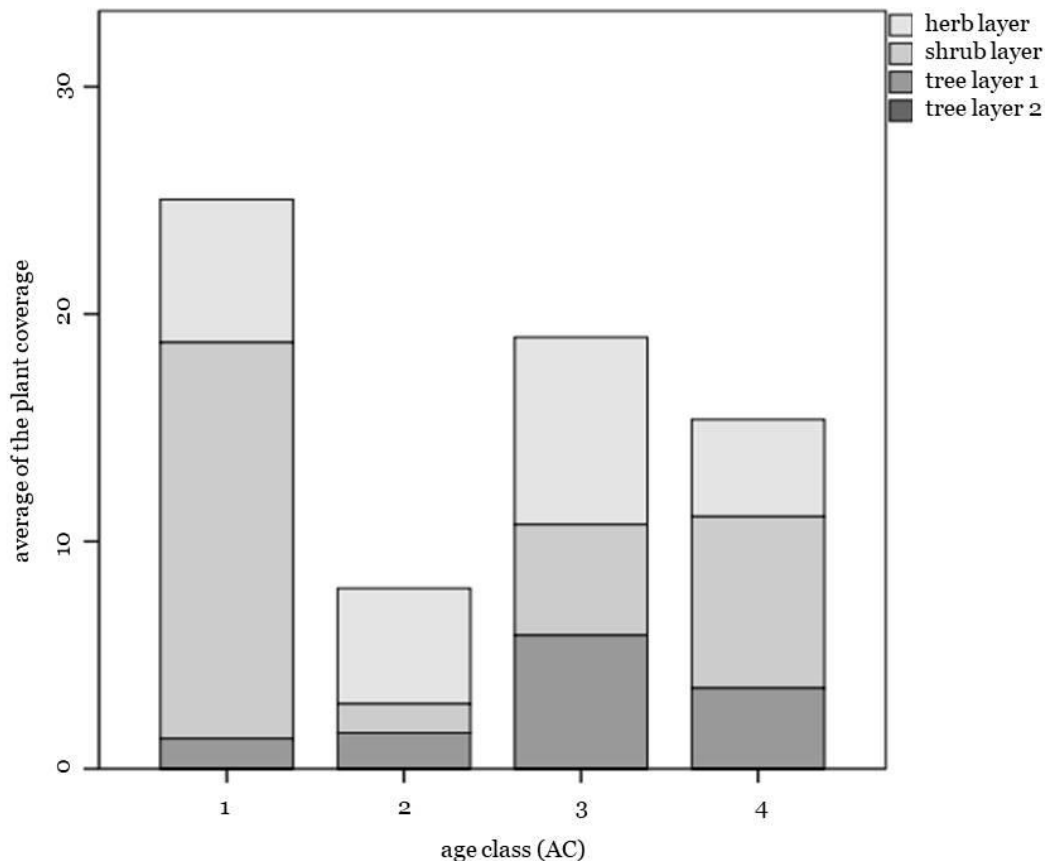


Figure 1: Coverage of the neophytes in the different plant layers and age classes.

## Discussion

The older the hybrid poplar stands are, the richer they get in species diversity. This increase is due to the higher number of native plant species. The number of species is less than in other studies (DELARZE & CIARDO 2002; ZERBE 2003). That hybrid poplar stands are generally poorer in the number of plant species is also shown by HÄRDTLE et al. 1996 (in BARSIG 2004), DIETRICH (2011) and STARFINGER & KOWARIK (2011). The increase of the Shannon-Wiener index shows that this increase is due to an equal increase of more than just a few species. DIETRICH (2011) showed similar results according to the neophyte occurrence: Neophytes don't appear more often in hybrid poplar stands.

According to the two groups of hybrid poplar forest stands it can be said that the more abundant group 2 forest stands are more divers in species, shadier and drier than the sampling points in group 1. Group 1 has similarities with other *Populus × canadensis* stands – *Urtica dioica*, *Rubus* sp., *Phalaris arundinacea* for example are very common plant species in these kind of plantations (HIMMLER & RÖMMLER 2001 in BARSIG 2004; ZERBE 2003). Group 2 could be the result of the protection of natural processes in the Donau-Auen Nationalpark.

The influence of 'Keimzellen' according to the reproduction of tree species in hybrid poplar stands was not shown. Therefore, the planted trees in the 'Keimzellen' might be too young to reproduce now. The number of species decreases while the number of neophytes increases with the age of the 'Keimzellen'.

## Conclusion

Due to the results it can be said that non-intervention is a good way to cope with hybrid poplar stands. The vitality decreases, the number of native and typical plant species increases with the age of the plantations. The opposite is the case in the managed 'Keimzellen'.

The fact that the introgression with the native *Populus nigra* is not higher than it was in 2005 (GNEUSS 2005; MICEK 2017), as well as the non-intervention philosophy of the national park, tightens this strategy too.

Therefore the recommendation for the Donau-Auen National Park is to leave the stands as they are and let nature conquer back the space for the natural vegetation.

German Download available at:

[https://infothek.donauauen.at/fileadmin/Infothek/2\\_WissenschaftlPublikationen/21\\_WissenschaftlicheReihe/10414\\_NPDA\\_39\\_2015\\_Knoll\\_Bestandsentwicklung\\_Hybridpappelforste\\_NP\\_Donau-Auen.pdf](https://infothek.donauauen.at/fileadmin/Infothek/2_WissenschaftlPublikationen/21_WissenschaftlicheReihe/10414_NPDA_39_2015_Knoll_Bestandsentwicklung_Hybridpappelforste_NP_Donau-Auen.pdf)

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