Use of Poplars for ecological restoration

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Introduction

The habitat directive of the European Union (1992) protects a list of threatened species and habitat types within the member states. This legislation obliges that habitat types or habitat of listed species must be managed in a good state of conservation. For example habitats which will be removed or oppressed by any project must be compensated before removing the original habitat. This obligation results in a growing economic market for ecological restoration of threatened habitat. Poplars have potentials for this new market which is looking for rapid techniques for buffering, restoring and creating habitat.

Different forest habitat types in Flanders (and many other parts of Europe) are in an unfavourable state of conservation (Thomaes et al. 2008). This is mainly caused by the poor environmental quality, fragmentation and intensive management of the forests. The first factor is mainly a consequence of acidification and nitrogen deposition which oppresses the natural vegetation. This process is often accelerated by the forest management which strives to dense homogeneous stands of acidifying tree species like Beech (*Fagus sylvatica*) or American oak (*Quercus rubra*). The intensive management mainly affects the natural mixture of tree species, the number of thick old trees and amount of dead wood in the forest.

To achieve a favourable state of conservation for the forest habitats in Flanders protection measurements must focus on buffering and connecting forest habitats and improving the forest structure and amount of dead wood (Thomaes et al. 2007).

Poplars have interesting characteristics which make it an ideal species for buffering and connecting forest habitats or creating and restoring habitat. The intensive management of classic poplar plantations limits the potentials of these forests strongly, but when forests are kept unmanaged Poplars can have high potentials for developing quickly towards natural forest habitats.

Herb vegetation

In different studies (De Keersmaeker & Muys 1995; Thomaes 2001; Thomaes et al. 2006; Verstraeten et al. 2004) we examined the effect of the tree species, site conditions and management on the soil development, shrub and herb vegetation and stand structure in newly planted forests on farmland.

The soil-pH under a Poplar stand planted on former farmland remains high while under nearly all other tree species soil-pH decreased (figure 1). This high pH creates good opportunities for the development of a herb layer typical for natural forests. Many species which are oppressed in old forests as a consequence of acidification could find a port of refuge in newly created forests on farmland around these forests.

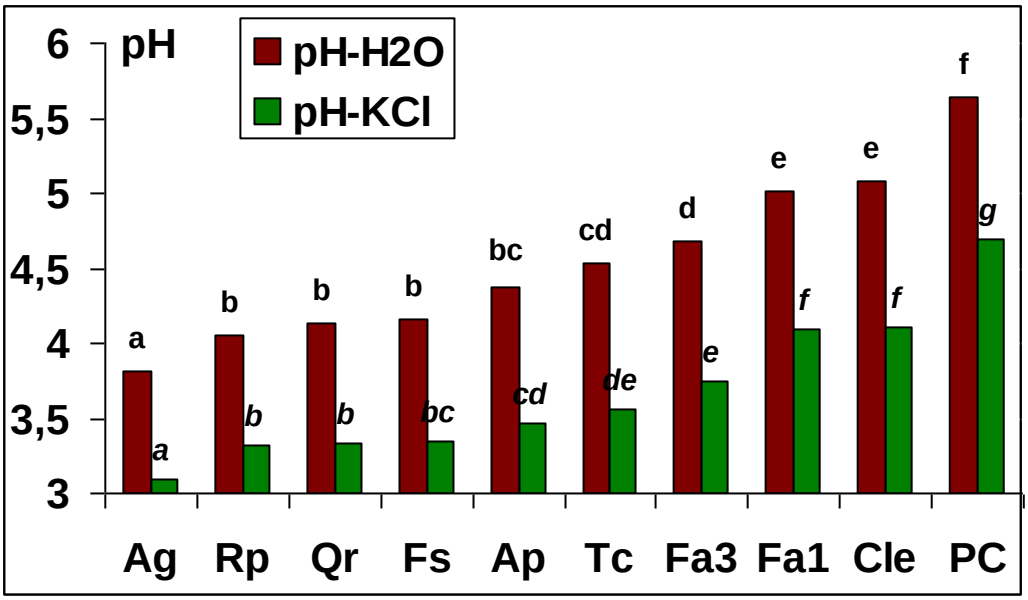

Figure 1: pH-KCl and pH-H_2O in different 33y old stands planted on agricultural land in the Mortagneforest. The letters above the diagrams indicate significant differences. Ag: *Alnus glutinosa;* Rp: *Robinia pseudoacacia;* Qr: *Quercus rubra;* Fs: *Fagus sylvatica;* Ap: *Acer pseudoplatanus;* Tc: *Tilia cordata;* Fa3: *Fraxinus americana* stand 3b; Fa1: *Fraxinus americana* stand 1a; Cle: Clearcut of *Populus* Cultivar and PC: *Populus* Cultivar (Thomaes et al. 2006).

The germination of ancient forest plant species (Honnay et al. 1998) in soil of different forest stands each planted with different tree species revealed that the *Populus* stand had the highest overall germination and had the highest germination for 3 out of 6 selected plants (Thomaes 2001). Only for *Lamium galeobdolon* the *Populus* stand had a significantly lower germination (table 1). Introducing different ancient forest plants in these stands learned us that Poplars scores intermediate for the survival of these plants (figure 2, Thomaes et al. 2006).

Table 1: Total germination (%) of 6 different old forest plants in soil of different 27y old stands planted on agricultural land in the Mortagneforest (Thomaes 2001). For the names of the stands see figure 1.

		Ag	Fs	Ap	PC
Anemone nemorosa	NS	0	5	5	5
Lamium galeobdolon	***	4^{a}	$11^{a,b}$	30^{b}	5^{a}
Lonicera periclymenum	***	41^{a}	$65^{a,b}$	$61^{a,b}$	66^{b}
Primula elatior	***	0^{a}	0^{a}	0^{a}	76^{b}
Scilla non-scripta	NS	13	15	6	10
Stellaria holostea	***	23^{a}	19^{a}	$26^{a,b}$	56^{b}
All woodland species	*	14a	19a,b	21a,b	36b

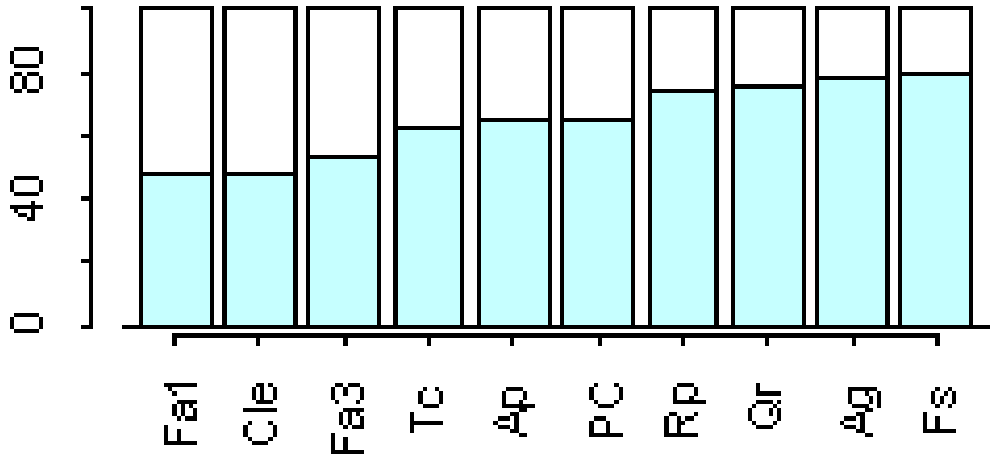

Figure 2: Percentage of survival (white) and die off (blue) of 6 different ancient forest plants (*Primula elatior, Scilla non-scripta, Mercurialis perennis, Anemone nemorosa, Pteridium aquilinum, Oxalis acetosella*) in different stands of the Mortagneforest (Thomaes et al. 2006). For the names of the stands see figure 1.

Verstraeten et al. (2004) compared the floristic herb layer and soil inhabiting arthropods of a Poplar stand with an adjacent stand of Ash (*Fraxinus excelsior*) with the same land use history and concluded that a similar list of ancient forest plants was found in both stands with a comparable species number and cover within a particular stand. Also the soil inhabiting arthropod fauna did not differ between the two tree species.

Verstraeten et al. (2004) estimates that 22% of the Flemish Poplar stands have a high floristic value while 41% is characterised by a low floristic value. Floristic rich Poplar stands were found by Verstraeten et al. (2004) in stands with a higher forest age, higher stand age, higher cover of the shrub layer and larger forest area. De Keersmaeker & Muys (1995) also found a relation between richness and forest age. Differences in forest age were explained by difference in soil phosphor content, originating from the historic farmland use.

Poplars offer a low percentage of shade to the ground vegetation. When planted on rich soils (for example farmland) the combination of light and nutrient rich soil will result in herb vegetations dominated by a small number of strongly competing species like *Urtica dioica, Galium aparine* and *Rubus fruticosus*. These competitors strongly limit the colonisation potentials for ancient forest plants. Shade can be increased by a shrub layer which affectively restrains these competitors (De Keersmaeker & Muys 1995; Martens 1997).

Forest structure

It is well known that Poplars grow faster than most other broadleaved tree species (DBH of 180cm after 25y, Meiresonne & Van Slycken 1996). If the forest is not economically managed this results in ecologically interesting forest structures with thick trees and large amounts of dead wood in a small time period.

From native Poplars it is known that they can reach the age of 150 years and at that time they reach a DBH of 5m. From the oldest Poplar clones it is known that they can reach an age of at least 120y. From the many new and fast growing clones the maximal age is however unknown (Verstraeten et al. 2004).

Thick trees are important for many animals, which are mainly depending on cavities in old thick trees. Woodpeckers, which make their nesting holes in living trees, play a key role for cavity depending fauna. These holes are used in following years by other cavity-nesting birds, bats and other mammals beside a high number of arthropods and fungi. Woodpeckers generally select trees with soft wood and trees with a certain diameter. Natural rotting cavities are also more present in trees with soft wood. This makes Poplar interesting for the restoration of the habitat of specific cavity depending species.

Vignon (2006) advises to plant a mixture of Willows and Oaks and pollard them regularly to create suitable cavities for *Osmoderma eremita* (a rare saproxylic beetle protected by the Habitat directive which lives in tree cavities). Vignon found the species in pollard willows of only 50y of age while the Oaks can create suitable conditions in a longer time period.

When Poplar stands are not cutted the high amount of stem biomass will result in big volumes of dead wood in a short period of time. Dead wood of Poplar decays faster than hardwood which makes it less interesting for dead wood depending organisms. Many dead wood depending organisms are also more or less restricted to one or a small group of tree species. Still there are a certain amount of more common species which can be found in the dead wood of Poplars.

There is a good natural regeneration of a diverse spectrum of tree species in Poplar stands which are comparable with the tree species richness in natural forests. When stands stay unmanaged they naturally evolve to semi-natural forest stands (Prins 1997, Lust et al. 2001). Verstraeten et al. (2004) found the transition of Poplar stands to natural tree species mixture mainly in 70-80y old Poplar stands.

Facts on biodiversity

Poplars do not score lower than other tree genera for the number of different groups of tree specific arthropods (Kennedy & Southwood 1984; Delplanque 1998; Heydemann 1982; Carter et al. 1979; Rotach 2003). Muys (1993) recorded a higher number of earthworm species under Poplar stands compared to other stands.

Hondong (1994) found more red listed species of Longhorn beetles and moths associated with *Populus* than associated with other tree genera. For butterflies *Populus* takes the third place in the ranking of the tree genera.

Casale et al (1993) found comparable ground beetles fauna in Poplars stands and adjacing alluvial forests except for large scale Poplar plantations.

The epiphytes that are found on Poplars are comparable to those on Aspen, Willows, Ash and Maple (Barkman 1958). The relatively high pH of Poplar bark makes the tree species interesting for threatened species of epiphytes. Mainly the old clones are preferred because these have a rougher bark (Barkman 1958; Margot 1965).

There are no comparing studies known for fungi (Walleyn R. pers. comm.) but there are a number of species which are only found on the genera *Populus* or *Populus* and *Salix*.

The number of breeding birds found in structure rich Poplar stands is comparable to other forests (Schmitz 1986; Van Gossum et al. 2001). The main factor is the presence of a dense shrub layer and natural ingrowth of other tree species.

Poplar cultivars

The quick growth and good stem forming abilities makes cultivars interesting for ecological restoration above or besides natural occurring *Populus* species. Current research on Poplar cultivars is mainly based on production. To use these cultivars for ecological restoration more research should be undertaken on the natural evolution by different Poplar cultivars (maximum diameter, age, cavities, dead wood decomposition).

Based on current knowledge we advise to use older clones (for example Robusta for Flanders) because these are less sensitive to diseases, have a rougher bark, have harder wood and presumable have a longer life span. Recent Poplar cultivars are often crossbreedings between American and European species and are considered non native which is a problematic issue for using them in the perspective of nature conservation.

Classical managed Poplar plantations have in general a low biodiversity. This is mainly due to management, site history and isolation from other forests, rather than related to the tree species.

Conclusion

Poplars are interesting tree species for buffering, creating or restoring forest habitat. Old forests are in general hard to replace, Poplar aforestations don't have a similar ecological value as old forests. But Poplar afforestations can be used to enlarge and connect small forests and to bring these habitats in a favourable state of conservation. Combining Poplars with other tree species will create the best options for restoring or replacing forest habitat.

If Poplars are used in restoration projects we advise to:

- Plant on farmland of low ecological value or areas reclaimed for nature after exploitations or other activities;
- Do not use drainage or irrigation;
- Mix different tree species and cultivars;
- Take care of the stand structure and the occurrence of a varying shrub layer and
- Leave the Poplars (largely) uncut and evolve naturally.

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