Poplar Commission of the Republic of Slovenia
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Poplars and Willows in Slovenia:
Report of the National Poplar Commission

Time period: 2012-2015

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I. POLICY AND LEGAL FRAMEWORK

Slovenia is the only country in Europe that combines the Alps, the Mediterranean, the Pannonian Plain and the Karst. Site conditions are favorable mainly for the development of high forest. Slovenia is a mountainous country and more than a third of its territory lies above an elevation of 600 m. Forests are of high economic importance for the country since it does not possess many other natural resources. Forested areas cover 1,184,526 ha or 58.4% of the total territory.

Forest management involves establishing an organic connection between economic activities in forests and nature conservation. Clearcutting has been forbidden since 1947. Natural regeneration is promoted wherever possible. If seed and seedlings are used, they should originate from known seed sources in Slovenian forests and from suitable tree species and provenances. Compared to forests in most EU countries, the semi-natural forests in Slovenia are fairly well-preserved since sustainable, co-natural and multifunctional management has been traditionally and legally incorporated into forestry practice.

The Forest Reproductive Material Act (2002) regulates production, marketing and use of forest reproductive material of high quality suited to the various site conditions, enabling operation of the forest ecosystems to be permanent and optimal, and the renewal thereof in compliance with the principles of protection of forest genetic resources. It covers the reproductive material of forest tree species and hybrids that are important for forestry purposes, to be used for: regeneration with planting or seeding, afforestation, maintenance of permanent buffer or anti-erosion zones of forest trees, design and maintenance of forest plantations. Based on the Forest Reproductive Material Act, there is a list of tree species and artificial hybrids (2010) for which the regulations of FRM apply. The list contains 77 forest tree species with Populus x spp.* and Salix x spp. The Rules on the conditions for the approval of forest seed object in the category “source of origin” and “selected” (2003) and the Rules on the conditions and procedures for the approval of forest seed objects for production of forest reproductive material in the category “qualified” and “tested” (2004). In Slovenia the production of the forest reproductive material of poplar and willow species and its artificial hybrids, to be placed on the market, must be based on basic material in the category “Selected”, “Qualified” or “Tested”.

The Forest Act (1993) regulates the protection, silviculture, exploitation and use of forests, and the disposal of forest as natural resources with the aim of ensuring their close-to-nature and multipurpose management in accordance with the principles of protection of the environment and natural values, long-term and optimal working of forests as ecosystems, and enabling their functions. The habitats of native plant and animal species is to be preserved or recreated in forests in accordance with the general parts of forest management plans. In forests with a changed composition of living forest communities, their natural composition should be gradually re-established.

Under this Act a forest plantation is not considered as forest. It is governed by provisions of the Regulation on the use of agricultural land for forest plantations (1986). The establishment of forest plantations is allowed in agriculturally marginal soils or poor soils where there is too much or too little water for agricultural production (land use code 1420). Short rotation coppice plantations (SRC) have been classified as eligible permanent crops (land use code 1240) by provisions of the Regulation on direct payment schemes (2015), which states that SRC from Article 4 of Regulation (EU) 1307/2013 is established with willow (Salix x spp.) or poplar (Populus x spp.) with a maximum harvest cycle of five years. No afforestation authorization is
required for the establishment of forest plantations and SRC plantations in agricultural land use “1420” and “1240”, respectively. The area can also be converted back to food production at any time without having to apply for clearing and conversional authorization. This implies that no afforestation authorization is required for the establishment of forest plantations and short rotation plantations outside forest land. This approach is meant to facilitate the creation of forest plantations and short-rotation plantations outside forests.

According to the Resolution on National Forest Programme (2007), the Forest Action Strategy is changing to more natural management of forest plantations. New poplar plantations with a longer production period (20-25 years) are restricted to the most suitable sites and will be used mainly for the wood processing and pulp industry.

Up to now no subvention for poplar and/or willow cultivation and production has been adopted, nor has it been recognized as important for the country in the framework of the new EU Rural Development Programme.

In Slovenia Natura 2000 sites cover 37.16 % of the total territory. 71% of the Natura 2000 sites is overgrown by forests. The Nature Conservation Act (2004) and the Regulation on special protection areas (Natura 2000) (2004) lay down measures for the conservation of biodiversity and the system of protection of natural values. In nature conservation guidelines for particular priority habitat types and species qualifying for Natura 2000 sites which are linked to these habitat types, zones with specific guidelines are determined in order to achieve more detailed protection goals for the conservation of protected habitat types and species in Natura 2000. The introduction of plants or animals of non-native species and the introduction of genetically modified organisms is prohibited under Natura 2000. For forest management plans which are done for forest units in Natura 2000 sites additional specific guidelines and measures are required to achieve more detailed protection objectives set out in nature protection guidelines of the Institute of the Republic of Slovenia for Nature Conservation.

II. TECHNICAL INFORMATION

1. Identification, registration and varietal control

a) Identification

One hundred mature European black poplar trees in native riparian populations were GPS mapped in situ for further phenotypical selection at the individual level by the Slovenian Forestry Institute (SFI). Under pilot testing the promising *Populus nigra* clone was selected by SFI. No basic material for the production of forest reproductive material has been approved up to now on the basis of experimental plantations.

An atlas of 12 woody plant roots including *Populus nigra* enriched by microphotographs of fine root morphology and anatomy was prepared in the reported period as part of the EUFORINNO project (http://euforinno.gozdis.si/presentation/) and published in 2016 (Mrak et al. 2016). *P. nigra* was sampled in native floodplain forest. The e-book is free of charge and available in the open repository SciVie (http://eprints.gozdis.si/1666/).
b) Registration of new cultivar

Up to now no clonal stoolbeds and no clonal material has been approved by the authorities. A register of clones, clonal mixtures and parents of family does not exist in Slovenia at present. The main reason is that the importance of using poplar or willow clones has not been recognized by the government authorities and wood sector.

c) Varietal control

Variety protection is not claimed.

2. Production Systems and Cultivation

a) Nursery

Planting of native poplars *P. nigra*, *P. alba*, *P. tremula* and willows *S. alba*, *S. eleagnos*, *S. purpurea*, *S. fragilis*, *S. viminalis* in Slovenia’s forests is very rare. The reason for this is the lack of forestry nurseries in Slovenia specialized for poplar and willow FRM cultivation and therefore lack of forest reproductive material on the market. The registered forestry nursery GLG maintains the first collection of 18 *P. nigra* genotypes propagated clonally from mature trees (8) and young trees of the Mura River population established in cooperation with SFI as part of the PEMURES project supported by the OP SI-AT 2007-2013 (http://www.pemures.com/cms/index.php/de/news). The GLG nursery still produces poplar clones *P. × canadensis* cl. Panonnia (syn. M1) and *P. deltoides* cl. S 1-8. The HPG Brežice produces poplar clones *P. × canadensis* cl. Panonnia (syn. M1), *P. deltoides* cl. 709, *P. deltoides* S 1-3, and *P. deltoides* S 6-7. Some clones are still introduced as pioneer crops in mixed stands in calamity areas or other afforestation areas in the sub-Pannonian ecological region.

b) Planted forest

Since Slovenia is a mountainous country, the possibilities for poplar plantations (5 m x 5 m, 400 plants/ha) are limited. All productive poplar plantations in Slovenia are concentrated in three main areas: Litija along the Sava River and areas in the Ljubljana Marshes (central Slovenia), Vrbina near Brežice along the lower part of the Sava River (SE Slovenia), and along the Mura River, where much of the Slovenian agricultural industry is concentrated (NE Slovenia). The most important potential areas are located along riverbanks and floodplain areas at an elevation up to 300 m, where we need to take into consideration the conservation of natural habitats in Natura 2000 and natural genetic resources of native tree species. The main barrier to the development of new plantations nowadays is also very limited commercial activity, no subvention for poplar and willow cultivation and production, no nursery tradition for developing new clones, and little information available for possible investors.

According to the data we gathered, the area of plantations with poplars for use over longer production periods (20 – 25 years) on non-forested areas has continuously decreased from 1944 ha in 1984 to 300 ha in 2015. In the period from 2013 to 2014 one third of all productive poplar plantations in the country were cut down due to the construction of new hydroelectric power plants along the lower part of the Sava River.
In last six years the first SRC plantations with willows and poplars were established on arable land. The Inger and Tordis SRC production plantation with willow clones is located on post-mining land. It was established on 4 ha in spring 2009. Cuttings were planted in a double row design with a density of 10,000 trees/ha. The primary aim of these plantations is the production of biomass power plants and recultivation of land directly or indirectly affected by mining activities (Čebul et al. 2012, Krajnc et al. 2013). During the winter of 2010 the willow was cut back to 10 cm of ground level for development of the multi-stemmed coppice. In spring 2013 and 2014 the first SRC experimental poplar plantations for testing old and new clones and pure P. nigra clones were established in different site conditions for biomass production. Planting density in poplar tests are 3 m x 0.5 m and 3 m x 1 m. At two different soil condition sites (light and heavy soils) in NE Slovenia, the Slovenian Forestry Institute and GLG are partners in a joint EU-POP project for testing of poplar clones from EU member states for use in short rotation coppice. Survival, growth and resistance to leaf rust for 25 poplar clones were measured. By agreement raw data was shared with clone owners and project partners. In trials a total of 40 poplar clones were planted, 5 of them pure P. nigra from Slovenian, Czech and Austrian collections. Rotation cycles are 2 and 4 years for poplars and 5 or more years for willows.

For the first time in Slovenia, 5 ha land was planted with native P. nigra and S. alba seedlings obtained from native forest genetic resources in the region. Both P. nigra and S. alba were used for the first creation of a beaver feeding area along the river terrace and for the first conversion of a poplar hybrid plantation to more natural structures. More information is available from the GoForMura project (http://goformura.gozdis.si/project/).

c) Indigenous forests

Native poplars and willows in Slovenia are P. nigra, P. alba, P. tremula, S. alba, S. fragilis, S. x rubens, S. eleagnos, S. purpurea, S. fragilis, S. viminalis, S. cinerea, S. triandra, S. myrsinifolia, S. petandra, S. daphnoides (Dakskobler et al. 2013). Analyses of the Forest Information System of the Slovenia Forest Service (data for 2015) revealed that stands including poplars (Populus nigra L., Populus alba L.) and willows (Salix sp.) cover 49,795 hectares, which represents 4.2% of the total Slovenian forested area. European black poplar is frequently present in forest vegetation communities: Querco roboris – Ulmetum laevis Issler, Alnetum incanae Ludi, Salici – populetum, Salicetum gr., Ulmo – Aceretum pseudoplatani Berger and Carici remotae – Fraxinetum W. Koch ex Faber (Marincek et al. 2002, 2003, 2006). Most willow and European black poplar communities are classified in the class Saliceta purpureae (Dakskobler et al. 2013). According to phytocenological relevés data, the aspen is a rare but naturally widespread species. It can grow in lowlands up to 1430 m above sea level.

d) Agroforestry and trees outside forests (TOF)

There are no agroforestry systems in Slovenia.

3. Genetics, Conservation and Improvement

All EUFORGEN technical guidelines on conserving the genetic diversity of the species at the European scale were translated into the national language. These guidelines are based on available knowledge of the species and on widely accepted methods for the conservation of forest genetic resources. The Slovenian editions published in the Slovenian professional journal
for forestry also provide an overview of the natural distributions of *P. nigra*, *P. alba*, and *P. tremula* in Slovenia (Božič 2010, Brus et al. 2012), describe their characteristic growing sites, ecological conditions for their growth, and plant associations where they appear, and provide recommendations for conservation and use. Particular emphasis is placed on the importance of various forms of mycorrhizae which allow European aspen and white poplar to also survive in arable sites.

a) Aigeiros Section

Primarily indigenous *P. nigra* in Slovenia is preserved in small locations along the main rivers and their tributaries on alluvial sites (Božič et al. 1999). In stands they are present as individual trees (solitaires) or in small groups of over-mature trees. The results of genetic studies using SSR gene markers indicate that the gene pool of remaining *P. nigra* populations in Slovenia maintains high genetic connectivity even if fragmented today. In natural populations the introgression of genes of *P. deltoides* was very low (Božič 2012).

Most conservation work is concentrated on *P. nigra*. Efforts have been made to preserve the remaining populations through *in situ* and *ex situ* measures. The SFI leads both an *in situ* and *ex situ* conservation program within the tasks of the Public Forest Service, financed by the Ministry of Agriculture, Forestry and Food of the Republic of Slovenia. An identification sheet for *P. nigra* prepared by EUFORGEN, a Hungarian identification sheet for the conservation of the selected genotype, and a EUFORGEN standardized list of descriptors for inventories of *P. nigra* stands (Alba 2000) were translated in the national language. The first seed stands of *P. nigra* in the category “selected” were approved under the provisions of the Forest Reproductive Material Act in 2015. Since the European black poplar crosses spontaneously with the widespread hybrid clones, genetic mixing with native black poplar seed stands cannot be excluded.

The exposure of native black poplar in Slovenia to genetic introgression was assessed using a combination of habitat and gene flow models (Debeljak et al. 2015). The habitat model was built using data mining of forest inventory data employing classification decision trees. Dispersion distances for pollen, seeds and vegetative parts at 0.9% and 0.001% of adventitious presence threshold were assessed using modified gene flow models. To protect native black poplar, protection zones around native black poplar stands were proposed. The intensity of introgression pressure by intersecting the occupied and potential habitat with the introgression pressure areas was assessed. The protection zones were 0.5–4.6 times larger than the occupied and potential habitat depending on the selected threshold and the type of dispersion vector. In the worst case scenario, 45.1% of protection zones would be exposed to high hybridization pressure. The authors recommend extending the proposed methodological approach to other regions with endangered black poplar. Complementarity of habitat modeling, dispersal modeling and evaluation of environmental hybridization pressures may significantly contribute to the development of active conservation strategies for black poplar as well as for other endangered tree species at the species level (Debeljak et al. 2015). The proposed approach provides an objective platform for designing conservation strategies at the level of riparian forests.

81 mature European black poplar trees were GPS mapped *in situ* along the Mura River in Natura 2000 sites for further phenotypical selection at the individual level. Among them 20 trees were phenotypically selected for potential selection of plus trees. An *ex situ* gene bank of native
European black poplar clones for conservation purposes was set up in the Izakovci poplar nursery managed by GLG. Besides reproduction of standard material in nurseries, it is necessary to continue with the selection and breeding of superior poplar and willow clones for conservation purposes and wood production in riparian zones.

The growth, vegetation and temperature characteristics of the native European black poplar stands were studied at selected sites along the Sava River in the subalpine ecological region (Vilhar et al. 2013). Based on the results, the selected forest stands are well preserved and have not recently been significantly exposed to negative human impact. Black poplar trees on the river island differ from the trees growing on river terraces in their horizontal stand structure. The measured temperature indicators and temperature stress in the flooded forests vary considerably, depending on the location of measurement (river terrace or river island) and on the type of vegetation (floodplain forest or meadow). Black poplar naturally regenerates only directly on the river banks but not in older floodplain forest stands. Recommendations for active protection of individual mature trees were proposed.

As genetic diversity is an essential element of trees species adaptation to climate change and other environmental changes, the EUFORGEN genetic monitoring working group reviews genetic monitoring methods and proposes options for creating a pan-European genetic monitoring system for dynamic conservation units of forest trees (Aravanopoulos et al. 2015). On a European level, 11 gene conservation units of European black poplar have been included in the pan-European strategy for genetic conservation of forest trees (de Vries et al. 2015). These units should be monitored for changes in their genetic diversity. Within the LIFEGENMON project, monitoring regions for European black poplar have been delineated along a transect from Germany to Greece to guide implementation of genetic monitoring. For more information see http://www.lifegenmon.si/.

b) Aigeiros, Leuce and Tacamahaca Sections

During the period under report a national archive of poplar clones was regularly maintained in the SFI nursery of Zadobrova. The 30 most bio-ecologically suitable and productive poplar clones for wood production in long rotations tested in Slovenia are included in the living archive and maintained by SFI. The genetic archive also serves as the source for collection of vegetative reproductive material for scientific purposes.

4. Forest Protection

The health status of all reproductive material in poplar nurseries is inspected twice a year by the Slovenian Forestry Institute, which is authorized for the official supervision of the health of all reproductive material for forest plantings, carried out in cooperation with forest inspectors. Phytosanitary measures are recommended and prescribed by forestry inspectors, and are obligatory for nursery managers. The implementation of the measures prescribed is overseen by forest inspectors.

Most frequently observed diseases were poplar leaf rusts (Melampsora spp.) and marssonina leaf-spot of poplar (Drepanopeziza punctiformis, sin. Marssonina brunnea). In some favorable years for the spread of these diseases, up to seven fungicide applications were performed in nurseries. Occasionally dothichiza bark necrosis of poplar (Cryptodiaporthe populea, sin Dothichiza populea) was detected in nurseries and in such cases the diseased propagation
material was forbidden to be marketed and phytosanitary measures were prescribed. The most frequently observed pest was *Chrysomela populi*, which was regularly controlled by insecticide applications. *Sciapteron tabaniformis* and *Saperda populnea* were often found in poplar nurseries, but caused little damage. Occasionally outbreaks of *Phratora vitellinae* (*Phyllodecta vitellinae*) were observed.

Poplar plantations were mostly affected by rusts, some older clones (I-214) were affected by premature leaf fall because of marssonina leaf-spot of poplar, and dieback of an old poplar plantation was detected because of drought and subsequently it was destroyed by the dothichiza bark necrosis of poplar.

### 5. Harvesting and Utilization

Production plantations can also have important potential for biomass production in Slovenia but more data that are reliable are needed for more detailed wood biomass potential estimation. In poplar plantations for long rotations, the mean annual increment was evaluated at around 14-18 m³/ha/year (Božič et al. 2012). In recent years, production cycles were prolonged from 20 to 25 years to reach a DBH of 40 cm or more (Lubi 2011).

Slovenia has no developed poplar or willow timber-based industries. There are no separate records on the use of poplar raw wood. Most poplar wood for consumers comes from Serbia in the form of components. The main raw material for paper manufacture used in the industry is recycled fiber obtained from recovered paper in the deinking process and in low extent fresh spruce and poplar wood for groundwood pulp manufacture.

The first results of SRC willow plantations established on post-mining land have shown that in the second year of coppice growth the Inger clone achieved a higher yield than the Tordis clone, with biomass yield of 4.6 t atro/ha and 3.5 t atro/ha, respectively (Čebul et al. 2012). The first results of SRC poplar plantations at the end of the first 2-year cutting cycle established in riparian sites vary significantly among clones and soil conditions. Pure *P. nigra* clone from Slovenian selection yielded on average 5.7 odt/ha, older poplar clones frequently planted in Slovenia (457, Pannonia, Lux, S1-8) yielded up to 13.9 odt/ha, clones from Germany selection up to 17.9 odt/ha and clones from Italian selection up to 39.3 odt/ha.

In native forest sustainable forest management is performed based on the forest management unit management plan. The forest management plan is prepared by forest authorities and approved by the Ministry for Agriculture, Forestry and Food. All forest owners are obligated to follow this management plan. Before taking on harvesting activities they must obtain permission from the regional unit of the Slovenia Forest Service. The local forester also marks the trees in the forest for felling and provides forest owners with harvesting guidelines.

### 6. Environmental Applications

*Populus* seed fibers are a natural source for production of oil super absorbents (Likon 2015). Poplar seed hair fibers are hollow hydrophobic microtubes with an external diameter between 3 and 12 μm, an average length of 4±1 mm and average tube wall thickness of 400±100 nm. The solid skeleton of hollow fibers consists of lignocellulosic material coated with hydrophobic
waxy coating with active surface area of 2.42 ± 0.16 m²/g and can effectively replace extremely expensive hydrophobic nano cellulose fibers (Likon et al. 2013).

The suitability of phragmites and poplar clones I-214, Lux, Guardi and P. alba cl. Villa Franca in constructed wetland and sand filter with the treatment of wastewater with a high salinity was intensively studied (Jurše 2015). Phragmites resulted in higher biomass yield and water use. Among four tested poplars, cl. I-214 and P. alba cl. Villa Franca had higher growth potential and resistance to higher salinity than cl. Lux and cl. Guardi (Jurše et al. 2015).

III. GENERAL INFORMATION

1. Administration and Operation of the National Poplar Commission or equivalent Organization

The Republic of Slovenia became a Contracting Party to the Convention Placing the International Poplar Commission (IPC) within the Framework of FAO on 25 May 2000. In response to the invitation from the IPC Secretary on 18 December 2013, the Scientific Board of the Slovenian Forestry Institute appointed a representative of the National Poplar Commission of Slovenia on 20 December 2013. In the framework of official cooperation, the promotion and exchange of ideas and materials between IPC, research workers, producers and landowners is carried out.

2. Literature

2012


BRUS, Robert, MARINŠEK, Aleksander, GREBENC, Tine, BOŽIČ, Gregor 2012. Tehnične smernice za ohranjanje in rabo genskih virov: trepetlika (Populus tremula) in beli topol (Populus alba), Slovenija. Gozdarski vestnik, ISSN 0017-2723, 70, 3, 149-156.


2013


JEMEC, Tina, KRAJNC, Nike, 2013. Zunajgozdni nasadi hitrorastočih drevesnih vrst. Iz znanosti za prakso v gozdi tehniki, 2, 1, 3.

KRAJNC, Nike, JEMEC, Tina, PIŠKUR, Mitja, 2013. Pridobivanje lesne biomase iz nasadov hitrorastočih drevesnih vrst, primer nasada Velenje (Exploitation of wood biomass from plantations of fast growing tree species, the case of the Velenje plantation. In: 3rd International


2014


2015


2016


3. Relations with other countries

The main cooperation was carried out between the Slovenian Forestry Institute and research institutions in Austria (BFW), Belgium (INBO Geraardsbergen), Croatia (Forestry Faculty in Zagreb), Germany (Bavarian Office for Forest Seeding and Planting, Teisendorf, Italy (PLF Casale Monferrato, Alasia Franco Vivia, Savigliano), Hungary (Forest Research Institute Sarvar) and Serbia (Institute of Lowland Forestry and Environment, Novi Sad).

Slovenia joined a Europe-wide collaborative testing of poplar clones (EU-POP) for short rotation coppice culture (SRC). Two poplar experts from the Slovenian public and private forest sectors attended the inception workshop on European cooperation on testing poplar clones for Bioenergy, which was held in Teisendorf, Germany in October 2013. In the framework of the international cooperation, the first plots for testing poplar clones for Bioenergy in SRC cultures were established in 2013 and 2014 in NE Slovenia. Later on a smaller experimental plot with willow clones selected in Croatia was established for phytoremediation purposes.

4. Innovations not included in other sections


1. SUMMARY STATISTICS (Q)

(see annex provided)
This report is based primarily on the specialized contributions of the following individuals and institutes:

Slovenian Forestry Institute  
Večna pot 2  
1000 Ljubljana  
http://www.gozdis.si/

Slovenia Forest Service  
Večna pot 2  
1000 Ljubljana  
http://www.zgs.si/zavod.za.gozdove.slovenije/index.html

The Institute of the Republic of Slovenia for Nature Conservation  
Tobačna ulica 5  
1000 Ljubljana  
http://www.zrsvn.si/sl/

Data was collected from the Forest Information System of Slovenia Forest Service, published data, literature and personal communications.