NOBANIS –Invasive Alien Species Fact Sheet

Acer negundo

Author of this species fact sheet: Piotr Mędrzycki, Faculty of Ecology, University of Ecology and Management, Warsaw, Poland. Phone: +48 22 825 80 35, E-mail: piotrmedrzycki@wp.pl

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Species description

Scientific names: *Acer negundo* L., Aceraceae.
Synonyms: *Negundo aceroides* Moench (1794), *Negundo fraxinifolium* (Nutt.) DC. (1824).
Common names: Box-elder, ash-leaved maple, manitoba maple (GB and US), Eschen-Ahorn (DE), askbladet løn (DK), saarvaher (EE), Saarnivaahtera (FI), askhlynur (IS), uosialapis klevas (LT), Ošlapu kļava (LV), Vederesdoorn (NL), asklønn (NO), klon jesionolistny, jesioklon (PL), asklönn (SE).

Fig. 1. Secondary trunks of an uprooted *Acer negundo*. Białowieża Forest, 2000, photo by P. Mędrzycki.

Fig. 2. (left) The leaves of Acer negundo, photo by Uwe Starfinger.
Fig. 3. (right) Samara clusters in late August, photo by P. Mędrzycki.

Species identification

While all maples have opposite leaves, and for a number of them the leaves are composed of small leaflets, *Acer negundo* is one of the few whose leaflet number is variable – from 1 (juvenile form in seedlings) to 5 or even 7 in older, fast growing branches and twigs. Young stems have green bark, often covered with "a whitish wax bloom" or hairs. There are many cultivars of various leaf colours and shapes.

A. negundo is usually a medium sized tree up to 20 (25) m high, and up to 90 (100) cm in diameter, in its primary (Hosie 1969) and in its invasive range (Zaleska 1958, Seneta 1991). Its architecture depends heavily on the habitat conditions. In mesic forests with stable soil it has the form of an upright tree with one trunk. When partially shaded *e.g.* at the forest border, its trunks start to weep down, even to a horizontal position. In non-forest habitats the individuals are much more ramified and seldom reaches more than 12-15 m of height (Sutton and Johnson 1974).

Other maples with composed leaves are all very rare in Europe. They can be found in botanical collections and not in ordinary parks or street plantings. The only two species with a variable leaflet number (*A. cissifolium* and *A. henryi*) are smaller and have more thin leaflets. Other species, from the sections Trifoliata, as *A. mandshuricum*, *A. nikoense* or *A. griseum*, always have 3 leaflets. For other traits see van Gelderen *et al.* (1994).

Native range

The primary range area of *Acer negundo* is limited to the New World. There are geographical vicariants from the same section, probably originating from the same Tertiary ancestor, present in Eastern Asia. The continuous range extends from New Jersey and central New York to the extreme southern Ontario, central Michigan and northern Minnesota, central Manitoba, central Saskatchewan and southern Alberta, central Montana and eastern Wyoming, Utah and California; and south to southern Texas and central Florida. It is also found locally in New Hampshire, Vermont, Massachusetts, Connecticut, Idaho, and Nevada. *A. negundo* has been probably naturalized in Maine, southern Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and in southeastern Washington and eastern Oregon. Geographical varieties of *A. negundo* occur in the

mountains of Mexico (states Nuevo Leon, San Luis Potosi, and south to Chihuahua) and in Guatemala (Rosario 1988).

Alien distribution

History of introduction and geographical spread

The species was imported deliberately to Europe together with a number of American plant species in the seventeenth century. The first known date is 1688, when it was encountered in the Fulham Garden in England (Wein 1931 after Kowarik 1992). A few years later it was imported to Holland (1690), and to Germany (1699). In Poland it was first introduced in the second half of the seventeenth century, and first noted in 1808 (Szymanowski 1960). In Russia it is known from the second half of the 18th century when experiences on its cultivation from seeds in botanical gardens of Petersburg and Moscow have begun. The first attempts of its introduction were unsuccessful; seedlings froze, as seeds were from a southern part of Northern America. Only in 19th century it was possible to reproduce this maple from the seeds received in Canada (Woody plants… www.ecosystema.ru). In Estonia it was first mentioned in the literature in 1865. The first introduction in Latvia in the beginning of the nineteenth century did not succeed, because the seedlings froze. However, in the first decades of the twentieth century *A. negundo* has spread very rapidly in gardens and parks (Lange *et al.* 1978).
In Lithuania it was initially cultivated in the 1930s and was first reported as escaped from cultivation in 1963 (Gudžinskas 1998). The species has not been widely planted in Norway, and currently it is available as a hardy, ornamental tree for private gardens, recommended for planting in gardens with rather steep slopes (S. T. Båtvik, pers. comm.).

Pathways of introduction

After its introduction, the plant became a quite popular garden tree due to its fast growth in the first years. Before the nineteenth century the species was tested in forestry, but the results were poor (von Schwerin 1919, Hegi 1977). In the second half of the nineteenth century it was rediscovered as a road and park tree. It was widely recommended for planting as a wind-break and shelter-belt tree (Ehrendorfer 1973, Tutin *et al.* 1968). In the first half of the twentieth century it became one of the most commonly planted alien tree species, together with the poplar hybrids, *Acer saccharinum* and *Fraxinus pennsylvanica.* Cultivars with variegated or yellow leaves are still often planted in gardens. They seem to be less invasive, but one must be aware of the wild rootstock on which they are grafted.
The species was also propagated and planted by bee-keepers. *Acer negundo* pollen is one of the earliest pollen sources in the spring. There is even a special honey, ”Boxelder's honey” which is sold in Białowieża, Poland.. The species' seeds may be transported accidentally during the autumn leaf fall.

Alien status in region

Naturalisation has taken place at a massive scale in disturbed, anthropogenic habitats and along river valleys in many regions of Poland, Germany (eastern parts, Rhine valley), Lithuania (Kuusk *et al.* 1996, Gudžinskas 1998), Ukraine (Mosyakin and Yavorska 2002) and Russia (Tzvelev 1996, 2000), see also table 1. Naturalised plants of this species are rarely found in Sweden (Rune Bengtsson, pers. comm.). In Latvia, the species is rather common throughout the country both in parks and in wild where it is found in river valleys, on roadsides and along railways. In Denmark the species is used in gardens and parks, but does not naturalise (Svart and Lyck 1991). In Estonia it is common in culture, but also is wild (Kukk 1999). In Norway only two localities in Oslo are regarded to have naturalised specimens of *Acer negundo*, both in close vicinity of planted

specimens.
In many riparian communities the species is considered as established. Lohmeyer and Sukkopp (1992) included this species in the group of "agriophytes", *i.e.* established in the natural plant communites in Central Europe.

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria						X	
Belgium				X			
Czech republic				X			
Denmark		X					
Estonia				X			
European part of Russia						X	
Finland		X					
Faroe Islands							X
Germany					X		
Greenland	X						
Iceland		X					
Ireland							X
Latvia					X		
Lithuania					X		
Netherlands				X			
Norway		X					
Poland						X	
Sweden			X				

Table 1. The frequency and establishment of *Acer negundo*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** - The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** - No information was available; **Native** - When a species is native in a country this is indicated in the table under the relevant frequency category.

Ecology

Habitat description

A. negundo is a quite ubiquitous tree. In its native range it occurs in many plant communities (22 Kuchler plant associations, 13 ecosystem types), including swamps, flood-plain forests, fresh mesic deciduous forests, mesic to dry conifer forests with pines, spruces and douglas-firs, oak savannas, chaparral and different kinds of prairie and grasslands (Rosario 1988).
Such an extremely wide habitat range is an effect of the high tolerance to the soil water deficit, as well as shortages of other below-ground resources. There are sex differences in the habitat preferences; both sexes are tolerant to extreme conditions, but females grow better in wetter and more nutrient-rich conditions (Dawson and Ehleringer 1993, Ward *et al.* 2002).
A. negundo is moderately resistant to flooding, *i.e.* less tolerant than poplars and willows, but more tolerant than most of the other species from mesic forests (Friedman and Auble 1999). In effect,

along the big rivers in its native range it usually occurs in the upper floodplain terraces (Rosario 1988, Everson and Boucher 1998).
A. negundo also colonises anthropogenic habitats and is often called a "weed tree".
The habitats where it is found in its native range and its invasive range are quite similar. It abundantly colonises riverside communities (*e.g.* floodplain forests) along small rivers and streams up to 1000 m a.s.l. It is found in mesic oak-hornbeam forests, pine forests, especially along the forest edges.
In the absence of flooding *A. negundo* is usually replaced in the course of succession by more shade-tolerant species. As well as colonising natural plant communities (*e.g.* forests and steppe), it also colonises a huge range of seminatural areas, such as neglected parks, settlements, abandoned arable fields, roadsides, railway lines, dumpsites and even building roofs.

Reproduction and life cycle
A. negundo is usually considered to be a completely dioecious and protandrous species. Single reports of other sexual forms (Fraser 1912, Hall 1951, 1953) have recently been updated with the discovery of regular and common occurrence of perfect flowers (*i.e.* composed of stamina and anthers) in Central-Eastern Poland (Mędrzycki, Kołaszewska and Browiński *in press*, Kołaszewska *et al.* 2005). In its primary range, the sex ratio variability across the river valleys was considered to reflect differential sex habitat preferences (Freeman *et al.* 1976, Ramp and Stephenson 1988, Ward *et al.* 2002), but in many cases the sex ratio oscillates around 1,0 without any evident correlation to the habitat conditions (Sachse 1991, Mędrzycki 2002).

The flowering period of *A. negundo* begins in early spring, before the development of leaves. The pollen of *A. negundo* is carried mainly by the wind, but pollen grains are heavier than those of *Corylus avellana* (Rosario 1988). There have been reports of at least supplementary pollination by bees, which gather huge quantities of pollen in early spring. The fruits of *A. negundo* are double samaras, as in the whole genus *Acer* and even the family Aceracae. The fruits are released usually in the spring, and after the frost period are ready to germinate. The usual seed material purity is 100% (Olson and Gabriel 1974, Kujawski and Davis 2002).

The age at first reproduction depends heavily on the availability of resources – in open areas with at least moderate soil conditions it may be as short as 5 years, but in the forest understorey it may extend to 15 years or more (Mędrzycki 2002). The availability of light seems to affect the yearly seed crop – light limited female individuals produced five times less seeds than individuals from open areas. The maximal fecundity is hard to estimate; 1-5 x 10^5 samaras per female tree per year may not be the maximal value. The maximum age is approximately 100 years, but exact measures are usually impossible, due to the lack of central annual growth rings.

The seed mass is comparable to other maples, but is unusually high when compared with other early-successional species (Bartels 1982).

Dispersal and spread
Regardless of the habitat the basic way of seed transport is wind dispersal. Samaras may be carried at least 50 m from the point of release (Sachse 1991). In certain habitats, *e.g.* river valleys, running water may also be effective as a dispersal agent. Given that box-elder seeds are able to survive in water for at least 6 weeks and to germinate before touching the ground (author's unpublished data), that mode of dispersal may often be a long-distance one.
The approximate spread rate may be from 0,6 to 1 m/yr when carried by wind; up to 100 m/yr when carried accidentally by cars and trains along the roads and rails or by the water (Mędrzycki 2002,

data from the Białowieża Forest for the box-elder invasion in the period 1900-2000).

Impact

Affected habitats and indigenous organisms

The influence of *A. negundo* on other plants seems not to differ too much from the impact of other deciduous trees. Its litter decomposes rather well, so it may accelerate litter mineralisation, in contrast to the species with hardly decomposable leaves, *e.g. Pinus silvestri*s or *Populus tremula.* However, this has not been thoroughly examined. The shading effect seems to be also quite similar to other maples.

The only specific impact of *A. negundo* is its permanent vegetative regrowth leads to domination in the flood-plain forests. The typical behaviour of *A. negundo* is to lean forward or fall down, touch the ground, root in the soil and to form fast-growing secondary shoots. Such a growth pattern may be repeated many times. Some of the horizontal trunks may be repeatedly covered by river deposits. This resulting amazingly complex organism (see Fig. 1 and 4) dominates the lower tree canopy layer and almost totally stops regeneration of poplars and willows (Künstler 1999). Perhaps the only limiting factor is the frequency and the duration of flooding.

In its primary range the species seems to be very prone to pathogenes (*e.g.* White and Whitham 2000). There seems to be a slight 'enemy release' effect in its secondary range.

Fig. 4. *Acer negundo* dominating the lower tree layer in an *Salici-Populetum* floodplain forest in Warsaw, 2004, photo by P. Pabjanek.

Genetic effects

As the species has no close relatives (Section *Negundo*) in the region of concern, there is no direct risk of hybridisation or introgression. *A. negundo* may have an indirect impact on the genetic structure of other competing species by establishing a different selective pressure or simply by decreasing the population number of other species.

Human health effects
The pollen of *A. negundo* is allergenic (Esch *et al.* 2001).

Economic and societal effects (positive/negative)
A. negundo has no direct value for forestry. The wild form and many cultivars have been used in landscape architecture for park, street, and countryside roadside plantings for a long time. Currently the wild form is less commonly chosen, but still remains an interesting choice, when low cost, vigorous growth and soil conditions tolerance are the plant selection criteria, *e.g.* for land reclamation.

In cities where it is deliberately planted or where spontaneously arrived individuals are common, the tree may heavily contribute to the air quality because of its high maximal photosynthetic rate which may exceed 25 μmol CO_2 m^{-2} s^{-1} (Foster 1992). However, no study has yet analysed this aspect. Spontaneous regeneration of the species creates dense thickets, which can easily become an intimate place for informal social life (not always appreciated by local authorities).

Management approaches

Prevention methods
Prevention would be the easiest and cheapest way of the *A. negundo* invasion management. It is unlikely that *A. negundo* can be planted in a way that avoids the spontaneous spread of the species. Since the decorative cultivars, most often propagated by grafting on the rootstock of wild forms, are produced and sold by many nurseries and garden centers, there is little chance to avoid it completely. It is therefore advisable to refrain from planting this species.

Eradication, control and monitoring efforts
In the vicinity of large populations a containment, *i.e.* an attempt to limit the occurrence of box-elder to already invaded area would be the best solution. Because of the relatively low dispersal rate of seeds with the wind, a containment zone extending 50-250 m from the seed sources may be large enough. Long-distance dispersal is possible, yet not at a massive scale (snow-runner, storms, turbulences, etc). However, the more interconnected the landscape, the greater the chance for the accidental carrying of seeds by the cars and trains or movement by the water. Under such circumstances the dispersal rate might be even 100 times greater, so 5-10 kilometres of the buffer zone diameter should not be too much.

Eradication could be realised mainly by the mechanical eradication of seedlings and juvenile individuals. Chemical treatment should be also quite effective; *A. negundo* is sensitive to many herbicides, *e.g.* to glyphosate.

Information and awareness
There are no reports of information or awareness campaigns regarding the species.

Knowledge and research
A. negundo has been studied to the widest extent in its home range. It has become a *de facto* model species for the habitat-driven sex differentiation evolutionary process (*distinctive selective forces* hypothesis, *cfr* Willson 1986, Dawson and Ehleringer 1993, Ward *et al.* 2002). Its population biology was studied by Doyle (born Sachse) in its native range in Wisconsin (Sachse 1991).A cross-scale study of *Acer negundo* invasion in relation to land use in the Białowieża Forest, using remote sensing was made by the author of this factsheet (Medrzycki and Pabjanek 2001, Mędrzycki

2002). The behaviour of the species in Warsaw (Poland) and its vicinities, has been studied by: Kosim (2005; Warsaw city parks), Sałapa (2005; in Saska Kępa and Gocław – the Warsaw quarters), Banaszek (2005; in the suburban town Wołomin near Warsaw), and Caban (2005; in the suburban town Piaseczno near Warsaw). The variability of reproductive systems has been studied by Mędrzycki, Kołaszewska and Browiński (2005, 2006 *in press*). The occurrence and impact of the box-elder on the flood-plain forests were studied in Vistula River Valley by Künstler (1999) and in Świder valley by Cieślińska (*in prep.*). Kosiński studied the behaviour of *A. negundo* in the mixed pine-oak forests in the Kampinoski National Park (2005).
An interesting GIS-based potential habitat modelling for the Czech Republic has recently been made by Hrazsky (2005).

Recommendations or comments from experts and local communities
None.

References and other resources

Contact persons

Filip Verloove (BE), National Botanic Garden of Belgium, E-mail: filip.verloove@cepa.be

Petr Pyšek (CZ) Institute of Botany, Academy of Sciences of the Czech Republic, CZ-252 43 Průhonice, Czech Republic, E-mail: pysek@ibot.cas.cz

Frank Klingenstein (DE) Bundesamt für Naturschutz (Federal Agency for Nature Conservation). Konstantinstraße 110, 53179 Bonn, Germany. www.bfn.de. Phone: +49(0)228/8491-264, E-mail: frank.klingenstein@bfn.de

Helene Nyegaard Hvid (DK), NOBANIS Danish Ministry of the Environment, Nature Agency, Haraldsgade 53, DK-2100 Copenhagen Ø, Phone: (+45) 72 54 2418, E-mail: nobanis@sns.dk

Tiiu Kull (EE) PhD, Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Head of Department of Botany, Riia 181, EE-51014 Tartu, Estonia. Fax +372 7 383013, E-mail: tiiu@zbi.ee

Ministry of Domestic Affairs, Nature and Environment (GL), P.O Box 1614, 3900 Nuuk, Greenland, Phone: (+299) 34 50 00, E-mail: nnpan@nanoq.gl

Colette O' Flynn (IE) National Biodiversity Data Centre, WIT West campus, Carriganore, Waterford, Ireland, Phone: +353 (0) 51306240, E-mail: coflynn@biodiversityireland.ie

Zigmantas Gudžinskas (LT) Institute of Botany, Žaliųjų Ežerų Str. 49, LT-08406 Vilnius, Lithuania. E-mail zigmantas.g@botanika.lt

Andrejs Svilans (LV) National Botanic Garden, Dendroflora Department, Miera 1, LV- 2169 Salaspils, Latvia. E-mail: andrejs.svilans@nbd.apollo.lv

Svein T. Båtvik (NO) Directorate for Nature Management. N-7485 Trondheim, Norway. Phone: +47 73 58 07 36. Fax: +47 73 58 05 01. E-mail: svein-t.batvik@dirnat.no

Piotr Mędrzycki (PL) Faculty of Ecology, University of Ecology and Management, Warsaw, Poland
Phone: +48 22 825 80 35, E-mail: piotrmedrzycki@wp.pl

Rune Bengtsson (SE) PhD, Swedish Biodiversity Centre, P.O. Box 54, SE-230 53 Alnarp, Sweden.
Phone: +46 40 41 51 50. E-mail: rune.bengtsson@cbm.slu.se

Prof. Dr. Vladimir Papchenkov (RU) Institute for the Biology of Inland Waters RAS, 152742, Borok, Russia. E-mail: papch@mail.ru

Links

USDA, NRCS. The PLANTS Database - *Acer negundo*
The map of the distribution of *Acer negundo* in North America

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