

Spread intensity and invasiveness of sycamore maple (*Acer pseudoplatanus* L.) in Lithuanian forests

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The primary objectives of this study were to estimate seedling abundance, spread intensity, and invasiveness of sycamore maple (*Acer pseudoplatanus* L.) in Lithuanian forests. The species was introduced to Lithuania in 1802, and since then has subsequently become gradually invasive. Seedling understory abundance, colonization and dispersal were investigated in six forest blocks covering the principal sycamore distribution areas in southwestern Lithuania. Seedlings height and densities in the understory were evaluated, and seedlings assigned to four height groups. Species invasiveness was estimated applying the Pest Plant Prioritization Process (PPPP), based on the Analytic Hierarchy Process (AHP) method. Results showed the average spread distance from the parent tree was 257 m, with a mean seedling number per hectare of 2064. Sycamore maple invasive score was 0.6426 (range: 0-1), the current relative to potential distribution rating was 0.57, and the social, environmental, and economic impact score was 0.1682. Such values were used to assess the Pest Plant Score for sycamore maple, obtaining a value (0.3537) lower than expectations (0.5). Results indicated that the species exhibits invasive properties and a rapid spread in the study area. Some implications of the above results in view of the upcoming climate change and the use of sycamore maple in Lithuanian forest plantations are discussed.

Keywords: Sycamore, Seedling spread, PPPP, Invasiveness, Pest Plant Score

Introduction

During the early 19th century, the practice of planting non-native tree species in Lithuania was initiated with the primary goal of increasing wood productivity. It was unknown at the time certain species would successfully undergo naturalization, and subsequently exhibit a widespread geographic distribution, threatening natural ecosystems. Vitousek & Walker (1989) characterized the alterations of the community stability and structure due to non-native tree species, which successfully proliferated and became invasive community members, limiting native plant growth (Lichstein et al. 2004). Boxelder (*Acer negundo* L.), black locust (*Robinia pseudoacacia* L.), and black cherry (*Prunus serotina* Ehrh.) are included in the list of invasive species in Lithuania, and additional

alien species are currently being considered for invasive status. One of the more problematic non-native species in Lithuania is the sycamore maple (*Acer pseudoplatanus* L., Sapindaceae), characterized by rapid growth (when grown on suitable sites) and potentially high timber prices (Hein et al. 2009). Sycamore maple is mostly a central-European, mountain species reaching its north-eastern range limit in Poland. Sycamore is rarely found in pure stands covering small areas on steep slopes on limestones where it forms its own communities (*Acerion pseudoplatani* alliance - Jones 1945). More frequently it grows in mixed broad-leaved forests of the *Carpinion* and *Alno-Padion* alliances (Boratynski 1999). In Lithuania, the species grows in fertile moist sites and in secondary forests. Moreover, it is shade and

frost tolerant (Navasaitis 2004), and in naturally regenerated stands often grows mixed with ash (Binggeli 1992). Typically, the species begins bearing fertile seeds at approximately 20 to 30 years of age (Burschel & Huss 1997, Navasaitis 2004).

Sycamore maple is well adapted to the current climatic conditions of central Europe, and is expected to expand beyond its current distributional limits (Kölling & Zimmermann 2007, Kölling 2007). This species has become naturalized in many countries, including Spain, Turkey, Ireland, Sweden, North and South America, India, and New Zealand (Binggeli 1992, Rusanen & Myking 2003). In Lithuania, sycamore maple may reach up to 24 m of height and 1 m of stem diameter (Januškevičius et al. 2006), and is mostly found in parks and gardens, with only few forest plantations.

The question we pose is whether sycamore maple may be considered an invasive non-native tree in Lithuania. Williamson & Fitter (1996) estimated that only approximately 10% of naturalized plant species become invasive and produce significant economic and ecological impacts. Historical records indicated sycamore maple was introduced to the Vilnius University Botanical Garden in 1802 (Skridaila 2001), and since then it readily spreads into local forest stands. Informed decisions must be made to control invasive trees in forests, which requires establishing the relative importance of each alien tree.

The principal objectives of this study were to estimate sycamore maple seedling abundance, spread intensity, and invasiveness in Lithuanian forests. Invasiveness was determined by evaluating the following questions: (i) how invasive is the species, *i.e.*, how rapidly can it spread? (ii) what is the present and potential extent of the species? (iii) what are the social, environmental, and economic impacts of the species in Lithuania?

Material and methods

Description of the study area

The Lithuanian climate is transitional and varies from maritime in the west to continental in the east (Galvonaite et al. 2007). The mean annual temperature is approximately 6 °C, and mean annual precipitation varies from 620 to 700 mm along an east-west gradient. Lithuania's terrain is an alternation of moderate lowlands and highlands, with a maximum elevation of nearly 300 m. Alisov (1954) classifies Lithuania in the southwest sub-area climate of the South Baltic. In general, the country lies in boreal and broad-leaved forest belts, and forests cover nearly 33% of the territory. The natural geographic range of hornbeam (*Carpinus betulus* L.) marks the border between the predominantly broadleaved zone to the south and the conif-

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Received: Sep 06, 2012 - Revised: Jul 26, 2013 - Final Acceptance: Feb 20, 2015

Citation: Straigyte L, Baliuckas V, 2015. Spread intensity and invasiveness of sycamore maple (*Acer pseudoplatanus* L.) in Lithuanian forests. iForest 8: 693-699 [online 2015-03-19] URL: <http://www.sisef.it/iforest/contents/?id=ifor0763-006>

Communicated by: Renzo Motta

erous zone to the north. Conifers constitute about 56.1% of the total forest area (source: State Forest Service). The main conifer species are Scots pine (about 35.3%) and Norway spruce (about 20.8%). Broadleaf trees dominate the central part of the country: birch constitutes about 22.2% of the total, followed by black alder (about 6.8%) and European aspen (about 3.8%). Other hardwoods make up 4.7% of the total forest area and consist of pedunculate oak (2.0%), common ash (1.8%) and other species (elms, hornbeam, etc.).

This study was conducted in six forest blocks, in south-western Lithuania (Tab. 1), differing in dominant tree species area and prevailing site type. The study area includes 40-90 year old stands. Soil fertility was obtained from the forest inventory database. The dominant tree species were *Pinus sylvestris* L., *Acer pseudoplatanus* and *Fagus sylvatica* L. The shrub layer was dominated by *Acer pseudoplatanus*, *Sorbus aucuparia* L. and *Corylus avellana* L. *Acer pseudoplatanus* and *Fagus sylvatica* are non-native to Lithuania.

Seedling abundance and spread intensity

The density of sycamore maple seedlings in the understorey was evaluated in each block per unit area and then reported to hectare. Seedlings were grouped into four height groups: (1) < 0.5 m; (2) 0.5-1.5 m; (3) 1.5-3 m; (4) > 3 m. No replicates per forest block were made as the data collection was performed in a comprehensive way (see below) to forest stand in areas larger than half a hectare at each site. The spread of sycamore maple was assessed by collecting the following information:

- latitude, longitude and altitude of the most likely parent tree or group of parental (mature) trees; in almost all cases mature trees were scattered over large areas and at considerable distance each other, so seedlings dispersal was considered from the closest mature tree;

- the area covered by sycamore maple in the understorey from the parent tree in four directions (N, E, S, and W): the number of seedlings along 5m-wide transects was recorded, and the average spread distance calculated based on mean values for all directions. The length of transects varied based on the seedling spread distance.
- the species composition in the canopy layer and the dominant tree species of the sampled stand;
- the relative density of the upper canopy layer on a scale 0 to 1.0, where 1.0 indicates the highest density, following the procedure adopted by the Lithuanian National Forest Inventory (2003-2007);
- the underbrush cover density was recorded as the coverage of the crown projection on the 5-m transect area (0-100%).

Statistical analysis was carried out using SAS software (SAS Institute, Inc., SAS/STAT software Release 9.3). SAS PROC CORR was used to calculate Pearson's pairwise correlation coefficients between seedling abundance and stand characteristics. The exact Kolmogorov-Smirnov two-sample two-sided test (SAS PROC NPAR1WAY) was performed for testing differences in seedling height classes and densities among the six sites. The same test was used in the comparison of different seedling groups by site fertility and underbrush cover. Mantel test with 10 000 permutations was carried out on a Euclidean distance matrix for similarity measures using densities of seedling height classes against a matrix of pairwise geographical distances between sites.

Invasiveness assessment

The Pest Plant Prioritisation Process (PPPP) was used to determine the invasiveness degree (Saaty 1995, Weiss & McLaren 2002). PPPP is a prioritization process or risk assessment based on the Analytic Hierarchy Process (AHP), which ranks weeds (or invasive plant species) by: (1) assessing plant invasiveness; (2) comparing the

species' present and potential distributions; and (3) determine the impacts of the plant on social, economic, and environmental values. The method described by Panetta & Dodd (1987) and developed by the Biosciences Research Division of the Department of Primary Industries, Victoria, Australia (Anonymous 2004) was followed in this study. Weightings of each criteria were set using an expert system relying on multi-criteria analysis (Anonymous 2004). An intensity rating (score) was assigned to each species considered for each criteria listed in Tab. 3 based on the following scale: high (1), medium-high (0.75), medium (0.5), medium-low (0.25), and low (0).

Invasiveness can be defined as the ability to establish, reproduce and disperse within an ecosystem. To assess a plant for both invasiveness and impact, information from a variety of sources including the scientific literature, databases, online information, journal articles and other sources was collected. Such information has been then grouped under several "criteria" that are listed in Tab. 3. For each criterion, an "intensity" value was assigned based on the following ratings: high (1.0); medium-high (0.75); medium (0.5); medium-low (0.25); and low (0.0). Wherever the information on a specific criterion was lacking, rating was set to 0.5 (medium). The scored ratings were then tallied and weighting for each criterion calculated to obtain an "invasiveness score" (IS) for maple (eqn. 1):

$$IS = (W_g \cdot W_c) \cdot R_i$$

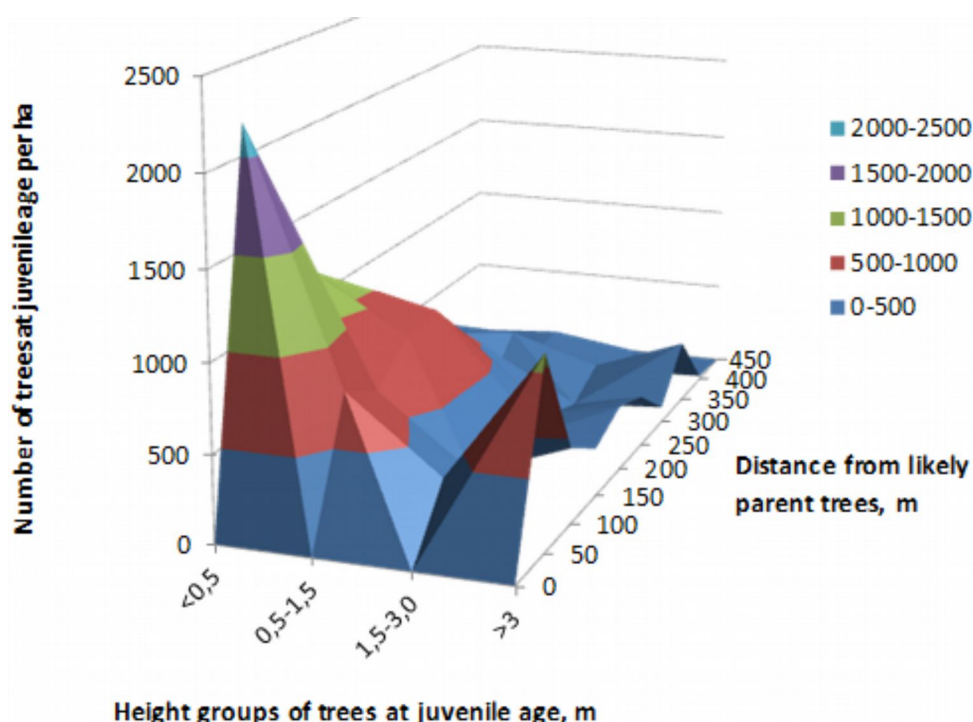
where W_g and W_c are the weightings calculated for groups and criteria, respectively, and R_i is the intensity rating value based on the scale reported above. The closer the invasiveness score is to 1, the more invasive the plant is.

Current and potential distributions are other major components required in the AHP. Current distribution of *A. pseudoplatanus* was derived from the Lithuanian Fo-

Tab. 1 - Descriptive data for the sycamore maple forest blocks used in this study. (*) Site Index: humidity (N, normal; L, temporarily wet); fertility (b, poor; c, fertile); soil texture (l, light soil; p, two story soil). (SD): standard deviation.

No	Forest enterprise, forest district	Region	Climate type	Latitude Longitude	Altitude a.s.l. (m)	Site index*	Stand age	No. seedlings ha ⁻¹	Seedling spread distance (m)	
									Mean	SD
1	Silutes, Rambyno	West southern	maritime	55° 02' 44" 22° 05' 35"	63	Ncl	60	2465	373	51
2	Silutes, Norkaiciu	West central	maritime	55° 26' 59" 21° 32' 17"	2	Ncl	90	3446	291	59
3	Jurbarko, Viesviles	West southern	maritime	55° 04' 52" 22° 24' 09"	24	Ncl	80	1354	210	119
4	Jurbarko, Viesviles	West southern	maritime	55° 04' 58" 22° 24' 25"	23	Ncl	60	492	134	71
5	Dubravos, Vaisvydavos	Central	transitional	54° 50' 38" 24° 02' 33"	79	Nbl	60	2528	209	34
6	Dubravos, Vaisvydavos	Central	transitional	54° 51' 26" 24° 02' 40"	68	Ncp	40	2098	130	13

Fig. 1 - *A. pseudoplatanus* seedling density as a function of the distance from the likely parent tree(s) by seedling height group. Density per hectare was pooled over 50m distance intervals from the source.



rest Inventory database, while its potential distribution was inferred based on the regional scientific literature (see references in Tab. 3). The ratio of present to potential distribution (*PPD* - range: 0-1) provides an indication of the stage the spreading of sycamore maple has currently reached.

Group and criteria ratings used to evaluate the species' impacts are listed in Tab. 4. To obtain an "impact score" (*I*), the intensity rating scores were multiplied by the overall weighting for each criterion and summed with all the other criteria scores, obtaining a value ranging between 0 and 1.

Finally, a Pest Plant Score (*PPS*) was obtained as follows (eqn. 2):

$$PPS = \alpha(IS) + \beta(PPD) + \gamma(I)$$

where *IS* is the invasiveness score, *PPD* is the ratio present-to-potential distribution, *I* is the impact and α , β and γ are weightings for the subcomponents drawn from the literature (Weiss & McLaren 2002).

Results

Seedling abundance and spread intensity

The highest sycamore maple spread density was observed in blocks dominated by birch, pine, maple, and lime. The mean number of seedlings per hectare over all study sites was 2064 ± 419 (Fig. 1), the maximum number observed was 3446 seedlings per hectare, and the minimum was 492.

A significantly higher percentage of sycamore maple seedlings was detected in the

Tab. 2 - P-values of the Kolmogorov-Smirnov test for differences in seedling height classes and densities among the six sites analyzed. The P-values for the first (upper row) and second (lower row) classes are reported above the diagonal, while the third (upper row) and fourth (lower row) classes are reported below the diagonal.

Site No.	1	2	3	4	5	6
1	-	0.2372	0.1630	<.0001	0.0068	0.0056
2	0.4143	-	0.6379	0.8001	0.3359	0.0643
3	0.4143	0.2011	-	0.0004	0.0347	0.2109
4	0.1126	<.0001	<.0001	-	0.1147	0.3033
5	<.0001	<.0001	0.2001	0.8107	-	0.4507
6	0.0387	0.0003	0.0267	0.8591	0.9582	-
1	0.1458	0.2562	0.9577	0.1258	0.8591	0.0218
2	0.0001	<.0001	0.5671	0.0477	0.9582	0.0851
3	0.9954	0.4392	0.3643	0.0083	0.8331	0.2985
4	<.0001	<.0001	0.7112	0.0189	0.9997	0.1250
5	<.0001	<.0001	0.7112	0.0189	0.9997	-
6	<.0001	<.0001	0.7112	0.0189	0.9997	-

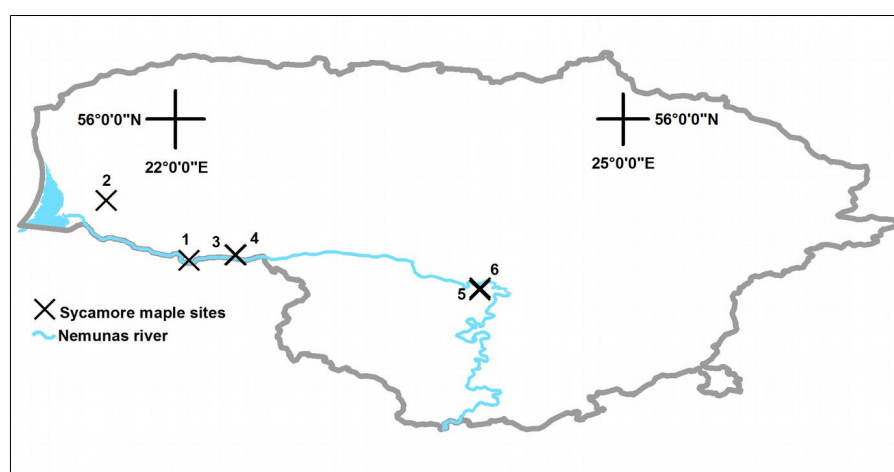


Fig. 2 - Location of sycamore maple sites used in this study.

Tab. 3 - Groups and criteria weightings for determining the invasive degree.

Group	Criteria	Notes	Criteria weightings	Rating	Impact
Establishment	Germination requirements	Seeds germinate in spring; seeds show dormancy (Pinfield 1987); germination regimes: 20°C, continuous light, 20 d (Pinfield et al. 1987)	0.0425	0.75	0.032
	Establishment requirements	Occurs under moderate canopy forest, prefers moist soil	0.3355	0.75	0.25
Growth/com-petitive ability	Disturbance requirements	Establishes in open woodlands, forest	0.122	0.75	0.09
	Life form	Tree	0.00576	0	0
	Allelopathic properties	Roots, leaves have moderate effect (Mensah 1972)	0.00864	0.5	0.0043
	Tolerates herbivore pressure	Roe deer browsing (Diaci 2002, Weidema & Buchwald 2010)	0.0456	0.5	0.0228
	Normal growth rate	Moderately rapid growth. One of the fastest growing trees in Europe (Cronk & Fuller 1995)	0.018432	0.75	0.0138
	Stress tolerances	Tolerates frost, fire	0.01776	0.5	0.0089
Reproduction	Reproductive system	Reproduces by seeds	0.005593	0.25	0.0014
	Propagule production	Propagule density (2064 ha ⁻¹)	0.05474	1	0.054
	Seed longevity	Seeds can be stored for 3 years at -3°C with 24-32% mc (Suszka 1978a, 1978b)	0.030464	0.25	0.0076
	Reproductive period	Trees are long lived (350-400 years); tree produces new growth each spring	0.012019	1	0.012
Dispersal	Time to reproductive maturity	Plants start flowering at 20 years of age (Navasaitis 2004)	0.016184	0	0
	Number of mechanisms	Propagules spread by wind, animals	0.094572	0.5	0.0472
	How far do propagules disperse	Propagules will disperse several hundred metres	0.189428	0.5	0.0947
Invasiveness Score		(max. = 1, min. = 0)	-	Σ	0.6426

first two height classes (≤ 0.5 m and 0.5-1.5 m) of the understory on fertile sites ($p = 0.0175$ and $p = 0.0006$, respectively). The P-values from Kolmogorov-Smirnov test for differences among the six sites for seedling height classes and densities are presented in Tab. 2. The estimates clearly show that the smallest (≤ 0.5 m) and the largest (> 3 m) seedling classes significantly differed among sites. Mantel's test using the total seedling quantity and the distance among sites resulted in a positive though not significant correlation ($r = 0.56$, $p > 0.05$). However, using the smallest class seedling quantity a significant result was obtained ($r = 0.91$, $p = 0.0263$), while no significant correlations were detected by the Mantel's test carried out the largest class data and the distance among sites ($r = 0.21$, $p > 0.05$).

Pearson's correlation coefficient between the underbrush cover and the quantity of sycamore maple seedlings was not statistically significant ($p > 0.05$). Nonetheless, it just revealed the tendency of a negative effect/relationship of underbrush cover on the quantity of seedlings in the first two height classes, as well as a positive effect on the fourth class (the largest seedlings). Underbrush cover was divided into two groups, the first including all the values below 50% and the other including all the values above such threshold. Differences in the quantity of seedlings in each height class were then tested using the Kolmogorov-Smirnov test, revealing significant differences in all but the third height class (1.5-3 m).

The age of the parent tree was positively correlated with the density of the largest

sycamore maple understorey seedlings ($r = 0.83$, $p < 0.0001$) and with the total quantity of seedlings ($r = 0.51$, $p = 0.0354$). The upper canopy layer density had positive effect on the quantities of smallest seedling group ($r = 0.87$, $p = 0.0026$) and negative on the largest group ($r = -0.77$, $p = 0.0154$). Mean seedling spread distance from the parent tree was 257 m.

Sycamore maple invasiveness

The invasiveness score obtained for sycamore maple in this study was 0.6426 (Tab. 3). The highest ratings were recorded for propagule density and the reproduction period (rating=1.0). Medium-high ratings (0.75) were obtained by germination, growth rate, and establishment and disturbance requirements. In particular, the establishment features of the species mostly contribute (58%) to increase the invasiveness score for sycamore maple.

The intensity ratings for the ratio of present to potential distribution are shown in Tab. 4. Based on data evaluation, a medium intensity rating was obtained (weight = 0.57). Indeed, sycamore maple in Lithuania has been primarily recorded along the roadsides, in the riparian corridors and near the few parent tree plantations (Fig. 2).

Criteria ratings for determining the social, environmental and economic impacts of sycamore maple are shown in Tab. 5. Based on such ratings, the impact score obtained for sycamore maple was very low (0.1682).

In order to evaluate the relative importance of sycamore maple as invasive plant species in Lithuania, results from invasiveness (Tab.

Tab. 4 - Intensity ratings for the ratio of present to potential distribution of sycamore maple.

Rating	Weight	Regional Rating
Very high	1	Infestations that can be eradicated with no chance of reinvasion from outside the area of control
High	0.85	Infestation(s) that can be eradicated with some chance of reinvasion
Medium high	0.71	Several small infestations beyond eradication
Medium	0.57	A large partially dispersed infestation or a few widely scattered small infestations
Medium low	0.42	Numerous large, dispersed infestations or many scattered, small infestations
Low	0.28	The majority of region is infested with some large areas still "clean" (more "clean" areas than infested)
Very low	0.14	The majority of region is infested with some small areas still "clean" (less "clean" areas than infested)
Extremely low	0	Reached full potential, but may increase in density within the infested area

Tab. 5 - Group and criteria ratings for determining social, environmental and economic impacts.

Group	No	Criteria	Comments	Rating	Impact
SOCIAL (Tourism, Visual aesthetics, Cultural sites)	1	To what extent does the weed restrict human access?	Would not hinder human access	0	0
	2	To what level does this weed reduce the tourism/aesthetics/recreational use of the land?	Sycamore not obvious to the average visitor	0	0
	3	To what level is the plant injurious, toxic or the spines affect people?	Not toxic and no spines	0	0
	4	How much damage is done to indigenous or European cultural sites?	No damage	0	0
NATURAL RESOURCES (soil, water and pro- cesses)	5	To what extent does this weed impact water flow within watercourses or water bodies?	No effect	0	0
	6	To what extent does the weed impact water quality (i.e., dissolved O ₂ , water temperature)?	No impact	0	0
	7	To what extent does the weed increase soil erosion?	No increase	0	0
	8	To what extent does this weed reduce the biomass of the community? (nb. biomass acting as a carbon sink).	Biomass may increase in forest gaps	0	0
	9	To what extent does the weed change the frequency or intensity of fires?	Can suppress fire in pine forests	0	0
Fauna and flora / vegetation and EVCs	10	To what extent does this weed impact the vegetation (composition on the following): a. High value EVCs b. Medium value EVCs c. Low value EVCs	Minor displacement Changes some dominant spp. Do not grow	0.25 0.5 0	0.0205 0.0240 0
	11	To what extent does this weed affect the structure of a vegetation community?	After long period, can affect trees, shrubs and ground cover	0.75	0.0518
	12	What effect does the weed have on threatened flora?	Data not available	0.5	0.0304
	13	What effect does the weed have on threatened fauna?	No threatened fauna affected	0	0
Flora and fauna / fauna	14	What effect does the weed have on non-threatened fauna spp.?	Alien moth eggs and larvae develop in leaves	0	0
	15	To what extent does this weed benefit or facilitate the establishment of indigenous fauna?	Provides some food and shelter for birds, mammals, insects	0.75	0.0173
	16	To what extent is the plant toxic or its burrs or spines affect indigenous fauna?	No effect	0	0
FLORA AND FAUNA/ FAUNA /Pest Animal	17	To what extent does this weed provide a food source for pest animals?	Provides minimal food for pest animals	0	0
	18	To what extent does this weed provide habitat/harbor for serious pests?	May provide harbor for rabbits and foxes throughout the year	1	0.0168
AGRICULTURE (Quality, Quantity, Cost to Production, Effect on land use and value)	19	To what extent does this weed impact on the quantity or yield of agricultural produce?	Little or negligible impact on quantity of yield	0	0
	20	To what extent does the weed impact on agricultural quality?	Negligible impact on quality of yield	0	0
	21	To what extent does this weed affect land values?	None	0	0
	22	To what extent does this weed cause a change in land use priorities?	No change	0	0
	23	To what extent does the presence of the weed increase the cost of harvesting?	Little effect	0	0
	24	To what extent does this weed act as an alternative host or vector for diseases of agriculture?	Not a host	0	0
Total Impact Score			-	Σ	0.1682

3), distribution (Tab. 4) and impact (Tab. 5) assessments were then combined by calculating the Pest Plant Score (PPS - eqn. 3):

$$PPS = 0.12 \cdot 0.6426 + 0.32 \cdot 0.57 + 0.56 \cdot 0.1682 = 0.3537$$

The obtained Pest Plant Score showed that, according to primary invasive parameters, the importance of sycamore maple as an invasive species was not high (0.3537), being lower than the average score (0.5).

Discussion and conclusion

Alien species are typically more invasive in regions climatically similar to their native environment. The northern limit for sycamore maple's native geographic range is Poland (Boratynski 1999), where climate is only slightly harsher than in Lithuania. All current climate change scenarios predict for the Baltic region an increase in temperature and

rainfall by at least 15% (Kjellström & Ruosteenoja 2007), thus a shift northbound of the habitats suitable for sycamore maple is expected. Indeed, such species has the potential to colonize plant communities similar to those where it is currently found in Poland (Denisiuk et al. 1999), such as *Fraxino-Ulmetum*, *Pino-Quercetum*, *Tilio-Carpinetum* and others. In the present study, the largest sycamore maple spread was observed in stands dominated by birch, pine, maple and lime, though it can act as a pioneer species colonizing meadows and abandoned pastures (Rusanen & Myking 2003).

In this investigation the average distance of maple seedlings from likely parent trees exceeds 200 meters, though other studies reported that very few seedlings may be found more than 50 m apart from parent trees (Degen 2006). The relatively high proportion of saplings up to 1.5 m in height suggests that a large part of the sycamore maple understorey

is likely to reach the upper canopy layer. Small seedlings (< 50 cm) can survive for long periods (> 15 years) under dense canopies where the light intensity is as low as 1% of the full light (Hättenschwiler & Körner 2000). Such characteristics, along with the rapid juvenile growth, allow the sycamore maple to colonize neighboring stands with dense canopies, especially where the competition in the understorey layer is low (Hein et al. 2009).

Studies of regeneration of broadleaved species in northeastern France showed that 13 years after gap creation, the understorey species composition was dominated by *Fagus sylvatica* and *Acer pseudoplatanus* seedlings (Collet et al. 2008), with density for the latter species reaching 19 000 per hectare and the mean seedling height of 0.7 m. In our study sites, such high density were not reached since the scattered distribution of the *A. pseudoplatanus* parent trees,

though the average height of seedlings was close to that reported by Collet et al. (2008).

In our study sites, density of Norway maple (*A. platanoides*) or small-leaved lime (*Tilia cordata*) seedlings in the understorey locally reached that of sycamore maple, but with a lower mean seedling height. Moreover, their distance from parent tree was lower than that recorded for sycamore maple. Furthermore, later bud flushing of *A. pseudoplatanus* as compared to *A. platanoides* allows their seedlings to avoid spring frost (Chylarecki & Straus 1968).

In Lithuania, the highest invasiveness among forest tree species was reported for boxelder (*Acer negundo* L. - Valantinaite et al. 2011), with a PPS of 0.464, followed by the red oak (*Quercus rubra* L. - Riepšas & Straigyte 2008). As compared to such species, sycamore maple showed an invasiveness much lower (0.354). However, its impact on the local biocoenosis should not be underestimated. Indeed, litter decomposition rate after 12 months was 30.4% for red oak (Straigyte & Žalkauskas 2012) and 43.5% for sycamore maple, suggesting a greater influence of the latter species on the microbial community.

In Denmark, the invasive capacity of sycamore maple has been widely exploited since the late 1960s to achieve reliable, rapid, and inexpensive establishment of a new generation of trees in canopy gaps following conifer wind throw (Jensen 1983, Tillisch 2001). In Lithuania, sycamore invasion has only been observed in recent years when it started to colonize the understorey of forest stands, determining a gradual changes in tree species composition.

High timber prices and rapid growth rates have made sycamore maple economically attractive. However, our results show that sycamore maple spreads rapidly from its planted locations. Therefore, a cautious approach should be taken when establishing new sycamore maple forest plantations.

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