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Environmental & Socio-economic Studies

DOI: 10.2478/environ-2021-0027

Environ. Socio.-econ. Stud., **2021, 9, 4: 71-95**

Original article

Invasive alien plants in Poland – the state of research and the use of the results in practice

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ABSTRACT

The participation of species of alien origin in the flora of individual regions of the world is increasing. A large proportion of these species pose a threat to biodiversity. Issues of the dynamics of changes in the flora and the scale and pace of the processes, with particular emphasis on the biology, ecology, chorology, and genetic variability of the populations of plants of alien origin, including those alien species which are invasive, have been the subject of many years of research in this field in Poland. The present study is an overview of the state of research on invasive plant species in Poland, including the main results of the basic and applied research which have provided the basis for (i) the preparation of a list of invasive plant species for Poland; (ii) assessing the degree of invasiveness of the species analysed, in accordance with the adoption of criteria and the development of methodological solutions. In this work, a new version of the list of invasive plant species has been prepared on the basis of earlier studies, combining theoretical and practical aspects of definition, and it is compared with the list of invasive alien plant species considered to constitute a threat to the EU and Poland as a member country. The categorization (risk assessment) of invasive alien species along with the identification of the most endangered types of natural habitats is often used in practice in the management of invasive plants in Poland. The results of our research have fed into the formulation of legal regulations at the global and regional levels.

KEY WORDS: IAS, invasive alien plants, risk assessment, Harmonia+

ARTICLE HISTORY: received 10 November 2021; received in revised form 15 December 2021; accepted 16 December 2021

1. Introduction

The participation and role of species of alien origin in the flora of individual regions of the world is systematically increasing (SEEBENS ET AL. 2017, 2018). A large proportion of these species pose a threat to biological diversity. According to the concept and terminology proposed by RICHARSON ET AL. (2000), PYŠEK ET AL. (2004), BLACKBURN ET AL. (2011) and widely accepted by researchers dealing with this issue, the invasive alien species (IAS) are a group of species defined as (i) invasive species with impact on ecosystem functioning and (ii) alien species becoming naturalized and rapidly spreading. The impacts of IAS on the environment, as well as on the economy, livelihoods and human health, have been documented in numerous studies, and biological invasions have become the focus of national and international policies (PYŠEK ET AL., 2017, VINOGRADOVA ET AL., 2018 and the literature cited therein). Scientists warning against invasive alien species suggest that synergy with other global changes exacerbates current invasions and facilitates new ones, thereby increasing the range and impacts of the invaders on environment and

socio-economical aspects of human activities (PYŠEK ET AL., 2020).

For these reasons, both further research and the accompanying practical activities are necessary to limit or mitigate the effects of this phenomenon. The implemented EU Strategy on Invasive Alien Species (GENOVESI & SHINE, 2004) as well as the Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species (EU Regulation on IAS) require a series of lists of alien species (including plants) according to their environmental, economic or health impacts.

The assumptions regarding nature protection adopted in Poland, based on the applicable legal acts, are aimed at limiting the emergence and spread of new alien species that threaten native biodiversity. Effective management of alien species requires their appropriate categorization also specifically for Poland (TOKARSKA-GUZIK ET AL., 2011a, 2012), and especially now, when a new legal regulation (Act of August 11, 2021 on Alien Species) is being implemented.

On December 18, 2021, the Act of August 11, 2021 on Alien Species entered into force, which fully implements the provisions of the EU Regulation on IAS into the Polish legal system. Individual entities indicated in the act, from the date of its entry into force, are obliged, inter alia, to carry out control measures in relation to invasive alien species of posing a threat to the Union (IAS EU) and invasive alien species posing a threat to Poland (IAS PL), which will certainly affect their status in the natural environment. The provisions of the act also introduce systems of administrative penalties and penal provisions, the amount of which may deter potential perpetrators from deliberate introductions into the natural environment IAS EU / IAS PL, which will also most likely have an impact on the situation of these species in the natural environment.

The present study reviews the state of research on invasive alien plant species in Poland, including the main fundamental and applied research providing the basis for (i) the preparation of a list of invasive alien plant species for Poland; (ii) assessing the degree of invasiveness of the species analysed, based on the criteria adopted and methodological solutions proposed. In this work, a new version (= 'verified') of the list of invasive plant species has been prepared, combining theoretical and practical aspects, on the basis of earlier studies and on a list of invasive alien plant species considered to be a threat to the wider EU.

1.1. An outline of the history of research on invasive alien plant species in Poland

Issues of the dynamics of changes in the flora and the scale and pace of the processes, with particular emphasis on biology, ecology, chorology, and genetic variability of the populations of plants of alien origin, including invasive species, have been the subject of many years of research in this field in Poland (e.g. DAJDOK & WUCZYŃSKI, 2008, DAJDOK & PAWLACZYK, 2009, ZAJĄC ET AL., 2011, TOKARSKA-GUZIK ET AL., 2011b, 2014, 2017, OTRĘBA & MICHALSKA-HEJDUK, 2014, CHMURA ET AL., 2015, SZYMURA & SZYMURA, 2015, ZAJĄC & ZAJĄC, 2015, BRZOSKO ET AL., 2016, BZDĘGA ET AL., 2016, DERING ET AL., 2018, DYDERSKI & JAGODZIŃSKI, 2018, 2019, 2020, REWICZ ET AL., 2020, DANIELEWICZ ET AL., 2021, STEFANOWICZ ET AL., 2021).

An attempt to summarize the main directions of the research on alien plants in Poland, in a historical context, was made by TOKARSKA-GUZIK (2005) and then in a review work by TOKARSKA-GUZIK ET AL. (2014). The latter paper was aimed at to complete and verify the previous review of the range of research conducted in Poland related to alien plants, and the practical use of the research results, and additionally to assess the contribution of the research from the area of Poland to the research conducted at an international level. The evaluation was made on the basis of creating a database containing over 3000 records, and eventually 1423 of them were used in the analysis, excluding historical studies published before 1945. In the above-mentioned studies, papers focusing specifically on invasive plants were cited, including information on distribution and migration pathways, biology, ecology, evolution and impact, genetic and cytogenetic aspects, aerobiology, mechanisms and models of spread, and aspects of invasive plant management. These surveys also include papers containing lists of alien plant species or groups of alien plant species prepared for Poland which have been cited in the Tokarska-Guzik review (Table 1).

The progressive transformations of the flora of vascular plants in Poland, new results of research on anthropophytes, as well as the practical considerations, created the need to develop an original, up-to-date catalogue of alien plant species occurring in Poland. The study *Alien plants in Poland with particular reference to invasive species*, prepared by a team of authors from various research centres in Poland, published by The General Directorate for Environmental Protection (GDEP), aimed to fill this existing gap (TOKARSKA-GUZIK ET AL., 2012, Table 1).

Table 1. Selected papers concerning lists of alien plant species (national and regional) in Poland (source: Tokarska-Guzik 2005, Tokarska-Guzik et al., 2014, supplemented)

Group of alien plant species	Author/year
Kenophytes	Kornaś, 1968, Zając et al., 1998
Archaeophytes	Zając & Zając, 1975, Zając, 1979, 1983, 1987a, 1987b, 1988, Węgrzynek et al., 2011, Anioł-Kwiatkowska & Szczęśniak, 2011
Ephemerophytes (casual aliens)	Michalak, 1981, Rostański & Sowa, 1986-1987, Urbisz, 2011, Jackowiak et al., 2017
American trees and shrubs	Hereźniak, 1992
Kenophytes of American origin	Sowa & Warcholińska, 1994
Anthropophytes	Mirek et al., 1995, 2002, 2020
Naturalised alien plants – neophytes (excluding archaeophytes)	Tokarska-Guzik, 2003
Established alien plant species (kenophytes)	Tokarska-Guzik 2005
Alien plants with particular reference to invasive species	Tokarska-Guzik et al., 2012
Alien vascular plants established in forests of Poland	Danielewicz et al., 2021

The 'new' catalogues of alien plant species for Poland include verified and updated lists of naturalised alien plants, casual alien plants, cultivated trees, and shrubs most often escaping from cultivation and, in particular, a list of invasive alien plant species.

Criteria for identifying the status of species were adopted after being drawn up by an EPPO team of experts (BRUNEL ET AL., 2010) and concerned: i) the distribution range in Poland based on the number of localities (of ATPOL squares – ZAJĄC & ZAJĄC, 2001, 2019) and distribution maps; ii) the size of the local populations; iii) the type of habitats colonised; iv) dynamic tendencies; v) type of threat. From this catalogue of alien plant species in Poland, a group of invasive species was identified. Based on the criteria adopted, they were allocated to one of the following groups of plant species: i) invasive at the national scale, ii) invasive at the regional scale, iii) invasive locally, and iv) potentially invasive. Furthermore, natural habitats threatened with the penetration of the given alien plant species were identified. At the national scale, 35 species were included in the group of invasive species, including 12 weeds of cultivation; 23 were categorized as invasive in particular regions (including 4 weeds); 14 as locally invasive, and 16 as potentially invasive.

In response to European and national regulations on invasive alien species, the General Directorate for Environmental Protection in Poland commissioned a project aiming at supporting their implementation. The aim of this study was to provide the necessary information about invasive and potentially invasive alien species in Poland (both plant and animal), to identify priority species threatening native flora and fauna, and to propose strategic actions to combat them.

A total of 118 species of alien plants (60) and animals (58) were analysed, counting 49 species of Union concern, included in the EU Regulation on IAS, 33 species listed in the Polish national regulation on IAS, as well as 36 previously unlisted species, more recently identified as invasive aliens in Poland.

The Belgian methodological scheme Harmonia^{+} (D'HONDT ET AL., 2014) was adjusted to Polish circumstances as Harmonia^{+PL} and applied for the assessment of species invasiveness. The procedure consists of 10 modules referring to the stage of invasion and the assessment of the impact of the assessed species in 5 domains. Altogether the evaluation questionnaire consists of 41 questions which were answered by external experts. As a final result, a measure of the invasiveness is obtained for each species in the form of a description and a numerical indicator. As a result, an agreed common assessment on every question is obtained together with a confidence level. The most important stage of the assessment is ranking the species into its category of invasiveness. The evaluation allowed us to rank the analysed species to one of 4 categories (non-invasive, potentially invasive, moderately invasive and very invasive species). 'Moderately invasive alien species' turned out to be the most numerous group. Altogether 10 species were ranked in the category 'very invasive alien plant species'.

2. Materials and methods

The species list has been compiled using the following sources:

- the list of invasive alien plant species published by TOKARSKA-GUZIK ET AL., 2012,
- the list of species assessed for degree of invasiveness using the invasiveness assessment questionnaires *Harmonia^{+PL} – procedure for*

negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland, conducted under GDEP project and published on-line http://projekty.gdos.gov.pl/igo-lista-inwazyjnych-gatunkow-obcych-roslin,

- lists of invasive plant species of Union concern for 2016, 2017, and 2019,
- the list of invasive alien species of Poland concern (Regulation of the Minister of the Environment of 9 September 2011).

Each of the invasive alien plant species thus compiled has been characterized on the basis of the following categories: (1) systematic, i.e. belonging to a particular family according to the study by MIREK ET AL. (2020) and THE PLANT LIST (2013); (2) life form i.e. the morphological type of the plant in terms of its adaptation to ecological conditions: tree, shrub, perennial, annual or biennial plant, creepers, water plants; (3) area of origin, i.e. geographical area in which the species occurs naturally (native range); (4) an indication that (i) the species is listed on the basis of the risk assessment performed, together with the year of introduction into the list (Commission Implementing Regulation (EU) 2016/1141 of 13 July 2016), (ii) the species is on the list of species of Poland concern (Regulation of the Minister of the Environment of 9 September 2011), (5) occurrence in the natural environment in Poland, i.e. absent, / absent; exclusively in cultivation, / present, / present; also in cultivation; (6) status, i.e. the degree of naturalisation in Poland and invasive tendencies; here groups of species are distinguished based on knowledge about their distribution and about tendencies for changes in their distribution i.e. invasive at the national, regional and local level, potentially invasive and category I-IV – determined on the basis of the scoring system adopted for individual assessment criteria in Poland according to TOKARSKA-GUZIK ET AL., 2012 (see explanation to Table 2); (7) degree of invasiveness according to the Harmonia^{+PL} procedure, i.e. non-invasive alien species, potentially invasive alien species, moderately invasive alien species, very invasive alien species and (8) the results of the IAS impact assessment on sample domains (i) impact on the environmental domain, (ii) impact on the economy, (iii) impact on the human domain, in this case, human health.

3. Results

The presented list of invasive alien vascular plant species for Poland includes 121 species (Table 2). Among the species on the list, 11 is still absent from Poland (but on the list of the Union concern, and with a probability of being invasive in Poland in the near future), and the remaining 110 species account for 3.1% of all vascular plant species in Poland estimated at approx. 3,542 taxa (MIREK ET AL., 2020). At the same time, the invasive alien species recorded so far in Poland constitute about 12.7% of the group of taxa classified as anthropophytes in the country. 20 of the total group of 121 species have not been recorded in the natural environment so far, but are present exclusively in cultivation, 56 species occur in the natural environment of the country, while 34 are additionally still cultivated in Poland (Fig. 1).

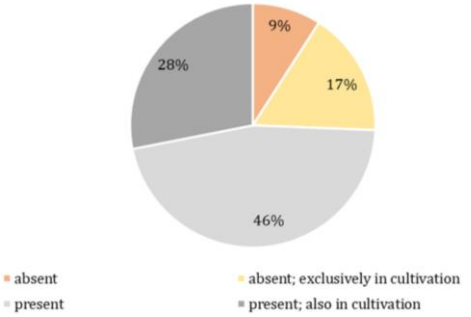


Fig. 1. Participation of invasive alien plant species in terms of occurrence in the natural environment in Poland

Most of species which have not been recorded in Poland so far are present in the list of species of Union concern, i.e. *Acacia saligna*, *Alternanthera philoxeroides*, *Cardiospermum grandiflorum*, *Ludwigia grandiflora*, *Ludwigia peploides*, *Microstegium vimineum*, *Parthenium hysterophorus*, *Persicaria perfoliata*, *Prosopis juliflora*, *Pueraria montana* var. *lobata.* There is no data on the occurrence of *Spartina anglica* in Poland, either in natural or anthropogenic habitats. Also the growing of *Spartina anglica* in Polish botanical gardens has not been confirmed (SUDNIK-WÓJCIKOWSKA ET AL., 2018).

Nevertheless, for 8 of the above-mentioned species, a risk assessment was carried out based on the Harmonia^{+PL} protocol, which classified 5 species (*Alternanthera philoxeroides, Ludwigia grandiflora*, *L. peploides, Microstegium vimineum* and *Pueraria montana* var. *lobata*) as moderately invasive alien species, 2 (*Persicaria perfoliata* and *Spartina anglica*) as potentially invasive, and one species was assessed as a very invasive alien. It is *Parthenium hysterophorus* – a species native to subtropical regions of North, Central and South America, which was once noted by G. Wangrin in 1938 in Szczecin, in landfill (square ATPOL AB83), where six individuals were observed (CELKA ET AL., 2018).

Table 2. The list of invasive alien plant species in Poland, including species of EU and Poland concern, uses the information contained in questionnaires assessing the degree of invasiveness for 60 plant species, posted on the website of the General Directorate for Environmental Protection (for references see Appendix 1)

Latin name of species	Synonym	Family	Life form	Origin - native range	Species of the EU and Poland concern	Occurrence in the natural environment in Poland	Status in Poland	Category	This assessment is based on information available at Harmonia[+PL]	Impact on the environmental domain					Impact on the economy				Impact on the human domain
							according to Tokarska-Guzik et al., 2012			on native species, through competition	on native species, through interbre-eding	on native species by hosting pathogens or parasites that are harmful to them	on ecosystem integrity, by affecting its abiotic properties	on ecosystem integrity, by affecting its biotic properties	on causing damage to infrastructure	on provisioning services	on regulation and maintenance services	on cultural services	on human health, by having properties that are hazardous upon contact
Acacia saligna (Labill.) H.L.Wendl.	*Acacia cyanophylla* Lindl	Fabaceae	M	Australia W	EU 2019	absent	N.A.		*not assessed*										
Acer negundo L.	*Negundo aceroides* Moench	Aceraceae	M	Am. N		present	naturalised - invasive at the national level	IV	potentially invasive alien species	high	no / very low	very low	low	high	low	moderately positive	moderately positive	moderately positive	low
Ailanthus altissima (Mill.) Swingle	*Ailanthus glandulosa* Desf.	Simaroubaceae	M	Asia E [China]	EU 2019	present; also in cultivation	naturalised - invasive at the regional level	III	very invasive	medium	no / very low	very low	medium	medium	very high	moderately positive	moderately positive	moderately positive	low
Alopecurus myosuroides Huds.	*Alopecurus agrestis* L.	Poaceae	T	Eur & Asia		present	naturalised (Ar) - invasive at the regional level	I	*not assessed*										
Alternanthera philoxeroides (Mart.) Griseb.	-	Amaranthaceae	H	Am. S	EU 2017	absent	N.A.		moderately invasive alien species	high	no / very low	low	high	high	medium	neutral	moderately negative	moderately negative	very low
Amaranthus retroflexus L.	*Amaranthus bulgaricus* Kov.	Amaranthaceae	T	Am. S & C		present	naturalised - invasive at the national level	I	*not assessed*										
Ambrosia artemisiifolia L.	*Ambrosia artemisiifolia* f. *artemisiifolia*	Asteraceae	T	Am. N [E & SW]		present	naturalised - invasive at the national level	IV	very invasive alien species	high	no / very low	low	high	medium	medium	significantly negative	significantly negative	moderately negative	very high
Amelanchier lamarckii F. G. Schroed.	*Amelanchier canadensis* K.Koch	Rosaceae	N M	Am. N [W Canada]		present; also in cultivation	naturalised - locally invasive	II	*not assessed*										
Amelanchier spicata (Lam.) K. Koch	*Amelanchier humilis* Wiegand	Rosaceae	N	Am. N [NE]		present; also in cultivation	naturalised - invasive at the regional level	IV	potentially invasive alien species	medium	no / very low	very low	medium	high	low	moderately positive	moderately negative	moderately negative	very low
Andropogon virginicus L.	*Anatherum virginicum* Spreng.	Poaceae	H	Am. N	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Anthoxanthum aristatum Boiss.	*Anthoxanthum puelii* Lecoq & Lamotte	Poaceae	T	Eur S		present	naturalised - invasive at the national level	I	*not assessed*										
Aronia ×prunifolia (Marshall) Rehder	*A. arbutifolia* (L.) Pers. × *A. melanocarpa* (Michx.) Elliott	Rosaceae	N	Am. N [NE]		present; also in cultivation	naturalised - locally invasive	II	*not assessed*										
Asclepias syriaca L.	*Asclepias grandifolia* E. Fourn.	Asclepiadaceae	H	Am. N [E]	EU 2017	present; also in cultivation	naturalised - potentially invasive	*not assigned*	potentially invasive alien species	high	no / very low	low	low	medium	very low	moderately positive	neutral	moderately positive	very low
Aster ×salignus WILLD.	= *A. lanceolatus* Willd. × *A. novi-belgii* L.	Asteraceae	H	Am. N		present	naturalised - locally invasive	I	*not assessed*										
Aster novi-belgii L.	*Symphyotrichum novi-belgii* (L.) G.L.Nesom	Asteraceae	H	Am. N [E]		present	naturalised - invasive at the regional level	IV	moderately invasive alien species	high	no / very low	medium	medium	high	very low	moderately negative	moderately positive	neutral	very low

Avena fatua L.	*Anelytrum avenaceum* Hack.	Poaceae	T	Asia		present	naturalised (Ar) - invasive at the national level	I	*not assessed*									
Azolla filiculoides Lam.	*Azolla caroliniana* Willd.	Salviniaceae	Hy	Am. S, Am. C & Am. N [W]	PL 2011	present; also in cultivation	naturalised - invasive at the regional level	III	moderately invasive alien species	high	no / very low	low	high	high	medium	significantly negative	moderately negative	significantly negative	low
Baccharis halimifolia L.	*Baccharis axillaris* Mart. ex Baker.	Asteraceae	N	Am. N	EU 2016	absent; exclusively in cultivation	N.A.		potentially invasive alien species	medium	no / very low	very low	low	high	low	neutral	moderately negative	neutral	medium
Bidens frondosa L.	*Bidens melanocarpus* Wiegland	Asteraceae	T	Am. N [N]		present	naturalised - invasive at the national level	III	moderately invasive alien species	high	high	medium	medium	high	very low	moderately positive	moderately negative	neutral	very low
Bromus carinatus Hook. & Arn.	*Ceratochloa carinata* (Hook. et Arn.) Tutin	Poaceae	T H	Am. N		present	naturalised - invasive at the national level	IV	potentially invasive alien species	high	no / very low	medium	low	high	low	moderately negative	moderately negative	moderately negative	medium
Buddleja davidii Franchet	*Buddleja striata* Z.Y. Zhang	Buddlejaceae	N	Asia E [China]		present; also in cultivation	locally naturalised - potentially invasive	*not assigned*	*not assessed*									
Bunias orientalis L.	*Bunias perennis* Sm.	Brassicaceae	H	Eur SE & Asia W		present	naturalised - invasive at the national level	III	*not assessed*									
Cabomba caroliniana Gray	*Cabomba australis* Speg.	Cabombaceae	Hy	Am. N & S	EU 2016	present; also in cultivation	*not listed*	*not assigned*	very invasive alien species	high	no / very low	very low	high	high	very high	significantly negative	moderately negative	moderately negative	very low
Cardiospermum grandiflorum Sw.	*Cardiospermum barbicaule* Baker	Sapindaceae	H li	Africa, Am N & Am S	EU 2019	absent	N.A.		*not assessed*									
Celastrus orbiculatus Thunb.	*Celastrus articulatus* Thunb.	Celastraceae	N li	Asia [Japan, China, Korea]		present; also in cultivation	locally naturalised	*not assigned*	moderately invasive alien species	high	no / very low	medium	high	high	medium	significantly negative	neutral	neutral	very low
Celtis occidentalis L.	*Celtis audibertiana* Spach	Ulmaceae	M	Am. N		present; also in cultivation	naturalised - locally invasive	I	*not assessed*									
Chaerophyllum aureum L.	*Bellia aurata* Bubani	Apiaceae	H	Eur C & S		present	naturalised - invasive at the regional level	I	*not assessed*									
Clematis vitalba L.	-	Ranunculaceae	N li	Eur [W, C, S], Africa [NW], Asia [Caucasus]		present; also in cultivation	naturalised - invasive at the regional level	II	moderately invasive alien species	high	no / very low	medium	high	high	low	neutral	moderately negative	moderately positive	low
Conyza canadensis (L.) Cronquist	*Erigeron canadensis* L.	Asteraceae	T H	Am. N [N]		present	naturalised - invasive at the national level	I	*not assessed*									
Cornus sericea L. emend. Murray	*Cornus stolonifera* Michx.	Cornaceae	N	Am. N [E & C]		present; also in cultivation	naturalised - invasive at the regional level	III	potentially invasive alien species	high	no / very low	medium	low	high	very low	neutral	neutral	moderately positive	very low
Cortaderia jubata (Lemoine ex Carrière) Stapf	*Gynerium jubatum* Lemoine ex Carrière	Poaceae	H	Am. S	EU 2019	absen; exclusively in cultivation	N.A.		*not assessed*									
Cotoneaster lucidus Schltdl.	*Cotoneaster acutifolius* Lindl. ex Ledeb.	Rosaceae	N	Asia E [Siberia]		present; also in cultivation	potentially invasive	*not assigned*	*not assessed*									
Crassula helmsii (Kirk) Cockayne	*Tillaea helmsii* Kirk	Crassulaceae	Hy	Australia & New Zealand	PL 2011	absent; exclusively in cultivation	N.A.		potentially invasive alien species	high	no / very low	very low	medium	high	very low	medium	significantly negative	moderately negative	very low
Digitalis purpurea L.	*Digitalis alba* Schrank	Scrophulariaceae	H T	Eur W		present; also in cultivation	naturalised - invasive at the regional level	II	*not assessed*									
Diplotaxis muralis (L.) DC.	*Arabis canadensis* Mill.	Brassicaceae	T	Eur S & W [Africa]		present	naturalised - invasive at the regional level	I	*not assessed*									
Echinochloa crus-galli (L.) P. Beauv.	*Panicum crus-galli* L.	Poaceae	T	Asia		present	naturalised (Ar) - invasive at the national level	I	*not assessed*									

Echinocystis lobata (F. Michx.) Torr. et A. Gray	*Micrampelis lobata* (Michaux) Greene	Cucurbitaceae	T li	Am. N [E]	PL 2011	present	naturalised - invasive at the national level	IV	moderately invasive alien species	high	no / very low	low	medium	high	low	moderately negative	moderately negative	neutral	low
Eichhornia crassipes (Martius) Solms	*Eichhornia cordifolia* Gand.	Pontederiaceae	H	Am. S	EU 2016	present; also in cultivation	*not listed*	*not assigned*	potentially invasive alien species	medium	no / very low	medium	medium	medium	low	moderately negative	moderately positive	moderately positive	low
Elodea canadensis Michx.	*Anacharis canadensis* (Michaux) Planchon	Hydrocharitaceae	Hy	Am. N		present; also in cultivation	naturalised - invasive at the national level	IV	potentially invasive alien species	medium	no / very low	very low	low	medium	medium	moderately negative	neutral	neutral	very low
Elodea nuttallii (Planch.) H. St. John	*Anacharis nuttallii* Planch.	Hydrocharitaceae	Hy	Am. N	EU 2017	present; also in cultivation	potentially invasive	*not assigned*	moderately invasive alien species	high	no / very low	very low	high	high	medium	moderately negative	moderately negative	moderately negative	very low
Epilobium ciliatum Raf.	*Epilobium adenocaulon* Hausskn.	Onagraceae	H	Am. N [N]		present	naturalised - invasive at the regional level	II	*not assessed*										
Eragrostis albensis Scholz	-	Poaceae	T	Eurasia E		present	naturalised - locally invasive	II	potentially invasive alien species	high	no / very low	very low	low	high	low	moderately negative	neutral	neutral	low
Erechtites hieraciifolia (L.) Raf. ex DC.	-	Asteraceae	T	Am. N & Am. S [N]		present	naturalised - invasive at the regional level	II	*not assessed*										
Ehrharta calycina Sm.	*Ehrharta adscendens* Schrad.	Poaceae	H T	Africa S	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Erigeron annuus (L.) Pers.	*Stenactis annua* (L.) Nees	Asteraceae	H T	Am. N [N]		present	naturalised - invasive at the national level	II	*not assessed*										
Fraxinus pennsylvanica Marshall	*Fraxinus darlingtonii* Britton.	Oleaceae	M	Am. N [C & E]		present	naturalised - invasive at the national level	III	potentially invasive alien species	medium	no / very low	medium	medium	medium	very low	neutral	neutral	moderately positive	very low
Galinsoga ciliata (Raf.) S. F. Blake	*Galinsoga quadriradiata* Ruiz & Pav.	Asteraceae	T	Am. C [Am. S ?]		present	naturalised - invasive at the national level	I	*not assessed*										
Galinsoga parviflora Cav.	*Adventina parviflora* (Cav.) Raf.	Asteraceae	T	Am. C & S		present	naturalised - invasive at the national level	I	*not assessed*										
Gunnera tinctoria (Molina) Mirbel	*Gunnera chilensis* Lam.	Gunneraceae	H	Am S	EU 2017	absent; exclusively in cultivation	N.A.		potentially invasive alien species	high	no / very low	very low	medium	high	medium	neutral	moderately negative	moderately negative	very low
Gymnocoronis spilanthoides (D.Don ex Hook. & Arn.) DC.	-	Asteraceae	Hy	Am S	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Helianthus tuberosus L.	*Helianthus tomentosus* Michx.	Asteraceae	G	Am. N		present	naturalised - invasive at the national level	II	moderately invasive alien species	high	no / very low	high	medium	high	medium	significantly positive	moderately negative	moderately negative	very low
Heracleum mantegazzianum Sommier et Levier	*Heracleum giganteum* Fischer ex Hornem	Apiaceae	H	central and eastern part of the Greater Caucasus	EU 2017	present; also in cultivation	naturalised - invasive at the national level	IV	very invasive alien species	high	medium	low	medium	medium	high	moderately negative	moderately negative	moderately negative	very high
Heracleum persicum Fischer	*Heracleum glabrescens* Boiss. & Hohen	Apiaceae	H	Asia SW, the Caucasus	EU 2016	absent; exclusively in cultivation	N.A.		very invasive alien species	high	medium	low	medium	medium	high	moderately negative	moderately negative	moderately negative	very high
Heracleum sosnowskyi Manden.	*Heracleum wilhelmsii* Fischer et AvéLallemant	Apiaceae	H	central and eastern part of the Greater Caucasus	EU 2016	present; also in cultivation	naturalised - invasive at the national level	IV	very invasive alien species	high	medium	low	medium	high	high	moderately negative	moderately negative	moderately negative	very high

Hordeum murinum L.	*Critesion murinum* (L.) Á.Löve	Poaceae	T	Eur & Asia		present	naturalised (Ar) - invasive at the regional level	I	*not assessed*										
Hydrocotyle ranunculoides L.	*Hydrocotyle cymbalarifolia* Muhl.	Apiaceae	H	Am. N, Am. C, Am. S, Africa	EU 2016	absent; exclusively in cultivation	N.A.		moderately invasive alien species	high	low	very low	high	high	medium	moderately negative	significantly negative	moderately negative	very low
Humulus scandens (Lour.) Merr.	*Humulus japonicus* Siebold et Zucc.	Cannabaceae	T li	Asia [China, Mongolia, Korea, Japan, Taiwan, Vietnam]	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Impatiens capensis Meerb.	*Impatiens biflora* Walter	Balsaminaceae	T	Am. N	PL 2011	present	naturalised - locally invasive	III	moderately invasive alien species	high	low	medium	high	high	low	moderately negative	moderately negative	neutral	very high
Impatiens glandulifera Royle	*Impatiens roylei* Walp.	Balsaminaceae	T	Asia C [Himalayas]	EU 2017	present; also in cultivation	naturalised - invasive at the national level	IV	moderately invasive alien species	high	no / very low	high	high	high	medium	moderately negative	moderately negative	moderately negative	low
Impatiens parviflora DC.	*Balsamina parviflora* (DC.) Ser.	Balsaminaceae	T	Asia C & E		present	naturalised - invasive at the national level	IV	potentially invasive alien species	medium	low	medium	low	medium	very low	neutral	moderately negative	moderately negative	very high
Juglans regia L.	*Juglans duclouxiana* Dode	Juglandaceae	M	Asia [SW, C & E]		present; also in cultivation	naturalised - invasive at the regional level	II	*not assessed*										
Juncus tenuis Willd.	*Juncus macer* A. Gray	Juncaceae	H	Am. N		present	naturalised - invasive at the national level	I	*not assessed*										
Lagarosiphon major (Ridley) Moss	*Elodea crispa* hort.	Hydrocharitaceae	Hy	Africa S	EU 2016	absent; exclusively in cultivation	N.A.		moderately invasive alien species	high	no / very low	low	high	high	medium	moderately negative	moderately negative	moderately negative	very low
Lemna minuta Kunth	*Lemna abbreviata* (Hegelm.) Hegelm.	Lemnaceae	Hy	Am. N & S		present	locally naturalised - potentially invasive	*not assigned*	*not assessed*										
Lemna turionifera Landolt	-	Lemnaceae	Hy	Am. N		present	naturalised - locally invasive	III	*not assessed*										
Lespedeza cuneata (Dum.Cours.) G.Don	*Lespedeza juncea* var. *sericea* (Thunb.) Lace & Hauech	Fabaceae	H Ch	Asia, Australasia	EU 2019	absent, exclusively in cultivation	N.A.		*not assessed*										
Lolium multiflorum Lam.	*Lolium aristatum* Lag.	Poaceae	H T	Eur S & W, Asia [SW] & Africa [N]		present	naturalised - invasive at the regional level	II	*not assessed*										
Ludwigia grandiflora (Michx.) Greuter & Burdet	*Adenola grandiflora* (Michx.) Raf.	Onagraceae	H Hy	Am. S	EU 2016	absent	N.A.		moderately invasive alien species	high	no / very low	high	high	high	high	significantly negative	significantly negative	moderately negative	low
Ludwigia peploides (Kunth) P.H. Kruk	*Jussiaea californica* (S. Watson) Jeps.	Onagraceae	H Hy	Am. S & C Am. N	EU 2016	absent	N.A.		moderately invasive alien species	high	no / very low	very low	high	high	high	significantly negative	significantly negative	moderately negative	low
Lupinus polyphyllus Lindl.	*Lupinus elongatus* Greene ex A. Heller	Fabaceae	H	Am. N [W]		present; also in cultivation	naturalised - invasive at the national level	III	moderately invasive alien species	high	no / very low	medium	high	high	very low	moderately positive	neutral	moderately positive	low
Lycium barbarum L.	*Lycium halimifolium* Mill.	Solanaceae	N	Eur SE & Asia E		present	naturalised - invasive at the regional level	I	*not assessed*										
Lygodium japonicum (Thunb.) Sw.	*Adiantum scandens* Lour.	Schizaeaceae	H	Asia SW & E	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Lysichiton americanus Hultén and St. John	-	Araceae	H	Am. N	EU 2016	absent; exclusively in cultivation	potentially invasive not so far recorded in Poland		non-invasive alien species	low	no / very low	very low	low	medium	very low	neutral	neutral	neutral	very low
Lysimachia punctata L.	*Lysimachia verticillaris* Spreng.	Primulaceae	H	Eur SE		present	naturalised - locally invasive	I	*not assessed*										

Mahonia aquifolium (Pursh) Nutt.	*Berberis aquifolium* Pursh	Berberidaceae	N	Am. N [W]		present	naturalised - potentially invasive	*not assigned*	*not assessed*										
Microstegium vimineum (Trin.) A. Camus	*Andropogon vimineus* Trin.	Poaceae	T	Azja S & E	EU 2017	absent	N.A.		moderately invasive alien species	high	no / very low	low	medium	high	very low	moderately negative	moderately negative	neutral	very low
Mimulus guttatus DC.	*Mimulus whipplei* A.L.Grant	Scrophulariaceae	H Hy	Am. N [W]		present	naturalised - invasive at the regional level	III	non-invasive alien species	medium	no / very low	very low	low	medium	very low	moderately negative	neutral	moderately positive	very low
Myriophyllum aquaticum (Vell.) Verdc.	*Myriophyllum brasiliense* Cambess.	Haloragaceae	Hy	Am. S	EU 2016	absent; exclusively in cultivation	N.A.		potentially invasive alien species	high	no / very low	low	low	medium	low	moderately negative	moderately negative	moderately negative	very low
Myriophyllum heterophyllum Michaux	-	Haloragaceae	Hy	Am. N	EU 2017	absent; exclusively in cultivation	N.A.		potentially invasive alien species	high	no / very low	very low	medium	high	low	moderately negative	moderately negative	moderately negative	very low
Onobrychis viciifolia Scop.	Onobrychis viciaefolia Scop.	Fabaceae	H	Eur S & SE		present	naturalised - invasive at the regional level	II	*not assessed*										
Oxalis corniculata L.	*Acetosella bakeriana* Kuntze	Oxalidaceae	T H	Eur S & Asia SW, Africa, Australia		present	naturalised - locally invasive	I	*not assessed*										
Oxalis fontana Bunge	*Oxalis stricta* L.	Oxalidaceae	T G	Am. N		present	naturalised - invasive at the national level	I	*not assessed*										
Oxycoccus macrocarpos (Aiton) Pursh	*Vaccinium macrocarpon* Aiton	Ericaceae	C	Am. N		present	naturalised - potentially invasive	*not assigned*	*not assessed*										
Padus serotina (Ehrh.) Borkh.	*Prunus serotina* Ehrh.	Rosaceae	M	Am. N [E] & Am. C [N]		present	naturalised - invasive at the national level	IV	moderately invasive alien species	high	low	medium	high	medium	medium	moderately negative	moderately negative	neutral	very low
Parthenium hysterophorus L.	*Parthenium pinnatifidum* Stokes	Asteraceae	T	Am. N & Am. S	EU 2016	absent	N.A.		very invasive alien species	high	no / very low	medium	high	high	medium	moderately negative	significantly negative	moderately negative	very high
Parthenocissus inserta (A. Kern.) Fritsch	*Parthenocissus vitacea* (Knerr) A.S. Hitchcock	Vitaceae	N li	Am. N [SW, C, NE]		present; also in cultivation	naturalised - invasive at the regional level	II	moderately invasive alien species	high	no / very low	low	medium	high	very low	neutral	moderately positive	moderately positive	high
Pennisetum setaceum (Forssk.) Chiov.	*Cenchrus setaceus* (Forssk.) Marrone	Poaceae	H	Middle East & Africa N	EU 2017	absent; exclusively in cultivation	N.A.		potentially invasive alien species	high	no / very low	low	low	medium	low	neutral	neutral	moderately positive	low
Persicaria perfoliata (L.) H. Gross	*Chylocalyx perfoliatus* (L.) Hassk. ex Miq.	Polygonaceae	T li	Asia E	EU 2016	absent	N.A.		potentially invasive alien species	high	no / very low	low	medium	medium	low	moderately negative	moderately negative	moderately negative	very low
Prosopis juliflora (Sw.) DC.	-	Fabaceae	N, M	Mexico C & N, Am. S	EU 2019	absent	N.A.		*not assessed*										
Polygonum polystachyum Wall. ex Meissner	*Aconogon polystachyum* (Wallich ex Meisn.) Haraldson; *Koenigia polystachya* (Wall. Ex Meisn.) T.M. Schust. & Reveal	Polygonaceae	H	Azja C [Himalayas]		present	naturalised - invasive at the regional level	II	*not assessed*										
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.)	*Dolichos hirsutus* Thunb.	Fabaceae	N li	Asia E & SE	EU 2016	absent	N.A.		moderately invasive alien species	high	no / very low	very low	medium	high	high	neutral	moderately negative	moderately negative	very low
Quercus rubra L.	*Quercus maxima* (Marshall) Ashe	Fagaceae	M	Am. N [E]		present; also in cultivation	naturalised - invasive at the national level	IV	moderately invasive alien species	high	low	medium	high	high	very low	moderately positive	moderately negative	moderately positive	very low
Reynoutria ×bohemica Chrtek et Chrtková	*R. japonica* Houtt. var. *japonica* × *R. sachalinensis* (F. Schmidt) Nakai]; *Fallopia ×bohemica* (Chrtek & Chrtková)	Polygonaceae	G	Antropog.	PL 2011	present; also in cultivation	naturalised - invasive at the national level	IV	very invasive alien species	high	no / very low	low	high	high	very high	moderately positive	significantly negative	neutral	very low

	J.P. Bailey																	
Reynoutria japonica (Houtt.) Ronse Decraene var. *japonica*	*Fallopia japonica* (Houtt.) Ronse Decr.	Polygonaceae	G	Asia E	PL 2011	present; also in cultivation	naturalised - invasive at the national level	IV	very invasive alien species	high	no / very low	low	high	high	very high	moderately positive	significantly negative	neutral	very low
Reynoutria sachalinensis (F. Schmidt) Nakai	*Fallopia sachalinensis* (F. Schmidt) Ronse Decraene	Polygonaceae	G	Asia E	PL 2011	present; also in cultivation	naturalised - invasive at the national level	IV	very invasive alien species	high	no / very low	low	high	high	very high	moderately positive	significantly negative	neutral	very low
Rhus typhina L.	*Datisca hirta* L.	Anacardiaceae	N M	Am. N [C & E]		present; also in cultivation	naturalised - invasive at the regional level	II	*not assessed*										
Robinia pseudoacacia L.	*Robinia pringlei* Rose	Fabaceae	M	Am. N [E]		present; also in cultivation	naturalised - invasive at the national level	IV	moderately invasive alien species	high	no / very low	low	high	high	low	moderately positive	moderately positive	moderately negative	low
Rosa rugosa Thunb.	*Rosa ferox* Lawrence	Rosaceae	N	Asia E [China, Korea, Japan]		present; also in cultivation	naturalised - invasive at the regional level	IV	moderately invasive alien species	high	low	low	medium	high	very low	moderately positive	neutral	moderately positive	very low
Rudbeckia laciniata L.	*Helianthus laciniatus* A.Gray.	Asteraceae	H	Am. N [E]		present; also in cultivation	naturalised - invasive at the regional level	IV	moderately invasive alien species	high	no / very low	very low	high	high	low	neutral	neutral	neutral	very low
Rumex confertus Willd.	*Rumex alpinus* var. *subcalligerus* Boiss.	Polygonaceae	H	Eur SE & Asia W		present	naturalised - invasive at the regional level	II	*not assessed*										
Salvinia molesta D.S. Mitch.	*Salvinia adnata* Desv.	Salviniaceae	Hy	Am. S [Brasil]	EU 2019	absent; exclusively in cultivation	N.A.		*not assessed*										
Senecio inaequidens DC.	*Senecio harveianus* MacOwan	Asteraceae	H	Africa S		present	locally naturalised - potentially invasive	*not assigned*	*not assessed*										
Setaria pumila (Poir.) Roem. et Schult.	*Oplismenus helvolus* (L.f.) P.Beauv.	Poaceae	T	Asia		present	naturalised (Ar) - invasive at the national level	I	*not assessed*										
Setaria viridis (L.) Beauv.	*Chaetochloa comosa* (Miq.) Koidz.	Poaceae	T	Eur & Asia		presnt	naturalised (Ar) - invasive at the national level	I	*not assessed*										
Solidago canadensis L.	*Solidago canadensis* subsp. *altissima* (L.) O. Bolos & Vigo	Asteraceae	G H	Am. N [E]		present; also in cultivation	naturalised - invasive at the national level	IV	moderately invasive alien species	high	high	low	medium	high	high	moderately negative	moderately negative	moderately negative	low
Solidago gigantea Aiton	*Solidago serotina* Aiton	Asteraceae	G H	Am. N		present; also in cultivation	naturalised - invasive at the national level	IV	moderately invasive alien species	high	high	low	medium	high	high	moderately negative	moderately negative	neutral	low
Solidago graminifolia (L.) Elliott	*Euthamia graminifolia* (L.) Nutt.	Asteraceae	G H	Am. N [N]		present	naturalised - invasive at the regional level	IV	moderately invasive alien species	high	no / very low	very low	high	high	low	moderately negative	moderately negative	moderately negative	very low
Spartina anglica C.E.Hubb	*Spartina × townsendii* sensu lato H. Groves & J. Groves	Poaceae	H	Antropog.	PL 2011	absent	potentially invasive species not so far recorded in Poland	*not assigned*	potentially invasive alien species	medium	no / very low	low	medium	high	low	neutral	neutral	moderately negative	very low
Spiraea tomentosa L.	*Sorbaria aitchisonii* (Hemsley) Hemsley ex Rehder	Rosaceae	N	Am. N [E]		present	naturalised - invasive at the regional level	IV	moderately invasive alien species	high	no / very low	high	medium	high	high	moderately negative	significantly negative	neutral	very low
Symphyotrichum ciliatum (Lindl.) Nesom	*Brachyactis ciliata* (Ledeb.) Ledeb.	Asteraceae	T	Am. N, Asia N & C		present	locally naturalised - potentially invasive	*not assigned*	*not assessed*										
Telekia speciosa (Schreb.) Baumg.	*Buphthalmum cordifolium* Waldst. & Kit.	Asteraceae	H	Europa		present	naturalised - invasive at the regional level	II	*not assessed*										
Triadica sebifera (L.) Small	*Carumbium sebiferum* (L.) Kurz	Euphorbiaceae	M	Asia E [China, Taiwan, Japan]	EU 2019	absent; exclusively in cultivation	N.A		*not assessed*										
Trifolium patens Schreb.	*Chrysaspis patens* (Schreb.) Holub	Fabaceae	H	Eur S		present	naturalised - locally invasive	II	*not assessed*										

Typha laxmannii Lepech.	*Typha angustissima* Griff. ex Rohrb.	Typhaceae	Hy H	Asia		present	locally naturalised - potentially invasive	*not assigned*	*not assessed*										
Ulex europaeus L.	*Ulex armoricanus* Mabille.	Fabaceae	N	Eur SW & Africa N	PL 2011	present; also in cultivation	naturalised	*not assigned*	moderately invasive alien species	high	no / very low	low	medium	high	low	moderately positive	moderately negative	neutral	very low
Vaccinium corymbosum L.	-	Ericaceae	N	Am. N		absent; exclusively in cultivation	potentially invasive	*not assigned*	not assessed										
Veronica filiformis Sm.	-	Scrophulariaceae	C H	Asia SW [Caucasus]		present	naturalised - invasive at the regional level	II	*not assessed*										
Veronica peregrina L.	*Veronica chillensis* Kunth	Scrophulariaceae	T	Am. N		present	naturalised - invasive at the regional level	II	*not assessed*										
Veronica persica Poir.	*Cardia filiformis* Dulac	Scrophulariaceae	T	Asia SW [Caucasus]		present	naturalised - invasive at the national level	I	*not assessed*										
Vicia grandiflora Scop.	*Vicia biebersteinii* M.Bieb.	Fabaceae	T li	Eur S & Asia SW		present	naturalised - invasive at the regional level	I	*not assessed*										
Xanthium albinum (Widder) H. Scholz	*Xanthium riparium* Itzigs. & Hertsch	Asteraceae	T	Am.N [S]		present	naturalised - invasive at the national level	IV	moderately invasive alien species	high	no / very low	low	medium	high	very low	moderately negative	moderately negative	moderately negative	low

Explanation:
Latin name of species – species names nomenclature according to *Vascular plants of Poland. An annotated checklist* (Mrek et al. 2020) and The Plant List (2013)
Synonym - one of the more commonly used names is given (if applicable)
Family – botanical (systematic)
Life form – i.e. the morphological type of the plant in terms of its adaptation to ecological conditions: M (megaphanerophyte) - tree, N (nanophanerophyte) - shrub, H (hemicryptophyte) – perennial plant, G (geophyte), T (terophyte) - annual or biennial plant, Hy (hydrophyte) - water plants, C (chamaephyte) – dwarf shrub, li (lianas) – creepers
Origin – geographical area in which species occurs naturally (native area): Am N – North America, Am C – Central America, Am S – South America, Eur – Europe; N – north, S – south, W – western, E – eastern
Species of the EU and Poland concern - the species that are included in the EU list are indicated, with the year of including in the list (EU 2016, EU 2017, EU 2019) and in the Regulation of the Minister of the Environment of 9 September 2011 (PL 2011); according to the new act on alien species (18 December 2021), species should not be duplicated on the lists
Occurrence in natural environment in Poland, i.e. absent, / absent; exclusively in cultivation, / present, / present; also in cultivation
Status in Poland – (according to Tokarska-Guzik et al. 2012) the degree of naturalisation in Poland; groups of species are distinguished based on the current knowledge about their current distribution and its dynamics: (i) locally naturalised, (ii) potentially invasive, (iii) invasive at the local level, (iv) invasive at the regional level, (v) invasive at the national level), N.A. – not aplicable
Category – (according to Tokarska-Guzik et al. 2012) **category I** – (sum of scores 10 or less) – segetal or ruderal weeds, able to appear in large numbers, mainly in anthropogenic habitats, or potentially invasive species, currently occupying limited areas or with small number of localities throughout the country or at a regional scale; **category II** – (sum of sores 11-12) – species in which invasive properties have already manifested in some regions by increasing the area of occupancy or the number of localities, or which are known to be invasive in other countries; **category III** – (sum of scores 13-14) – species occurring in a few localities in large numbers or scattered over many localities in small numbers, with known negative impact on native species, habitats and ecosystems and/or on the economy and society; **category IV** – (sum of scores 15 and more) – the occurrence of those species in Poland is fundamental – both a substantial number of localities and large local populations are known; most of them continue to increase the number of localities or expand the area of occupancy
The assessment based on information available at Harmonia^{+PL} – categories of species distinguished on the basis of the assessment: (i) non-invasive alien species, (ii) potentially invasive alien species, (iii) moderately invasive species, (iv) – very invasive alien species

Among the 121 species in the list there are 29 species of woody plants (19 - trees, 10 - shrubs including 4 climbers) and 90 species of herbaceous plants - 58 perennials, and 32 annual or biennial plants with also 4 climbers (Fig. 2).

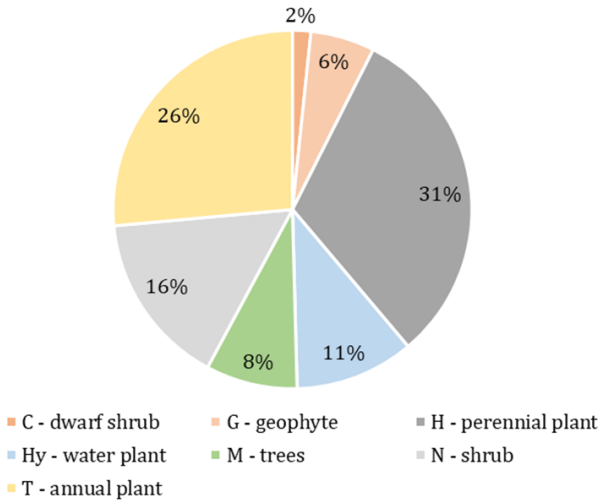


Fig. 2. Participation of the life forms in the group of 121 invasive alien plant species listed for Poland

Most belong to the angiosperms cluster, and only 3 are ferns, namely: *Lygodium japonicum*, and the two aquatic fern species *Azolla filiculoides* and *Salvinia molesta*. Only *A. filiculoides* occurs in the natural environment, the other two species are kept in cultivation, mainly in botanical gardens. Invasive alien plants of Poland are represented by 52 families, of which the most numerous are Asteraceae (21 species), Poaceae (16), Fabaceae (10), Rosaceae (7) and Polygonaceae (6) (Fig. 3).

Table 2 summarises two assessments of alien plant species based on different criteria. In the case of the work by TOKARSKA-GUZIK ET AL. (2012), the assessment concerned 92 invasive alien species, the majority of which were found in Poland. Approximately 70% of invasive alien species have been assessed as invasive at the national or regional levels. Among the assessed species, on the basis of the adopted criteria and the score scale, four categories were distinguished, with the most numerous share being in categories I and IV (Fig. 4; for explanation see figure description). The other results are discussed in the cited publication.

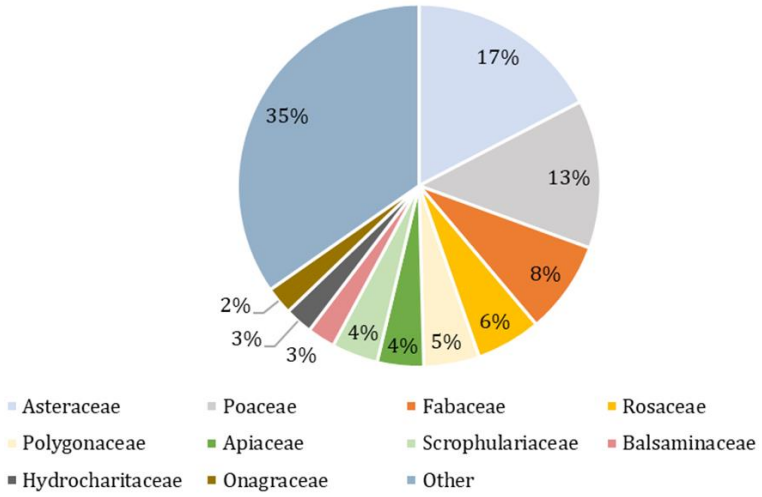


Fig. 3. The families most frequently represented among invasive alien plant species in Poland

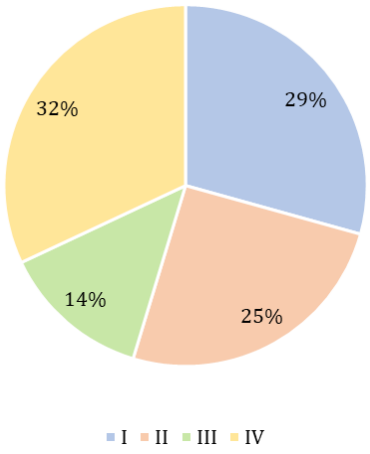


Fig. 4. Categories of invasive alien species distinguishing to sum of scores (after Tokarska-Guzik et al., 2012)

Explanations:
Category – (according to Tokarska-Guzik et al. 2012) **category I** – (sum of scores 10 or less) – segetal or ruderal weeds, able to appear in large numbers, mainly in anthropogenic habitats, or potentially invasive species, currently occupying limited areas or with small number of localities throughout the country or at a regional scale; **category II** – (sum of sores 11-12) – species in which invasive properties have already manifested in some regions by increasing the area of occupancy or the number of localities, or which are known to be invasive in other countries; **category III** – (sum of scores 13-14) – species occurring in a few localities in large numbers or scattered over many localities in small numbers, with known negative impact on native species, habitats and ecosystems and/or on the economy and society; **category IV** – (sum of scores 15 and more) – the occurrence of those species in Poland is fundamental – both a substantial number of localities and large local populations are known; most of them continue to increase the number of localities or expand the area of occupancy

The assessment carried out using the Harmonia+PL protocol has not previously been compared with other assessments completed in Poland in the past.

Objective assessments of threats posed by the presence of invasive alien species require using transparent and repeatable procedures (ROY ET AL., 2018). The Belgian protocol Harmonia+ meets those requirements and, after some fine-tuning to the Polish circumstances, proved to be a useful tool for assessing invasiveness of the selected pool of alien species.

As much as 95% of all assessed plant species were classified at least as potentially invasive in Poland. This result confirms that imposing legal restrictions for these species is fully justified, even though some of them are not even present in cultivation in the Polish territory, let alone occurring in natural environment (Fig. 5).

Regarding the negative impacts on the environmental domain, they are mostly manifested as competition with native species. As many as 83,3% of the assessed plants were classified as high in this category. Conversely, hybridisation with native species and transmission of pathogens were not strongly represented: in each of these categories there were only about 6% of species whose impact was ranked as high. At the same time, there were twice as many species that had strong negative impact on ecosystem integrity by affecting its biotic properties, than those that strongly affected its abiotic properties.

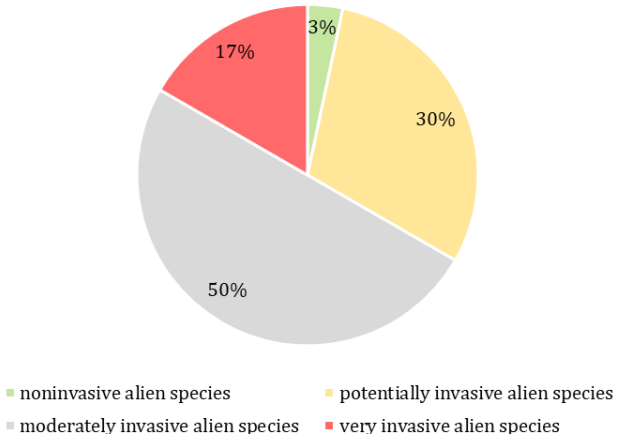


Fig. 5. The level of invasiveness of invasive alien plant species in Poland assigned to the species analysed on the basis of the Harmonia+PL procedure

Impacts on the human economy were most significant due to infrastructure damage: high and very high categories were attributed to nearly one fourth of the assessed species. The same level of threat to regulation and maintenance ecosystem services was identified for only about 17% of the species, and only 10% had a strong negative impact to provisioning service. Relatively few species had strong negative impacts on cultural services and human health (Fig. 6a-j).

4. Discussion

A comparison assessment of invasiveness in two different ways, presented in TOKARSKA ET AL., 2012 and in the present paper - the importance of the actual and/or potential impacts of IAS - indicates that their results are mostly consistent in case of the lowest categories of invasiveness. Species not included in the Harmonia+PL assessment are mostly plants that, in the comparison from 2012, had category I or II (see explanation under Fig. 4 and Table 2), or had no assigned category, and therefore were not included as invasive, even at the local level.

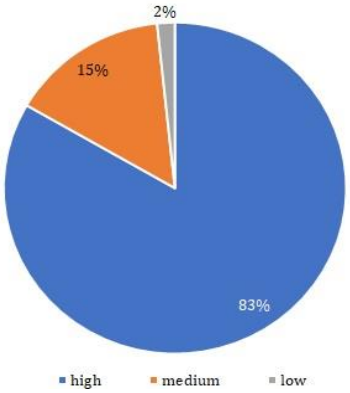
However, in a few cases the difference in the obtained categories of invasiveness (see Table 2) is rather surprising, especially for species from the highest category. For example, some of the species with the highest scores - IV or III (Fig. 4) in 2012 were only considered potentially invasive when assessed using the Harmonia+PL procedure. This is the case with *Acer negundo*, *Amelanchier spicata*, *Bromus carinatus*, *Elodea canadensis*, *Impatiens parviflora* and *Mimulus guttatus*. While the situation with regard to *Mimulus guttatus* (recognized by Harmonia+PL as "not invasive") can be explained by the low socioeconomic impact of this species (which is an important factor in the Harmonia+PL procedure), in the case of such species as *Acer negundo* or *Bromus carinatus*, it is less understandable and not intuitive for the ecologist. A more uniform situation applies in the opposite direction - species assessed on the basis of Harmonia+PL as "very invasive", in the case of the 2012 classification also usually had IV or III category - this applies to taxa of the genus *Reynoutria*, *Heracleum* or *Ambrosia*.

The explanation of the most serious differences seems to be related to the significantly different nature of the assessments - the 2012 assessment was conducted mainly by ecologists and was mainly based on natural criteria (chorology, ecology of the plant species and impact on the natural environment in general or its selected elements). Harmonia+PL, on the other hand, is a multifaceted assessment that takes into account, apart from the natural aspect, also the socio-economic impact. However, based on the examples provided, it seems that the environmental impact, should not be assessed (in scores) at the same level of significance as the economic impact. Our results seem to point out the need to differentiate between the evaluation

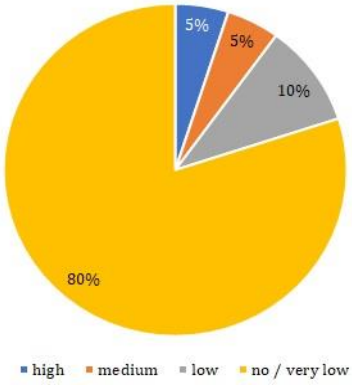
of environmental and economic impact. Perhaps the environmental impact should have a slightly higher importance than the socio-economic one in calculating the sum of points in the entire species assessment procedure, especially because of its importance as a component of a wider process of global environmental changes.

The results obtained were then used for prioritizing the significance of different pathways of introduction and spread of invasive alien species of Union concern in Poland, following the obligations of the EU Regulation on IAS. For priority pathways, including escape of ornamental plants, action plans were developed (TOKARSKA-GUZIK ET AL., 2018). The results of the assessments were also used to prioritize alien species that require the implementation of urgent control measures in Poland. For some of those species, including knotweeds and hogweeds, pilot control was implemented in 2021 to select the most effective measures that could then be used at wider scales. This is particularly important in view of the new act on alien species in Poland that came into force in December 2021.

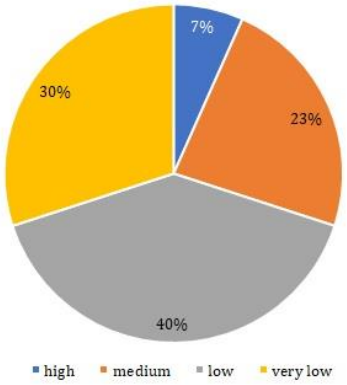
The dynamic nature of biological invasions makes it necessary to regularly review and update risk assessments (Fig. 7). This is, for instance, because a species that used to be considered to be non-invasive may manifest its invasiveness due to climate change. Assessments obviously need to be carried out for species newly included into European and national legislation.



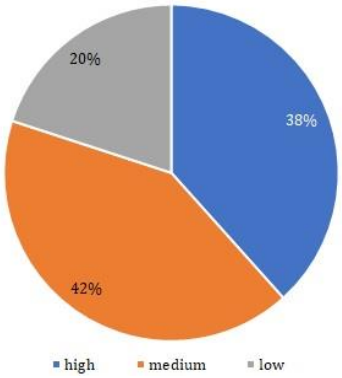
a/ Competition



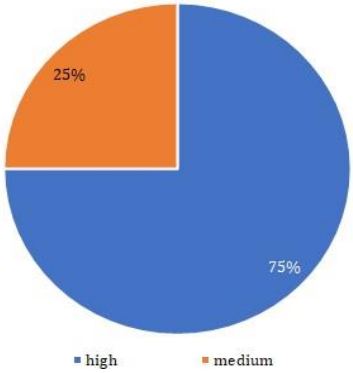
b/ Hybridisation



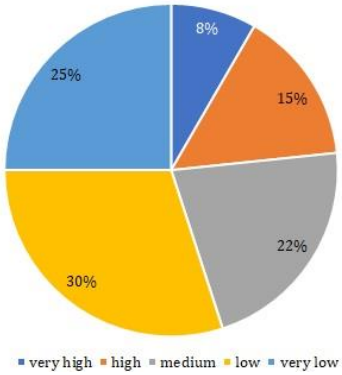
c/ Pathogen transmission



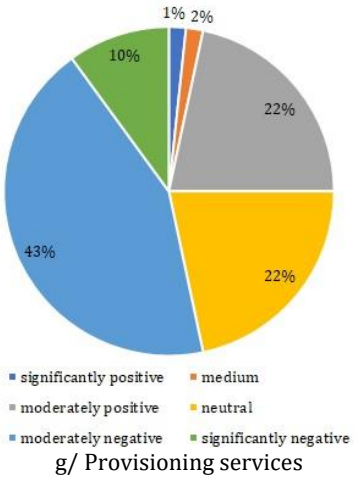
d/ Ecosystem integrity, by affecting its abiotic properties



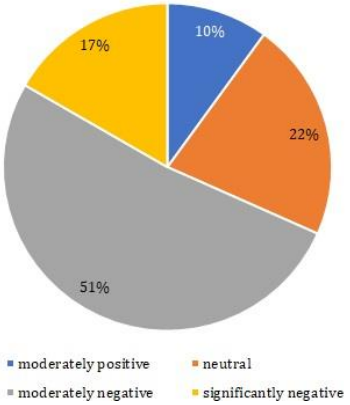
e/ Ecosystem integrity, by affecting its biotic properties



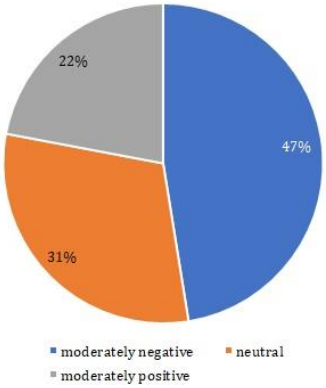
f/ Infrastructure damage



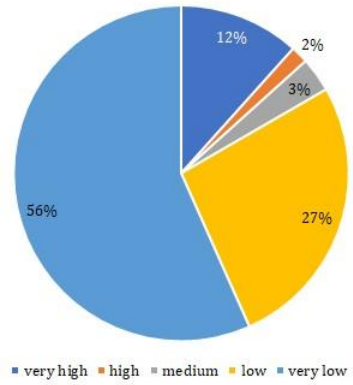
g/ Provisioning services



h/ Regulation and maintenance services



i/ Cultural services



j/ Human health

Fig. 6. The negative impacts of invasive alien plant species on the environmental domain, economy, ecosystem services and human health calculated according to Harmonia^{+PL} procedure

A

B

C

D

Fig. 7. The dynamic nature of biological invasions makes it necessary to regularly review and update risk assessments (photo: Barbara Tokarska-Guzik)

A – *Senecio inaequidens* – A species of South-African origin, spreading dynamically in southern Poland; B – *Grindelia squarrosa* – A species native to western and central North America showing rapid spread in Ukraine – it has already two recorded localities in Poland; C – Escapees from gardens are increasing - the photo shows a garden variety of the genus *Rudbeckia* in a ruderal habitat; D – *Polygonum polystachyum* - the species brought to Poland as an ornamental plant, has a dozen or so localities, it is proposed for inclusion in the EU list in 2022

Ackowledgements

The study has been carried out within the project entitled "Developing principles for the control of and resistance to invasive alien species together with undertaking pilot actions and social education" and was co-financed from European Union funds in frameworks of the programme the Infrastructure and the Environment 2014-2020 (No. POIS.02.04.00-00-0100 / 16) and statutory research of the Botany and Nature Protection Team at the University of Silesia in Katowice.

We express our gratitude to Professor Ian Trueman for his linguistic help.

References

Act of August 11, 2021 on Alien Species (*Journal of Laws,* item 1718).

Anioł-Kwiatkowska J., Szczęśniak E. (eds.). 2011. Zagrożone archeofity Dolnego Śląska. Endangered archaeophytes of Lower Silesia, *Acta Botanica Silesiaca, Supplementum.* Uniwersytet Wrocławski. Instytut Biologii Roślin, Wrocław.

Blackburn T.M., Pyšek P., Bacher S., Carlton J.T., Duncan R.P., Jarošík V., Wilson J.R.U., Richardson D.M. 2011. A proposed unified framework for biological invasions. *Trends in Ecology & Evolution*, 26: 333–339.

Brunel S., Branquart E., Fried G., van Valkenburg J., Brundu G., Starfinger U., Buholzer S., Uludag A., Joseffson M., Baker R. 2010. The EPPO prioritization process for invasive alien plants. *Bulletin OEPP/EPPO*, 40: 407–422.

Brzosko E., Jermakowicz E., Mirski P., Ostrowiecka B., Tałałaj I., Wróblewska A. 2016. *Inwazyjne drzewa i krzewy w Biebrzańskim Parku Narodowym i Suwalskim Parku Krajobrazowym*. Stowarzyszenie „Uroczysko", Białystok.

Bzdega K., Janiak A., Książczyk T., Lewandowska A., Gancarek M., Sliwinska E., Tokarska-Guzik B. 2016. A survey of genetic variation and genome evolution within the invasive *Fallopia* complex. *PLoS ONE,* 11, 8: e0161854.

Celka Z., Bzdęga K., Jackowiak B. 2018. *Parthenium hysterophorus* L. Invasiveness assessment survey in Poland based on Harmonia^{+PL} – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska, Warszawa.

Chmura D., Tokarska-Guzik B., Nowak T., Woźniak G., Bzdęga K., Koszela K., Gancarek M. 2015. The influence of invasive *Fallopia* taxa on resident plant species in two river valleys (southern Poland). *Acta Societatis Botanicorum Poloniae*, 84, 1: 23–33.

Commission Implementing Regulation (EU) 2016/1141 of 13 July 2016 adopting the list of invasive alien species considered as posing a threat to the Union in accordance with Regulation (EU) No 1143/2014 of the European Parliament and of the Council (OJ L 189 of 14.07. 2016, p. 4, as amended) with updates: Commission Implementing Regulation (EU) 2017/1263 and Commission Implementing Regulation (EU) 2019/1262.

D'hondt B., Vanderhoeven S., Roelandt S., Mayer F., Versteirt V., Ducheyne E., San Martin G., Grégoire J-C., Stiers I., Quoilin S., Branquart E. 2014. *Harmonia+ and Pandora+: risk screening tools for potentially invasive organisms*. Belgian Biodiversity Platform, Brussels.

Dajdok Z., Pawlaczyk P. (eds). 2009. *Inwazyjne gatunki roślin ekosystemów mokradłowych Polski*. Wydawnictwo Klubu Przyrodników, Świebodzin.

Dajdok Z., Wuczyński A. 2008. Alien plants of field margins and fields of southwestern Poland. *Biodiversity Research and Conservation,* 9–10: 19–33.

Danielewicz W., Wiatrowska B., Dajdok Z., Tokarska-Guzik B. 2020. Rośliny naczyniowe obcego pochodzenia zadomowione w lasach Polski. *Fragmenta Floristica et Geobotanica Polonica*, XXVII, 2: 451–471.

Dering M., Sękiewicz K., Iszkuło G., Chojnacka A., Tomaszewski D., Pers-Kamczyc E., Karolewski P. 2018. Spatial genetic structure and clonal structure of *Prunus serotina* during invasive spread. *Silva Fennica*, 52, 3: 1–21, article id 9987.

Dyderski M.K., Jagodziński A.M. 2018. Drivers of invasive tree and shrub natural regeneration in temperate forests. *Biological Invasions*, 20: 2363–2379.

Dyderski M.K., Jagodziński A.M. 2019. Functional traits of acquisitive invasive woody species differ from conservative invasive and native species. *NeoBiota*, 41: 91–113.

Dyderski M.K., Jagodziński A.M. 2020. Impact of invasive tree species on natural regeneration species composition, diversity, and density. *Forests,* 11, 4: 456.

Genovesi P., Shine C. 2004. *European strategy on invasive alien species*. Nature and environment, No. 137. Council of Europe Publishing: 1–67.

Hereźniak J. 1992. Amerykańskie drzewa i krzewy na ziemiach polskich. [in:] M. Ławrynowicz & A. U. Warcholińska (eds.). *Rośliny pochodzenia amerykańskiego zadomowione w Polsce.* Łódzkie Towarzystwo Naukowe. Szlakami Nauki, 19: 97–150.

Jackowiak B., Celka Z., Chmiel J., Latowski K., Żukowski W. 2017. Checklist of the vascular flora of Wielkopolska (Poland): casual alien species. *Biodiversity Research and Conservation* 46,1: 35–55.

Kornaś J. 1968. Prowizoryczna lista nowszych przybyszów synantropijnych (kenofitów) zadomowionych w Polsce. [in:] J.B. Faliński (ed.). Synantropizacja szaty roślinnej. I. Neofityzm i apofityzm w szacie roślinnej Polski. *Materiały Zakładu Fitosocjologii Stosowanej Uniwersytetu Warszawskiego,* 25: 43–53.

Michalak S. 1981. Lista efemerofitów Opolszczyzny. *Zeszyty Przyrodnicze Opolskiego Towarzystwa Przyjaciół Nauk*, 13–14: 3–10.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M. 1995. Vascular plants of Poland. A checklist. – Polish Botanical Studies, *Guidebook Series*, 15: 1–303.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M. 2002. *Flowering plants and pteridophytes of Poland. A checklist*. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M. 2020. *Vascular plants of Poland. An annotated checklist.* W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Otręba A., Michalska-Hejduk D. (eds). 2014. *Inwazyjne gatunki roślin w Kampinoskim Parku Narodowym i w jego sąsiedztwie*. Wydawnictwo. Kampinoski Park Narodowy, Izabelin.

Pyšek P., Hulme P.E., Simberloff D., Bacher S., Blackburn T.M., Carlton J.T., Dawson W., Essl F., Foxcroft L.C., Genovesi P., Jeschke J.M., Kühn I., Liebhold A.M., Mandrak N.E., Meyerson L.A., Pauchard A., Pergl J., Roy H.E., Seebens H., Kleunen M., Vilà M., Wingfield M.J., Richardson D.M. 2020. Scientists' warning on invasive alien species. *Biological Reviews*, 95, 6: 1511–1534.

Pyšek P., Pergl J., Essl F., Lenzner B., Dawson W., Kreft H., Weigelt P., Winter M., Kartesz J., Nishino M., Antonova L. A., Barcelona J.F., Cabezas F.J., Cárdenas D., Cárdenas-Toro J., Castaño N., Chacón E., Chatelain C., Dullinger S., Ebel A.L., Figueiredo E., Fuentes N., Genovesi P., Groom Q.J., Henderson L., Inderjit Kupriyanov A., Masciadri S., Maurel N., Meerman J.C., Morozova O., Moser D., Nickrent D.L., Nowak P.M., Pagad S.N., Patzelt A., Pelser P.B., Seebens H., Shu W., Thomas J., Velayos M., Weber E., Wieringa J.J., Baptiste M.P., van Kleunen M. 2017. Naturalized alien flora of the world: Species diversity, taxonomic and phylogenetic patterns, geographic distribution and global hotspots of plant invasion. Preslia**,** 89, 3: 203–274.

Pyšek P., Richardson D.M., Rejmánek M., Webster G., Williamson M., Kirschner J. 2004. Alien plants in checklists and floras: towards better communication between taxonomists and ecologists. *Taxon*, 53: 131–143.

Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the Prevention and Management of the Introduction and Spread of Invasive Alien Species.

Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of alien species that could be a threat to native species or natural habitats in case of their release into the natural environment (Journal of Laws No 210, item 1260).

Rewicz A., Myśliwy M., Adamowski W., Podlasiński M., Bomanowska A. 2020. Seed morphology and sculpture of invasive *Impatiens capensis* Meerb. from different habitats. *PeerJ*, 8: e10156.

Richardson D.M., Pyšek P., Rejmánek M., Barbour M.G., Panetta F.D., West C.J. 2000. Naturalization and invasion

of alien plants: concepts and definitions. *Diversity and Distributions*, 6: 93–107.

Rostański K., Sowa R. 1986–1987. Alfabetyczny wykaz efemerofitów Polski. *Fragmenta Floristica et Geobotanica Polonica*, 31–32, 1–2: 151–205.

Roy H.E., Rabitsch W., Scalera R., Stewart A., Gallardo B., Genovesi P., ..., Zenetos A. 2018. Developing a framework of minimum standards for the risk assessment of alien species. *Journal of Applied Ecology*, 55, 2: 526–538.

Seebens H., Blackburn T.M., Dyer E.E., Genovesi P., Hulme P.E., Jeschke J.M., Pagad S., Pyšek P., Winter M., Arianoutsou M., Bacher S., Blasius B., Brundu, G., Capinha C., Celesti-Grapow L., Dawson W., Dullinger S., Fuentes N., Jäger H., Kartesz J., Kenis M., Kreft H., Kühn I., Lenzner B., Liebhold A., Mosena A., Moser D., Nishino M., Pearman D., Pergl J., Rabitsch W., Rojas-Sandoval J., Roques A., Rorke S., Rossinelli S., Roy H.E., Scalera R., Schindler S., Štajerová K., Tokarska-Guzik B., van Kleunen M., Walker K., Weigelt P., Yamanaka T., Essl F. 2017. No saturation in the accumulation of alien species worldwide. *Nature Communications*, 8, 14435.

Seebens H., Blackburn T.M., Dyer E.E., Genovesi P., Hulme P.E., Jeschke J.M., Pagad S., Pyšek P., van Kleunen M., Winter M., Ansong M., Arianoutsou M., Bacher S., Blasius B., Brockerhoff E.G., Brundu G., Capinha C., Causton C.E., Celesti-Grapow L., Dawson W., Dullinger S., Economo E.P., Fuentes N., Guénard B., Jäger H., Kartesz J., Kenis M., Kühn I., Lenzner B., Liebhold A.M., Mosena A., Moser D., Nentwig W., Nishino M., Pearman D., Pergl J., Rabitsch W., Rojas-Sandoval J., Roques A., Rorke S., Rossinelli S., Roy H.E., Scalera R., Schindler S., Štajerová K., Tokarska-Guzik B., Walker K., Ward D. F., Yamanaka T., Essl F. 2018. Global rise in emerging alien species results from increased accessibility of new source pools. *Proceedings of the National Academy of Sciences of the United States of America*, 115, 10: 2264–2273.

Solarz W., Dajdok Z., Mazurska K., Tokarska-Guzik B. 2018. Action plan for the priority pathway: "Escape of ornamental plant species from non-commercial horticultural crops (e.g. from home and allotment gardens, parks)". General Directorate for Environmental Protection, Warsaw (manuscript).

Sowa R., Warcholińska A.U. 1994. The list of American flowering plants established in Poland (kenophytes). *Thaiszia – Journal of Botany*, 4: 197–210.

Stefanowicz A.M., Kapusta P., Stanek M., Frąc M., Oszust K., Woch M.W., Zubek S. 2021. Invasive plant *Reynoutria japonica* produces large amounts of phenolic compounds and reduces the biomass but not activity of soil microbial communities. *Science of the Total Environment*, 767: 145439.

Sudnik-Wójcikowska B., Korniak T., Jackowiak B. 2018. Spartina anglica C.E.Hubb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska, Warszawa.

Szymura M., Szymura T.H. 2015. Growth, phenology, and biomass allocation of alien *Solidago* species in central Europe. *Plant Species Biology*, 30: 245–256.

The Plant List. 2013. Version 1.1. Available at http://www.theplantlist.org

Tokarska-Guzik B. 2003. The expansion of some alien plant species (neophytes) in Poland. [in:] L.E. Child, J.H. Brock, G. Brundu, K. Prach, P. Pyšek, P.M. Wade, M. Williamson (eds.). *Plant invasions: ecological threats and management solutions*. Backhuys Publishers, Leiden, The Netherlands: 147–167.

Tokarska-Guzik B. 2005. *The Establishment and Spread of Alien Plant Species (Kenophytes) in the Flora of Poland*. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Tokarska-Guzik B., Bzdęga K., Koszela K., Żabińska I., Krzuś B., Sajan M., Sendek A. 2011b. Allergenic invasive plant *Ambrosia artemisiifolia* in Poland: threat and selected aspects of biology. *Biodiversity Research and Conservation*, 21: 41–56.

Tokarska-Guzik B., Bzdęga K., Nowak T., Lewandowska A., Gancarek M., Frelich M. 2014. Alien plants in Poland: research directions and putting the results into practice. *Biodiversity Research and Conservation*, 35: 57–74.

Tokarska-Guzik B., Dajdok Z., Zając M., Urbisz A., Danielewicz W. 2011a. Identyfikacja i kategoryzacja roślin obcego pochodzenia jako podstawa działań praktycznych. *Acta Botanica Silesiaca*, 6: 13–43.

Tokarska-Guzik B., Dajdok Z., Zając M., Zając A., Urbisz A., Danielewicz W., Hołdyński Cz. 2012. *Rośliny obcego pochodzenia w Polsce ze szczególnym uwzględnieniem gatunków inwazyjnych. [Alien plants in Poland with particular reference to invasive species].* Generalna Dyrekcja Ochrony Środowiska, Warszawa: 1–197.

Tokarska-Guzik B., Fojcik B., Bzdęga K., Urbisz Al., Nowak T., Pasierbiński A., Dajdok Z. 2017. *Inwazyjne gatunki z rodzaju rdestowiec Reynoutria spp. w Polsce – biologia, ekologia i metody zwalczania*. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Urbisz A. 2011. *Occurrence of temporarily-introduced alien plant species (ephemerophytes) in Poland – scale and assessment of the phenomenon*. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Vinogradova Y., Pergl J., Essl F., Hejda M., van Kleunen M., Regional Contributors, Pyšek P. 2018. Invasive alien plants of Russia: insights from regional inventories. *Biological Invasions*, 20: 1931–1943.

Węgrzynek B., Nowak T., Urbisz A., Urbisz A., Pasierbiński A., Tokarska-Guzik B. 2011. Archaeophytes in the Silesian Uplands (S Poland) – ecological aspects of their occurence and dynamic tendencies in their distribution. [in:] B. Zemanek (ed.) *Geobotanist and Taxonomist. A volume dedicated to Professor Adam Zając on the 70th anniversary of his birth*. Institute of Botany, Jagiellonian University, Cracow: 139–156.

Zajac A., Zajac M. (eds). 2001. *Distribution Atlas of Vascular Plants in Poland*. Laboratory of Computer Chorology, Institute of Botany, Jagiellonian University, Cracow: 1–715.

Zajac A., Zajac M. (eds). 2019. *Distribution Atlas of Vascular Plants in Poland: Appendix*. Laboratory of Computer Chorology, Institute of Botany, Jagiellonian University, Cracow: 1–319.

Zając A. 1979. Pochodzenie archeofitów występujących w Polsce. *Rozprawy Habilitacyjne Uniwersytetu Jagiellońskiego*, 29: 1–213.

Zając A. 1983. Studies on the origin of archeophytes in Poland. Part I. Methodical considerations. Zeszyty Naukowe Uniwersytetu Jagiellońskiego 670, *Prace Botaniczne*, 11: 87–107.

Zając A. 1987a. Studies on the origin of archeophytes in Poland. Part II. Taxa of Mediterranean and Atlantic Mediterranean origin. Zeszyty Naukowe Uniwersytetu Jagiellońskiego 790, *Prace Botaniczne*, 14: 7–50.

Zając A. 1987b. Studies on the origin of archeophytes in Poland. Part III. Taxa of Irano-Turanian, Euro-SiberianIrano-Turanian and Medieterraean-Irano-Turanian origin. Zeszyty Naukowe Uniwersytetu Jagiellońskiego 834, *Prace Botaniczne*, 15: 93–129.

Zając A. 1988. Studies on the origin of archeophytes in Poland. Part IV. Taxa of Pontic-Pannonian, Mediterraneo-

South Asiatic, South Asiatic and Middle Europaean origin. Archaeophyta anthropogenea. Archaeophyta resistentia. Archaeophytes of unknown origin. Zeszyty Naukowe Uniwersytetu Jagiellońskiego 872, *Prace Botaniczne*, 17: 23–51.

Zając A., Tokarska-Guzik B., Zając M. 2011. The role of rivers and streams in the migration of alien plants into the Polish Carpathians. *Biodiversity Research and Conservation*, 23, 43–56.

Zając A., Zając M., Tokarska-Guzik B. 1998. Kenophytes in the flora of Poland: list, status and origin. [in:] J.B. Faliński, W. Adamowski, B. Jackowiak (eds.) *Synanthropization of plant cover in new Polish research*. *Phytocoenosis* 10 (N.S.) *Suppl. Cartogr. Geobot.* 9: 107–116.

Zając A., Zając M. (eds.). 2015. *Rozmieszczenie kenofitów w Karpatach Polskich i na ich przedpolu [Distribution of kenophytes in the Polish Carpathians and their foreland]*. Institute of Botany, Jagiellonian University, Cracow.

Zając E., Zając A. 1975. Lista archeofitów występujących w Polsce. Zeszyty Naukowe Uniwersytetu Jagiellońskiego. *Prace Botniczne*, 3: 7–15.

Appendix 1. The list of questionnaires assessing the degree of invasiveness for 60 plant species, posted on the website of the General Directorate for Environmental Protection			
	Authors	Title	link
1.	Chmura D., Chmiel J., Danielewicz W. 2018.	*Acer negundo* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127036/Acer-negundo_klon-jesionolistny_EN_icon_1.pdf
2.	Jackowiak B., Bąbelewski P., Tokarska-Guzik B. 2018.	*Ailanthus altissima* (Mill.) Swingle. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127037/Ailanthus-altissima_EN_icon.pdf
3.	Kompała-Bąba A., Woźniak G., Jackowiak B. 2018.	*Alternanthera philoxeroides* (Mart.) Griseb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127038/Alternanthera-philoxeroides-alternatera-krokodylowa_EN_icon.pdf
4.	Bzdęga K., Tokarska-Guzik B., Jackowiak B. 2018.	*Ambrosia artemisiifolia* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127039/Ambrosia-artemisiifolia_ambrozja-bylicolistna_EN_icon.pdf
5.	Celka Z., Chmiel J., Urbisz A. 2018.	*Amelanchier spicata* (Lam.) K. Koch. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127040/Amelanchier-spicata_swidosliwa-klosowa_EN_icon.pdf
6.	Tokarska-Guzik B., Wołkowycki D., Jackowiak B. 2018.	*Asclepias syriaca* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127041/Asclepias-syriaca_trojesc-amerykanska_EN_icon.pdf
7.	Nowak T., Korniak T., Chołdyński Cz. 2018.	*Aster novi-belgii* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127042/Aster-novi-belgii_aster-nowobelgijski_EN_icon.pdf
8.	Szczęśniak E., Myśliwy M., Dajdok Z. 2018.	*Azolla filiculoides* Lam. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127043/Azolla-filiculoides_EN_icon.pdf
9.	Chmiel J., Tokarska-Guzik B., Chołdyński Cz. 2018.	*Baccharis halimifolia* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127044/Baccharis-halimifolia_EN_icon.pdf

10.	Wylazłowska J., Michalska-Hejduk D., Urbisz A. 2018.	*Bidens frondosa* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127045/Bidens-frondosa_Uczep-amerykanski_EN_icon.pdf
11.	Szczęśniak E., Dajdok Z., Tokarska-Guzik B. 2018.	*Bromus carinatus* Hook. & Arn. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127046/Bromus-carinatus_stoklosa-splaszczona_EN_icon.pdf
12.	Nowak T., Krajewski Ł., Tokarska-Guzik B. 2018.	*Cabomba caroliniana* A. Gray. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127047/Cabomba-caroliniana-Kabomba-karoli%C5%84ska-EN_icon.pdf
13.	Purcel A., Nowak T., Danielewicz W. 2018.	*Celastrus orbiculatus* Thunb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127048/Celastrus-orbiculatus_dlawisz-okraglolistny_EN_icon.pdf
14.	Danielewicz W., Sotek Z., Sudnik-Wójcikowska B. 2018.	*Clematis vitalba* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127049/Clematis-vitalba_powojnik-pnacy_EN_icon_1.pdf
15.	Danielewicz W., Wołkowycki D., Gazda A. 2018.	*Cornus sericea* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127050/Cornus-sericea_deren-rozlogowy_EN_icon.pdf
16.	Sotek Z., Kompała-Bąba A., Tokarska-Guzik B. 2018.	*Crassula helmsii* (Kirk) Cockayne. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127051/Crassula-helmsii_grubosz-helmsa_EN_icon.pdf
17.	Celka Z., Halladin-Dąbrowska A., Dajdok Z. 2018.	*Echinocystis lobata* (F. Michx.) Torr. & A. Gray. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127052/Echinocystis-lobata_EN_icon.pdf
18.	Gąbka M., Kamiński R., Tokarska-Guzik B. 2018.	*Eichhornia crassipe*s (Mart.) Solms. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127053/Eichhornia-crassipes_eichornia-gruboogonkowa_EN_icon_2.pdf
19.	Kolada A., Gąbka M., Urbisz A. 2018.	*Elodea canadensis* Michx. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127054/Elodea-canadensis_moczarka-kanadyjska_EN_icon_2.pdf

20.	Kolada A., Gąbka M., Urbisz A. 2018.	*Elodea nuttallii* (Planch.) H. St. John. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127055/Elodea-nuttallii_moczarka_EN_icon.pdf
21.	Dajdok Z., Nobis M., Sudnik-Wójcikowska B. 2018.	*Eragrostis albensis* H. Scholz. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127056/Eragrostis-albensis_milka-polabska_EN_icon_3.pdf
22.	Gazda A., Wołkowycki D., Hołdyński Cz. 2018.	*Fraxinus pennsylvanica* Marshall. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127057/Fraxinus-pennsylvanica_jesion-pensylwanski_EN_icon_2.pdf
23.	Melon E., Tokarska-Guzik B., Zając M. 2018.	*Gunnera tinctoria* (Molina) Mirb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127058/Gunnera-tinctoria_gunera-brazylijska_EN_icon.pdf
24.	Nowak T., Żołnierz L., Jackowiak B. 2018.	*Helianthus tuberosus* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127059/Helianthus-tuberosus_slonecznik-bulwiasty_EN_icon.pdf
25.	Sachajdakiewicz I., Śliwiński M., Tokarska-Guzik B. 2018.	*Heracleum mantegazzianum* Sommier & Levier. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127061/Heracleum-mantegazzianum-Barszcz-mantegazziego-EN_icon.pdf
26.	Sachajdakiewicz I., Bzdęga K., Urbisz A. 2018.	*Heracleum persicum* Desf. ex Fisch., C.A.Mey. & Avé-Lall. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127062/Heracleum-persicum-Barszcz-perski-EN_icon.pdf
27.	Sachajdakiewicz I., Szewczyk M., Tokarska-Guzik B. 2018.	*Heracleum sosnowskyi* Manden. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127063/Heracleum-Sosnowskyi-Barszcz-Sosnowskiego-EN_icon_3.pdf
28.	Nowak T., Popiela A., Sudnik-Wójcikowska B. 2018.	*Hydrocotyle ranunculoides* L. f. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127064/Hydrocotyle-ranunculoides_hydrocotyle-ranunculoides_EN_icon.pdf
29.	Adamowski W., Myśliwy M., Dajdok Z. 2018.	*Impatiens capensis* Meerb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127065/Impatiens-capensis_niecierpek-pomaranczowy_EN_icon.pdf

30.	Adamowski W., Krzysztofiak A., Dajdok Z. 2018.	*Impatiens glandulifera* Royle. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127066/Impatiens-glandulifera_EN_icon.pdf
31.	Adamowski W., Chmura D., Choldyński Cz. 2018.	*Impatiens parviflora* DC. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127067/Impatiens-parviflora_niecierpek-drobnokwiatowy-EN_icon.pdf
32.	Michalska-Hejduk D., Kopeć D., Sudnik-Wójcikowska B. 2018.	*Lagarosiphon major* (Ridley) Moss. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127068/Lagarosiphon-major_Lagarosyfon-wielki_EN_icon.pdf
33.	Urbisz A., Rosadziński S., Zając A. 2018.	*Ludwigia grandiflora* (Michx.) Greuter & Burdet. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127069/Ludwigia-grandiflora_EN_icon.pdf
34.	Podlaska M., Rosadziński S., Zając A. 2018.	*Ludwigia peploides* (Kunth) P.H. Raven. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127070/Ludwigia-peploides_EN_icon_8.pdf
35.	Wołkowycki D., Tokarska-Guzik B., Jackowiak B. 2018.	*Lupinus polyphyllus* Lindl. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127071/Lupinus-polyphyllus_lubin-trwaly_EN_icon.pdf
36.	Sudnik-Wójcikowska B., Melon M., Tokarska-Guzik B. 2018.	*Lysichiton americanus* Hultén & H.St.John. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127072/Lysichiton-americanus-Tulejnik-ameryka%C5%84sk-EN_icon.pdf
37.	Wołkowycki D., Chmura D., Jackowiak B. 2018.	*Microstegium vimineum* (Trin.) A. Camus. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127073/Microstegium-vimineum_EN_icon.pdf
38.	Dajdok Z., Tokarska-Guzik B., Jackowiak B. 2018.	*Mimulus guttatus* DC. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127074/Mimulus-guttatus_kroplik-zolty_EN_icon.pdf
39.	Sierka E., Gąbka M., Urbisz A. 2018.	*Myriophyllum aquaticum* (Vell.) Verdc. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127075/Myriophyllum-aquaticum_wywlocznik-brazylijski_EN_icon.pdf

40.	Gąbka M., Sierka E., Urbisz A. 2018.	*Myriophyllum heterophyllum* Michx. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127076/Myriophyllum-heterophyllum_wywlocznik-roznolistny_EN_icon.pdf
41.	Halarewicz A., Otręba A., Danielewicz W. 2018.	*Padus serotina* (Ehrh.) Borkh. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127077/Padus-serotina_czeremcha-amerykanska_-EN_icon.pdf
42.	Celka Z., Bzdęga K., Jackowiak B. 2018.	*Parthenium hysterophorus* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127078/Parthenium-hysterophorus_parthenium-ambrozjowate_EN_icon.pdf
43.	Krzysztofiak A., Śliwiński M., Danielewicz W. 2018.	*Parthenocissus inserta* (A.Kern.) Fritsch. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127080/Parthenocissus-inserta_winobluszcz-zaroslowy_EN_icon.pdf
44.	Urbisz A., Nobis M., Zając A. 2018.	*Pennisetum setaceum* (Forssk.) Chiov. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127081/Pennisetum-setaceum_rozplenica-szczecinkowata_EN_icon.pdf
45.	Chmura D., Sotek Z., Zając M. 2018.	*Persicaria perfoliata* (L.) H. Gross. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127082/Persicaria-perfoliata_EN_icon.pdf
46.	Hołdyński Cz., Bomanowska A., Zając M. 2018.	*Pueraria montana* (Lour.) Merr. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127083/Pueraria-montana_opornik-latkowaty_EN_icon.pdf
47.	Woziwoda B., Chmura D., Danielewicz W. 2018.	*Quercus rubra* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127084/Quercus-rubra_dab-czerwony_EN_icon.pdf
48.	Bzdęga K., Urbisz A., Tokarska-Guzik B. 2018.	*Reynoutria japonica* Houtt. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127085/Reynoutria-japonica_rdestowiec-japonski_EN_icon.pdf
49.	Urbisz A., Bzdęga K., Tokarska-Guzik B. 2018.	*Reynoutria sachalinensis* (F. Schmidt) Nakai. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127086/Reynoutria-sachalinensis_EN_icon.pdf

50.	Bzdęga K., Urbisz A., Tokarska-Guzik B. 2018.	*Reynoutria ×bohemica* Chrtek & Chrtkova. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127087/Reynoutria-x-bohemica_EN_icon.pdf
51.	Danielewicz W., Mirski P., Gazda A. 2018.	*Robinia pseudoacacia* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127090/Robinia-pseudoacacia_robinia-akacjowa_EN_icon.pdf
52.	Popiela A., Brzosko E., Gazda A. 2018.	*Rosa rugosa* Thunb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127091/Rosa-rugosa_roza-pomarszczona_EN_icon.pdf
53.	Brzosko E., Szymura M., Tokarska-Guzik B. 2018.	*Rudbeckia laciniata* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127093/Rudbeckia-laciniata_rudbekia-naga_EN_icon.pdf
54.	Szymura M., Bzdęga K., Tokarska-Guzik B. 2018.	*Solidago candensis* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127094/Solidago-canadensis-_-Nawloc-kandyjska-EN_icon.pdf
55.	Szymura M., Bzdęga K., Tokarska-Guzik B. 2018.	*Solidago gigantea* Aiton. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127095/Solidago-gigantea_nawloc-pozna_EN_icon.pdf
56.	Szymura M., Kompała-Bąba A., Urbisz A. 2018.	*Solidago graminifolia* (L.) Elliott. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127096/Solidago-graminifolia_nawloc-waskolistna_EN_icon.pdf
57.	Sudnik-Wójcikowska B., Korniak T., Jackowiak B. 2018.	*Spartina anglica* C.E.Hubb. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127097/Spartina-anglica_spartyna-angielska_EN_icon.pdf
58.	Wiatrowska B., Michalska-Hejduk D., Dajdok Z. 2018.	*Spiraea tomentosa* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127098/Spiraea-tomentosa_tawula-kutnerowata_EN_icon.pdf
59.	Popiela A., Sobisz Z., Nowak T. 2018.	*Ulex europaeus* L. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127099/Ulex-europaeus_EN_icon.pdf

60.	Dajdok Z., Celka Z., Sudnik-Wójcikowska B. 2018.	*Xanthium albinum* (Widder) H. Scholz. Invasiveness assessment survey in Poland based on Harmonia+PL – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. Source: Generalna Dyrekcja Ochrony Środowiska. www.projekty.gdos.gov.pl/igo, data dostępu: 2021-12-16	http://projekty.gdos.gov.pl/files/artykuly/127100/Xanthium-albinum_rzepien-wloski_EN_icon.pdf