Appendix A

Harmonia^{+PL} – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland

QUESTIONNAIRE

A0 | Context

Questions from this module identify the assessor and the biological, geographical & social context of the assessment.

a01. Name(s) of the assessor(s):

first name and family name

1. Teresa Nowak
2. Ludwik Żołnierz – external expert
3. Bogdan Jackowiak

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	07-04-2018
(2)	dr hab.	Department of Botany and Plant Ecology, Wrocław University of Environmental and Life Sciences	31-01-2018
(3)	prof. dr hab.	Department of Plant Taxonomy, Institute of Environmental Biology, Faculty of Biology, Adam Mickiewicz University in Poznań	15-04-2018

a02. Name(s) of ***the species*** under assessment:

Polish name: Słonecznik bulwiasty

Latin name: ***Helianthus tuberosus*** L.

English name: Jerusalem-artichoke

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acomm02. Comments:

The Latin name and its synonyms are provided on the basis of taxon database (The Plant List 2013 – B), and the Polish name has been adopted from the up-to-date nomenclature of vascular plants in Poland (Mirek et al. 2002 – P). "Jerusalem artichoke" is the most commonly used English name (e.g. Flora of North America 2018 – I). Apart from a wild species, two registered cultivated varieties of Jerusalem artichoke are the most popular in Poland: 'Albik' and 'Rubik' (Lista odmian roślin rolniczych – *List of varieties of agricultural plants* 1998 – P), which can be observed in sites other than cultivated areas.

Polish name (synonym I) Topinambur	Polish name (synonym II) –
Latin name (synonym I) *Helianthus tomentosus*	Latin name (synonym II) –
English name (synonym I) Topinambour	English name (synonym II) Sunroot

a03.**Area** under assessment:

Poland

acomm03. Comments:

–

a04. **Status** of *the species* in Poland. *The species* is:

	native to Poland
	alien, absent from Poland
	alien, present in Poland only in cultivation or captivity
	alien, present in Poland in the environment, not established
X	alien, present in Poland in the environment, established

aconf01. Answer provided with a

low	medium	high	level of confidence
		X	

acomm04. Comments:

Jerusalem artichoke *Helianthus tuberosus* (topinambour) is a North American species spread and established throughout Poland (Zając and Zając 2001, Tokarska-Guzik 2005, Tokarska-Guzik et al. 2012 – P). It can be also encountered as a cultivated plant. Sometimes, it is quite difficult to distinguish between spontaneously growing species and the ones running wild from cultivation (Paul 2013 – P). This species is observed in 18 out of 42 surveyed botanical gardens or aboreta in Poland. Seven of them experience a spontaneous spreading of the species, and ten of them have undertaken measures to restrain the area of its occurrence (Employees of botanical garden... 2018 – N)

a05. The impact of *the species* on major domains. *The species* may have an impact on:

X	the environmental domain
X	the cultivated plants domain
	the domesticated animals domain
	the human domain
X	the other domains

acomm05. Comments:

Spreading of Jerusalem artichoke from the site of its cultivation affects the natural environment. As a perennial producing stolons and tubers, it forms dense patches, mainly along lowland and mountain rivers. In this way, it displaces native herbaceous species and reduces the local biodiversity. At the beginning, when shoots forming the population are not so dense, the co-existing species can be observed. But after some time, shoots become

denser and eliminate native species, and consequently only monospecific formations of sunflower remain (Nowak 1990-2017 – A, Kompała-Bąba and Błońska 2008, Żołnierz et al. 2011 – P). This species penetrates plant communities, overgrows other species and shadows them as well as affects them through allelopathy i.e.the secretion to the environment of various chemical substances which detrimentally affect (inhibit) germination and growth of co-occurring species(Balogh 2008, Filep et al. 2016 – P). The presence of this species is reported fromprotected areas (e.g. Chmiel 2006, Tokarska-Guzik et al. 2007, Bomanowska et al. 2014, Kwiatkowski 2017 – P). Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels – code 6430 are among endangered natural habitats (Tokarska-Guzik et al. 2012 – P). Competitive effect of this species can be also observed for growing conditions, when crop rotation is applied. Tubers remaining in the soil develop into plants, which compete with a plant cultivated in a given year (CABI 2018 – B). Moreover, this species has an allelopathic impact on some crops and concurrent weeds (Tesio et al. 2011 – P). In Poland, crops with Jerusalem artichoke weeds are rarely observed (Nowak 1990-2017 – A). Considering the impact on "other facilities", this species – after the vegetation period, can present a risk to flood-control facilities. Fewer fine roots of this species after its death make the soil more susceptible to erosion. Moreover, animals searching for tubers can disturb the soil, and thus weaken river banks and flood defences (Balogh 2008 – P, CABI 2018 – B).

A1 | Introduction

Questions from this module assess the risk for *the species* to overcome geographical barriers and – if applicable – subsequent barriers of captivity or cultivation. This leads to *introduction*, defined as the entry of *the organism*to within the limits of *the area* and subsequently into the wild.

a06.The probability for ***the species*** to expand into Poland's natural environments, **as a result of self-propelled expansion** after its earlier introduction outside of the Polish territory is:

	low
	medium
X	high

aconf02.	Answer provided with a	low	medium	high **X**	level of confidence

acomm06. Comments:

This species occurs in numerous stands in neighbouring countries (Gudžinskas 1997, Protopopova et al. 2006, Pyšek et al. 2012, Medvecka et al. 2012 – P, Bundesamt für Naturschutz 2018– B). Diaspores of those populations can enter Poland and favour the species expansion. Animals can support the movement of vegetative diaspores (tubers, parts of underground shoots) (CABI 2018 – B). They can be also transported with the river current if a plant is growing near the river bed.

a07.The probability for *the species* to be introduced into Poland's natural environments by **unintentional human actions** is:

	low
	medium
X	high

aconf03.	Answer provided with a	low	medium	high **X**	level of confidence

acomm07. Comments:

Parts of underground shoots or tubers are often transported with soil, in which they were growing, e.g. during road construction, other investments, or agrotechnical treatments (Balogh 2008, Bzdęga et al. 2009 – P, Nowak 1990-2017 – A).

a08.The probability for *the species* to be introduced into Poland's natural environments by **intentional human actions** is:

	low
	medium
X	high

aconf04.	Answer provided with a	low	medium	high **X**	level of confidence

acomm08. Comments:

Numerous functions of topinambour (medicinal, melliferous, ornamental, industrial, or as food or fodder) (CABI 2018 – B) result in the common cultivation of a few varieties. Therefore, this species or its varieties can spread to adjacent open or distorted areas (Nowak 1990-2017 – A). The risk of Jerusalem artichoke spreading to natural and semi-natural habitats is still increasing due to an increase in the number and areas of its cultivation sites. The species and its varieties can be bought in garden shops, including online shops (e.g. Future Gardens 2018 – I). Jerusalem artichoke is used by and recommended for hunt management (Dajdok and Śliwiński 2009 – P, Żołnierz 2009-2014– A, Polski Związek Łowiecki2018 – I). It can be cultivated as an energy crop and as a raw material for the process industry (Sawicka et al. 2012 – P). It also attracts a growing interest of bee-keepers (Portal pszczelarski 2018 – I).

A2 | Establishment

Questions from this module assess the likelihood for *the species* to overcome survival and reproduction barriers. This leads to *establishment*, defined as the growth of a population to sufficient levels such that natural extinction within *the area* becomes highly unlikely.

a09. Poland provides **climate** that is:

	non-optimal
	sub-optimal
X	optimal for establishment of *the species*

aconf05.	Answer provided with a	low	medium	high **X**	level of confidence

acomm09. Comments:

Jerusalem artichoke shows great tolerance for climatic factors. It is frost-resistant and has satisfactory tolerance for drought. That's why this species is capable of inhabiting areas from Newfoundland to southern states of the USA within its native range (Swanton et al. 1992 – P, Missouri Botanical Garden – I), as well as areas in Europe, whose climatic diversity is considerable (Balogh 2008 – P). This species is also observed in areas near the equator (CABI 2018 – B). Climatic conditions in Poland are optimal for the species development.

a10.Poland provides **habitat** that is

	non-optimal
	sub-optimal
X	optimal for establishment of *the species*

aconf06.	Answer provided with a	low	medium	high **X**	level of confidence

acomm10. Comments:

The lowland and foothills provide optimal conditions for this species. The highest located sites are at 400 ma.s.l. (Zającand Zając 2015 – P). This species prefers sunny and warm habitats in floodplains with clayey or sandy and clayey soils, which are rich in nutrients and store moisture (Ellenberg et al. 1992, Balogh 2008, Pyšek et al. 2012 – P). It often occupies

ruderal areas beyond alluvial zones, inter alia, along railroads and roads (Wróbel 2006, Wrzesień et al. 2016 – P) or in urban areas (e.g. Jackowiak 1993, Witosławski 2006, Kompała-Bąba and Błońska 2008, Denisow et al. 2017 – P). Jerusalem artichoke dominates in nitrophilous riparian communities of high perennials. It is also present in various ruderal communities formed in warm, averagely moist habitats (Kompała-Bąba and Błońska 2008, Medvecka et al. 2012, Pyšek et al. 2012 – P). It shows good tolerance both for water shortage and short-term flooding (CABI 2018 – B).

A3 | Spread

Questions from this module assess the risk of *the species* to overcoming dispersal barriers and (new) environmental barriers within Poland. This would lead to spread, in which vacant patches of suitable habitat become increasingly occupied from (an) already-established population(s) within Poland.

Note that spread is considered to be different from range expansions that stem from new introductions (covered by the Introduction module).

a11.The capacity of *the species* to disperse within Poland by natural means, **with no human assistance**, is:

	very low
X	low
	medium
	high
	very high

aconf07.	Answer provided with a	low	medium **X**	high	level of confidence

acomm11. Comments:

On the basis of data collected in Poland, it is difficult to unequivocally define the capability of Jerusalem artichoke to spread throughout Poland without human action. Many papers on local flora define this species as “poorly expansive” (inter alia, Chmiel 1993, Czarna 2009 – P). It appears that this species, similarly like in other European regions, mainly spreads through tubers or their fragments transported, inter alia, with the river current or by animals (Balogh 2008 – P). Effectiveness of vegetative reproduction of *H. tuberosus* is high and largely results from high regeneration capabilities of not only tubers and rootstocks, but also overground shoots (Bzdęga et al. 2009 – P). Generative diaspores, that is, fruits, makea smaller contribution to dispersion of this species (Balogh 2008 – P). An achene does not have a pappus, so it is dispersed anemochorously (anemochory – dispersal of seeds or fruits using air movements) only over small distances. However, zoochory (dispersion by animals) is more important, both external (ectozoochory) – where mammals are vectors, and internal (endozoochory), as reported fromSouth Europe (Mori et al. 2017 – P). In areas with a shorter vegetation period and under unfavourable summer conditions, the vegetative reproduction of this species becomes even less significant as produced seeds are unable to germinate (Balogh 2008, Dajdok and Śliwiński 2009 – P, Żołnierz 2009-2014– A). The population observed in Poland for two consecutive years did not produce achenes capable of germinating. Not fully developed fruits were in the oldest heads, and they did not germinate despite their stratification (Żołnierz 2009-2014 – A). However, it cannot be excluded that under particularly favourable climate conditions in the flowering and growing period, some achenes will be able to germinate as reported from theareas located to the south of Poland. In these areas, seedlings did not survive either (Moravcová et al. 2010 – P). The spreading process of *H. tuberosus* in Poland can be very diverse on a local level and depends on such factors as: geomorphology of a river valley, the nature of local plant communities, the presence and population of animals feeding on tubers of this species, or the type and intensity of anthropogenic effects, etc.

Although all types of collected data were analysed, the species capability tospread in Poland without human action was finally assessed as low taking into account C-type data. Thus:

Approximantion (C-type data):
Jerusalem artichoke usually spreads vegetatively by its underground parts (Balogh 2008 – P). It can be also dispersed by. e.g. animals or water. Moreover, its dispersion by achenes also cannot be excluded. However, there is no detailed information on spreading distances. Such a method of dispersion has not been observed at the Silesian Upland because this species does not bloom during colder summers or achenes do not reach maturity (Nowak 1990-2017 – A). On the basis of the above information, the species ability to spread in Poland without human impact is assessed as "low".

a12. The frequency of the dispersal of *the species* within Poland by **human actions** is:

	low
	medium
X	high

aconf08.	Answer provided with a	low	medium	high **X**	level of confidence

acomm12. Comments:

Occurrence of this species in new stands distant from already existing stands is predominantlycaused by human action. Disturbance and removal of soil, e.g. during any investment works favours the transportation of parts of tubers and stolons of Jerusalem artichoke into new places (Nowak 1990-2017 – A). Jerusalem artichoke also spreads through running from cultivation. The cultivation area of this species has been recently increasing due to a greater interest of unprofessional gardeners who consider it as anornamental plant thatcan also provide products for culinary purposes. This interest is confirmed by a great number of websites on this species (e.g. Eko-uprawy 2012, Chmiel 2016, Future Gardens 2018 – I). Topinambour is an object of interest as it can be used as a forage plant, an energy crop, or a raw material for pharmaceutical and process industry (Sawicka et al. 2012 – P), and a melliferous plant (Góral 1999 – P, Portal pszczelarzy 2018– I). Feeding plots for wild animals with growing topinambour make a significant contribution to spread of this species (Polski Związek Łowiecki 2018 – I).

A4a | Impact on the environmental domain

Questions from this module qualify the consequences of *the species* on wild animals and plants, habitats and ecosystems.

Impacts are linked to the conservation concern of targets. Native species that are of conservation concern refer to keystone species, protected and/or threatened species. See, for example, Red Lists, protected species lists, or Annex II of the 92/43/EWG Directive. Ecosystems that are of conservation concern refer to natural systems that are the habitat of many threatened species. These include natural forests, dry grasslands, natural rock outcrops, sand dunes, heathlands, peat bogs, marshes, rivers & ponds that have natural banks, and estuaries (Annex I of the 92/43/EWG Directive).

Native species population declines are considered at a local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as (near) extinction. Similarly, limited ecosystem change is considered as transient and easily reversible; severe change is considered as persistent and hardly reversible.

a13. The effect of *the species* on native species, through **predation, parasitism or herbivoryis**:

X	inapplicable
	low
	medium
	high

aconf09.	Answer provided with a	low	medium	high	level of confidence

acomm13.	Comments: This species is a non-parasitic plant – not applicable.

a14. The effect of *the species* on native species, through **competition** is:

	low
	medium
X	high

aconf10.	Answer provided with a	low	medium	high **X**	level of confidence

acomm14.	Comments: Jerusalem artichoke has strong competitive capabilities, which result in the gradual elimination of other species originally growing in the specific area (Nowak 1990-2017 – A, Kompała-Bąba andBłońska 2008, Żołnierz et al. 2011 – P). Due to nutrients stored in tubers, topinambour can quickly grow in spring before the growth of other coexisting species. The advanced growth and dense communities of high individuals of topinambour reduce the species abundance by 30-70% (Hejda et al. 2009, Żołnierz et al. 2011 – P). Effects of depleted vegetation cover are particularly significant in protected areas (e.g. Tokarska-Guzik et al. 2007, Bomanowska et al. 2014 – P).

a15. The effect of *the species* on native species, through **interbreeding** is:

X	no / very low
	low
	medium
	high
	very high

aconf11.	Answer provided with a	low	medium	high **X**	level of confidence

acomm15.	Comments: No native species related to Jerusalem artichoke occur in Poland.

a16.The effect of *the species* on native species by **hosting pathogens or parasites** that are harmful to them is:

	very low
	low
	medium
X	high
	very high

aconf12.	Answer provided with a	low	medium **X**	high	level of confidence

acomm16.	Comments: Sixteen identified species of pathogenes/parasites can be hosted by this species and affect or potentially affect native species (Najberek in preparation– N). They include pathogenous insects, fungi, fungous organisms, bacteria and viruses. They are mainly observed on the representatives of the Asteraceae family, usually on the species from a dozen to several dozen of botanic families. The following viruses have been identified: - lettuce infectious yellows virus – the species included on the EPPO A1 list; not reported fromPoland (Lettuce infectious *yellows* 'closterovirus' 2018 – I); - beet curly top virus – not reported fromPoland (Curly top (Beet curly top virus 2018 – B); - potato yellow dwarf nucleorhabdovirus – the species included on the EPPO A1 list; does not occur in EU countries (Potato yellow dwarf nucleorhabdovirus 2018 – I);

- tomato spotted wilt orthotospovirus – the species included on the EPPO A2 list; no data on its occurrence in Poland (EPPO 2018 – B).

The following bacteria have been identified:
- *Phytoplasma solani* – the species included on the EPPO A1 list; only related species reported fromPoland (Fránová et al. 2014 – P);
- *Pseudomonas syringae* pv. tagetis (Rhodehamel and Durbin 1985 – P); no data on its occurrence in Poland.

The following fungi have been identified:
- *Plasmopara halstedii* – an organism causing downy mildew of sunflower, formerly reported fromPoland, currently not observed (EPPO 2008 – I, *Plasmopara halstedii* (downy mildew of sunflower) 2018 – B);
- *Sclerotinia sclerotiorum* – the fungi causing the disease – white mould; reported fromPoland (Paukszta et al. 2012 – P);
- *Alternaria helianthi* – the species not reported fromPoland (CABI, EPPO 2002 – B);
- *Alternariaster helianthi* – the species not reported fromPoland (leaf blight of sunflower; *Alternariaster helianthi* 2018 – B)
- *Sclerotium rolfsii* – the species present in Poland (Orlikowski and Ptaszek 2013 – P);
- *Erysiphe cichoracearum* (Balogh 2008 – P);
- *Erysiphe cichoracearum* var. *latispora* observed on topinambour in the central part of Poland (Ruszkiewicz-Michalska and Michalski 2005 – P).

The following insects have been identified:
- *Bemisia tabaci* – the species included on the EPPO A2 list; present in the EU countries (*Bemisia tabaci* 2018 – I);
- *Liriomyza trifolii* – the species included on the EPPO A2 list; formerly reported fromPoland, currently not observed (*Liriomyza trifolii* (American serpentine leafminer 2018 – B);
- *Nemorimyza maculosa* – the species included on the EPPO A1 list; not reported fromPoland (Chrysanthemum leaf miner (Nemorimyza maculosa) 2018 – B);
- *Strauzia longipennis* – the species not reported fromPoland (Everatt et al. 2015 – I).

Moreover, one species of nematode *Meloidogyne javanica* (sugarcane eelworm 2018 – B) has been reported fromPoland. The majority of listed species arenot reported fromPoland. Only three following species of fungi: *Sclerotinia sclerotiorum*, *Sclerotium rolfsii*, *Erysiphe cichoracearum*var. *latispora*, one species of insect – *Bemisia tabaci* (EPPO A2) and one species of nematode – *Meloidogyne javanica,* represent the group of parasites/pathogenes that can be hosted by *Helianthus tuberosus*. However, thefuture appearance of other pathogens in Poland cannot be excluded.

There are no detailed data for Poland concerning the impact of mentioned parasites/ pathogenes related or potentially related to Jerusalem artichoke on native flora species.

a17. The effect of *the species* on ecosystem integrity, by **affecting its abiotic properties** is:

	low
X	medium
	high

aconf13. Answer provided with a

low	medium	high
	X	

level of confidence

acomm17. Comments:

Dead shoots of topinambour from the previous year can change the trophic level of soil and isolate it from the sunlight (Nowak 1990-2017 – A). Animals feeding on its tubers may cause erosion and consequently, ruderalization of habitats in sites occupiedby *Helianthus tuberosus*, particularly, if they competitively displaced other species with the well-developed system of underground shoots stabilising soil (Balogh 2008 – P, Żołnierz 2009-2014 – A). Abiotic changes can be also induced by allelopathic substances produced by this species (Vidotto 2008 – P).

a18. The effect of *the species* on ecosystem integrity, by **affecting its biotic properties** is:

	low
	medium
X	high

aconf14.	Answer provided with a	low	medium	high **X**	level of confidence

acomm18. Comments:

Jerusalem artichoke has a significant impact on the ecosystem integrity by affecting its abiotic properties. As its population is growing and becoming denser, it eliminates plants of other species which also modifies the fauna composition and structure of biocenosis. Strong competitive skills of topinambour are particularly important in this process. They result from the rapid growth of its underground parts (tubers, stolons), overground parts, and allelopathic properties. Moreover, topinambour produces compounds influencing the germination and growth of species accompanying plant crops (Tesio et al. 2011 – P). Additionally, this species contributes to synanthropization of fauna, e.g. in peripheral regions of Wrocław the population of wild boars is increasing as communities of *H. tuberosus* present in this area are the considerable part of the feeding base.

A4b | Impact on the cultivated plants domain

Questions from this module qualify the consequences of *the species*for cultivated plants (e.g. crops, pastures, horticultural stock).

For the questions from this module, consequence is considered 'low' when presence of *the species* in (or on) a population of target plants is sporadic and/or causes little damage. Harm is considered 'medium' when *the organism's* development causes local yield (or plant) losses below 20%, and 'high' when losses range >20%.

a19. The effect of *the species* on cultivated plant targets through **herbivory or parasitism** is:

	inapplicable
X	very low
	low
	medium
	high
	very high

aconf15.	Answer provided with a	low	medium	high **X**	level of confidence

acomm19. Comments:

This species is a plant, which exhibits no parasitic properties.

a20. The effect of *the species* on cultivated plant targets through **competition** is:

	inapplicable
X	very low
	low
	medium
	high
	very high

aconf16.	Answer provided with a	low	medium	high **X**	level of confidence

acomm20.	Comments:

There are no detailed data from Poland. Papers on local flora very rarely refer to the species from cultivated areas. This species is usually present in ruderal habitats, uncultivated lands, or riverine habitats (e.g. Chmiel 1993, Wayda 1996, Bzdęga et al. 2009, Żarnowiec et al. 2010 – P). Jerusalem artichoke usually expands to non-agricultural lands. It can be also observed among crops, usually at their fringe as this species spreads from adjacent uncultivated lands and feeding plots for wild animals (Żołnierz 2009-2014 – A). It can again appear on uncultivated lands subjected to restoration. In sites of its former cultivation, new individuals can develop from tubers retained in the soil even two years after introducing new elements of crop rotation, even if weed control was performed (Schittenhelm 1996 – P). According to Weber and Gut (2005 – P), *Helianthus tuberosus* is one of the most expansive European weeds with high potential of being introduced to areas covered by such crops as: cereals, pulses, root crops, and others. The mechanism of competitive effect of *H. tuberosus* as crop weeding is probably similar to this effect in natural ecosystems and distorted habitats. It consists in rapid growth which is additionally stimulated by fertilization and shadowing of cultivated species. The allelopathic properties of *H. tuberosus* affecting the germination phase, and the further growth of coexisting species, including weeds, is emphasized within this context (Vidotto et al. 2008 – P).

Although Jerusalem artichoke is widespread, its impact on crops in Poland is assessed as "very low" due to a small scale of weeding with this species.

a21. The effect of *the species* on cultivated plant targets through **interbreeding** with related species, including the plants themselves is:

	inapplicable
X	no / very low
	low
	medium
	high
	very high

aconf17.	Answer provided with a	low	medium	high **X**	level of confidence

acomm21.	Comments:

There are no data on Jerusalem artichoke interbreeding with the common sunflower *Helianthus annuus* in Poland. The possibility of spontaneous transfer of *Helianthus annuus* genes to other species of this genus, including *H. tuberosus* is also considered. Different seasons of species blooming are among factors reducing this process (Rutkowski 1998 – P). According to Faure et al. (2002 – P) the probability of such an occurrence is very low, but not impossible. The likelihood of *H. tuberosus* interbreeding is limited by its low capability toproduce fully developed seeds which can germinate (Balogh 2008 – P) and no survivability of seedlings revealed in the tests by Moravcova et al. (2010 – P). However, the breeding experiments have been conducted in the USA. They consist in interbreeding the mentioned species to improve characteristics of achenes and tubers (Kantar et al. 2014 – P).

a22. The effect of *the species* on cultivated plant targets by **affecting the cultivation system's integrity** is:

	very low
X	low
	medium
	high
	very high

aconf18.	Answer provided with a	low	medium **X**	high	level of confidence

acomm22.	Comments: This species occurs throughout Poland, but it is rarely dispersed from cultivated areas (cf. point a20).

a23. The effect of *the species* on cultivated plant targets by hosting **pathogens or parasites** that are harmful to them is:

	very low
	low
	medium
	high
X	very high

aconf19.	Answer provided with a	low	medium	high **X**	level of confidence

acomm23.	Comments: Listed parasites/pathogenes refer to both wild and cultivated plants, and they treat Jerusalem artichoke as a host or a vector (cf. point a16). The majority of listed species has not been demonstrated in Poland. Only 3 species of fungi: *Sclerotinia sclerotiorum*, *Sclerotium rolfsii*, *Erysiphe cichoracearum* var. *latispora*, 1 insect species – *Bemisia tabaci* (EPPO A2) and 1 species of nematode – *Meloidogyne javanica* represent the group of parasites/pathogenes which can be carried by *Helianthus tuberosus*.The papers cited in point a16 present a large group of cultivated plants, both vegetables and ornament plants, often crops under cover. *Sclerotinia sclerotiorum* may cause white mold of e.g. the common sunflower *Helianthus annuus.* In Poland, *Sclerotium rolfsii* was observed for the first time leaves of ornament plants: *Epipremnum aureum*, *Hedera helix* and *Peperomia obtusifolia* (Orlikowski and Ptaszek 2013 – P). And *Erysiphe cichoracearum* var. *latispora* causing powdery mildew disease in sunflower family was just found on cultivated *Helianthus tuberosus* and representatives of ornamental plants of Asteraceae family: *Rudbeckia laciniata* and *Rudbeckia hirta* (Ruszkiewicz-Michalska and Michalski 2005). Bemisia tabaci can be present on e.g. cabbage *Brassica oleracea*, potato *Solanum tuberosum*, tomato *Solanum lycopersicum* and other plants CABI 2018a – B). *Meloidogyne javanica* was found on e.g. carrot *Daucus carota*, celery *Apium graveolens* and others (*Meloidogyne javanica* (sugarcane eelworm) 2018 – B). There are no detailed studies on the contribution of *Helianthus tuberosus* to the spread of discussed parasites/pathogenes. Jerusalem artichoke is very resistant to insect pests, and this group does not contain any herbivorous insects specifically related to this species (Balogh 2008 – P). Fungal pathogenes are also related to other species of *Helianthus* genus (Balogh 2008 – P).

A4c | Impact on the domesticated animals domain

Questions from this module qualify the consequences of *the organism* on domesticated animals (e.g. production animals, companion animals). It deals with both the well-being of individual animals and the productivity of animal populations.

a24.The effect of *the species* on individual animal health or animal production, through **predation or parasitism** is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf20.	Answer provided with a	low	medium	high	level of confidence

acomm24.	Comments: Jerusalem artichoke exhibits no parasitic properties.

a25. The effect of *the species* on individual animal health or animal production, by having properties that are hazardous upon **contact**, is:

X	very low
	low
	medium
	high
	very high

aconf21.	Answer provided with a	low	medium	high **X**	level of confidence

acomm25.	Comments: The species impact on animals upon direct contact has not been confirmed.

a26. The effect of *the species* on individual animal health or animal production, by hosting **pathogens or parasites** that are harmful to them, is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf22.	Answer provided with a	low	medium	high	level of confidence

acomm26.	Comments: The plant species is neither a host nor a vector for pathogenes or parasites harmful to animal targets.

A4d | Impact on the human domain

Questions from this module qualify the consequences of *the organism* on humans. It deals with human health, being defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (definition adopted from the World Health Organization).

a27. The effect of *the species* on human health through **parasitism** is:

X	inapplicable
	very low
	low
	medium
	high
	vert high

aconf23.	Answer provided with a	low	medium	high	level of confidence

acomm27.	Comments: This species exhibits no parasitic properties.

a28. The effect of *the species* on human health, by having properties that are hazardous upon **contact**, is:

X	very low
	low
	medium
	high
	very high

aconf24.	Answer provided with a	low	medium	high **X**	level of confidence

acomm28. Comments:

No information has been found on properties of *Helianthus tuberosus*, which could make this species hazardous upon direct contact. Only an accidental food allergy was reported after eating raw topinambour (experienced by one person with allergy to many food products). The reaction was not observed after heat treatment (Doyen et al. 2011 – P).

a29.The effect of *the species* on human health, by hosting **pathogens or parasites** that are harmful to humans, is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf25.	Answer provided with a	low	medium	high	level of confidence

acomm29. Comments:

This species does not affect human health by transmitting pathogenes or parasites harmful to human targets.

A4e | Impact on other domains

Questions from this module qualify the consequences of *the species* on targets not considered in modules A4a-d.

a30. The effect of *the species*on causing damage to **infrastructure** is:

	very low
	low
X	medium
	high
	very high

aconf26.	Answer provided with a	low	medium **X**	high	level of confidence

acomm30. Comments:

The growth of underground parts of topinambour, especially after the completed vegetation period, may cause a threat to flood-control facilities. Fewer fine roots of the species after its death make the soil, in which topinambour was growing, more susceptible to erosion. Alsoanimals, particularly wild boars, searching for tubers, initiate erosion and may lead to damage within the area of river banks, flood protection structures and road shoulders (Żołnierz 2009-2014 – A, CABI 2018 – B).

A5a | Impact on ecosystem services

Questions from this module qualify the consequences of *the organism* on ecosystem services. Ecosystem services are classified according to the Common International Classification of Ecosystem Services, which also includes many examples (CICES Version 4.3). Note that the answers to these questions are not used in the calculation of the overall risk score (which deals with ecosystems in a different way), but can be considered when decisions are made about management of *the species*.

a31. The effect of *the species* on **provisioning services** is:

	significantly negative
	moderately negative
	neutral
	moderately positive
X	significantly positive

aconf27.	Answer provided with a	low	medium	high **X**	level of confidence

acomm31. Comments:

Jerusalem artichoke, not only cultivated, is classified as a food and fodder plant due to inulin usually found in tubers, shoots and leaves. Inulin is used in the food industry (e.g. dairy – as medium for bacteria in functional food), cosmetics and pharmaceutical industry. Cosmetics industry uses its anti-bacterial properties, and in pharmaceutical industry inulin is used for, inter alia, probiotic functions (Kosaric et al. 1984, Baldini et al. 2004, Mystkowska and Zarzecka 2013, Sawicka et al. 2012, Chyc and Ogonowski 2014, Helmi et al. 2014, Mystkowska et al. 2015, Horochowska et al. 2017 – P). Leaves of Jerusalem artichoke can be used as an intermediate product for provision services – its anti-fungal properties are used as the natural protection for storing fruits and vegetables (Chen et al. 2013 – P). This species is also used as a melliferous plant (Portal pszczelarski *[Apiarian portal]* – I). Breeding experiments are conducted in the USA, consisting in interbreeding between anannual species of the common sunflower *Helianthus annuus* and a perennial plants of Jerusalem artichoke *Helianthus tuberosus* to improve characteristics of achenes and tubers. They are also mentioned in the aspect of ecosystem services and their profitability (Kantar et al. 2014 – P). The second important application of Jerusalem artichoke is using it as the renewable resource of energy and material for producing biofuels (Cheng et al. 2009, Piskier 2009, Kowalczyk-Juśko et al. 2012, Gunnarsson et al. 2014, Johansson et al. 2015 – P). As it is presented above, this assessed species is a very important and useful plant.

a32. The effect of *the species* on **regulation and maintenance services** is:

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf28.	Answer provided with a	low	medium	high **X**	level of confidence

acomm32. Comments:

The massive appearance of Jerusalem artichoke in river valleys can indirectly increase the flood risk. Fewer fine roots of the species after its death make the soil more susceptible to erosion. Moreover, animals digging for tubers can disturb the soil and, thus, weaken river banks and flood protective structures (CABI 2018 – B, cf. point a30). However, Jerusalem artichoke may also has a positive effect, considering maintenance services. This species can be used for phytoremediation (it removes toxic substances, such as heavy metals or pesticides, from soil) and for land reclamation (Antonkiewicz and Jasiewicz 2003, Ignatowicz 2009, Klimont 2012 – P).

a33. The effect of *the species* on **cultural services** is:

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf29.	Answer provided with a	low	medium	high X	level of confidence

acomm33. Comments:

According to some sources, this species is used as an ornament plant (CABI 2018 – B). This species is rarely observed in private gardens in Poland as it does not always bloom and due to the availability of a relatively wide range of species and varieties with similar features, e.g. rough oxyeye *Heliopsis scabra* (Nowak 1990-2017 – A). Among negative aspects of the species significance for cultural services, we can mention its appearance which is not very aesthetic after the vegetation period. It particularly refers to the areas used by humans for recreation, including the protected areas.

A5b | Effect of climate change on the risk assessment of the negative impact of *the species*

Below, each of the Harmonia^{+PL} modules is revisited under the premise of the future climate. The proposed time horizon is the mid-21st century. We suggest taking into account the reports of the Intergovernmental Panel on Climate Change. Specifically, the expected changes in atmospheric variables listed in its 2013 report on the physical science basis may be used for this purpose. The global temperature is expected to rise by 1 to 2°C by 2046-2065.

Note that the answers to these questions are not used in the calculation of the overall risk score, but can be considered when decisions are made about management of *the species*.

a34. INTRODUCTION – Due to climate change, the probability for *the species*to overcome geographical barriers and – if applicable – subsequent barriers of captivity or cultivation in Poland will:

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf30.	Answer provided with a	low	medium	high X	level of confidence

acomm34. Comments:

Due to its numerous functions and no specific climate and soil requirements (similar to those of potato), this species is cultivated in almost every part of Poland. Wild or feral (from cultivation), this species is widespread in Poland (Zając and Zając 2001 – P). So, this species overcame all barriers limiting its additional occurrence apart from cultivation (e.g. Nowak 1990-2017 – A, Paul 2013 – P; numerous papers on local flora of vascular plants).

a35. ESTABLISHMENT – Due to climate change, the probability for *the species*to overcome barriers that have prevented its survival and reproduction in Poland will:

	decrease significantly
	decrease moderately
X	not change

	increase moderately
	increase significantly

aconf31.	Answer provided with a	low	medium	high **X**	level of confidence

acomm35. Comments:

It is the established species in Poland (Tokarska-Guzik et al. 2012 – P), which has quite high tolerance towards the climate. Thus, a temperate increase by 1-2°C will not affect the process of its establishment.

a36. SPREAD – Due to climate change, the probability for *the species*to overcome barriers that have prevented its spread in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf32.	Answer provided with a	low	medium **X**	high	level of confidence

acomm36. Comments:

No data on this issue. Global warming and the related longer vegetation period can be assumed to increase the probability of producing by Jerusalem artichoke *Helianthus tuberosus* seeds that are fully developed and capable of germinating. It would increase the spreading potential of the species (Żołnierz 2009-2014 – A). Regarding photoperiodism, *Helianthus tuberosus* is a short-day species. Development of flowers and headsrequires appropriately high temperatures (Paungbut et al. 2015 – P). The first autumn frosts inhibit the process of fruit development. According to Balogh (2008 – P) observations in Hungary, there are not too many fully developed achenes of *H. tuberosus*, and they are only formed in the earliest developed baskets. Moreover, achenes are more developed in plants growing in dry habitats. Balogh (2008 – P) also claimed that in years of better grapevine yields, *H. tuberosus* started to bloom earlier and fruit production was more efficient. Assuming that climate changes delay the autumn frosts, the sexual reproduction of *H. tuberosus* will become a significant factor for the species spreading in regions, where achenes previously did not become mature. However, there areno detailed studies confirming this thesis.

a37. IMPACT ON THE ENVIRONMENTAL DOMAIN – Due to climate change, the consequences of *the species* on wild animals and plants, habitats and ecosystems in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf33.	Answer provided with a	low	medium **X**	high	level of confidence

acomm37. Comments:

Provided that there are more populations of Jerusalem artichoke (cf. point a36), its impact on the natural environment can moderately increase (Żołnierz 2009-2014 – A).

a38. IMPACT ON THE CULTIVATED PLANTS DOMAIN – Due to climate change, the consequences of *the species* on cultivated plants and plant domain in Poland will:

	decrease significantly
	decrease moderately

X	not change
	increase moderately
	increase significantly

aconf34.	Answer provided with a	low	medium	high **X**	level of confidence

acomm38. Comments:

The impact of the species on cultivated plants depends on the agricultural economy. For the current structure of crops, climate changes will not modify the species impact on cultivated plants.

a39. IMPACT ON THE DOMESTICATED ANIMALS DOMAIN – Due to climate change, the consequences of *the species* on domesticated animals and animal production in Poland will:

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf35.	Answer provided with a	low	medium	high **X**	level of confidence

acomm39. Comments:

The species shows no effect on animal production (cf. points a24 – a26). Climate changes will not modify the species impact within the assessed domain.

a40. IMPACT ON THE HUMAN DOMAIN – Due to climate change, the consequences of *the species* on human in Poland will:

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf36.	Answer provided with a	low	medium	high **X**	level of confidence

acomm40. Comments:

The species shows no effect on humans (cf. points a27 – a29). Thus, climate changes will not modify the species impact within the assessed domain.

a41. IMPACT ON OTHER DOMAINS – Due to climate change, the consequences of *the species* on other domains in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf37.	Answer provided with a	low	medium **X**	high	level of confidence

acomm41. Comments:

Provided that there are more populations of Jerusalem artichoke (cf. point a36), its impact on other facilities can moderately increase.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.63	0.75
Environmental impact (questions: a13-a18)	0.65	0.90
Cultivated plants impact (questions: a19-a23)	0.25	0.90
Domesticated animals impact (questions: a24-a26)	0.00	1.00
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.50	0.50
Invasion (questions: a06-a12)	0.88	0.92
Impact (questions: a13-a30)	0.65	0.86
Overall risk score	0.57	
Category of invasiveness	moderately invasive alien species	

A6 | Comments

This assessment is based on information available at the time of its completion. It has to be taken into account. However, biological invasions are, by definition, very dynamic and unpredictable. This unpredictability includes assessing the consequences of introductions of new alien species and detecting their negative impact. As a result, the assessment of the species may change in time. For this reason it is recommended that it is regularly repeated.

acomm42. Comments:

The risk assessment of Jerusalem artichoke *Helianthus tuberosus* conducted for Poland has classified this species into the group of “moderately invasive alien species” (value of the negative impact is 0.65). This result seems to be adequate for the current situation in Poland. Jerusalem artichoke got the highest values (1.00) in modules “Introduction” (questions: a06-a08) and “Establishment” (questions: a09-a10). A relatively high score was given for the module "Impact on the natural environment" (questions a13-a18) – 0.65. And the spreading rate is relatively low when compared to other invasive species. The species scored 0.63 points in the module “Spread” (questions: a11-a12). At the same time, the score 0 was given for modules “Impact on animal production” and “Impact on human targets” (questions: a27-a29), and very low score – 0.25, was provided for the module "Impact on cultivated plants" (questions: a19-a23). A relatively low score was given for the module "Impact on other facilities" (question: a30) – 0.50. Results from the performed assessment are consistent with a previously prepared assessment of invasive level of this species, which was based on scores given for specific elements (range in Poland, size of local population, types of colonised habitats, dynamic tendencies, a type of hazards – ecological, economic and social). Jerusalem artichoke got 11 points out of 21 and was classified into the group of “species having invasive properties in some areas, expandingtheir distributionrange or a number of habitats, or having a high invasive potential exhibited in other countries”. Referring to Poland, the spreading rate of this species can differ depending on habitat conditions and the land use. The species entering into protected areas is the most important and requires monitoring. This domain requires a list of specific recommendations. However, due to its practical use, topinambour is perceived by the society as a very useful species (e.g. Invitation for Topinambour Festival in Tychy 2016 – I), and not as the undesired one (Nowak 1990-2017 – A). Taking into account the above, measures undertaken to eliminate

and control this species should be precisely addressed to habitats near crop cultivation to stop effectively its spreading, and simultaneously find the social acceptance. A stricter control of food plots with growing topinambour, is proposed. Because in many cases, it is a serious source of dispersion of this species.

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