



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. Elżbieta Melon – external expert
2. Barbara Tokarska-Guzik
3. Maria Zając

acomment01.	Comments:	degree	affiliation	assessment date
	(1)	mgr inż	Botanic Garden, Faculty of Biology, University of Warsaw	22-01-2018
	(2)	prof. dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	26-01-2018
	(3)	prof. dr hab.	Institute of Botany, Jagiellonian University, Kraków	28-01-2018

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

Polish name: Gunera brazylijska^{*)}
Latin name: ***Gunnera tinctoria***(Molina) Mirb.
English name: Chilean Gunnera

acommm02.

Comments:

*) NOTE:

Two species are cultivated (and present in the market) in Poland: *Gunnera tinctoria* and *G. manicata*. Often, their names are confused mutually.

According to the UE invasive species list, the formally valid (legal) Polish name of *Gunnera tinctoria* is “gunera brazylijska” (and this name is used as the main one).

Gunnera tinctoria originates from Chile and the Polish name “gunera chilijska” should be reserved for this species.

Gunnera manicata originates from Brazil, therefore using the name “gunera brazylijska” would be advisable in this case.

It would be worthwhile to sort out the nomenclature and use names adequate for the state of knowledge, particularly because of the fact that English names sound correct and are used consistently.

It should be noted that the taxonomical position of the analysed species and the related *Gunnera manicata* (Brazilian giant rhubarb) species is unclear (O’Rourke and O’Flynn 2014 – B).

Latin names and customary English names are cited based on the taxonomical databases and publications (Plant List 2013– B, CABI 2018 – B). The most frequently used and accepted synonyms include: *Gunnera chilensis* Lam., *Gunnera scabra* (Ruiz.&Pav.), *Panke tinctoria* Molina (basionym), *Gunnera pilosa* Kunth (Plant List 2013 – B; Gioria and Osborne 2013 – P). Also, the following synonyms are used: *Panke acaulis* Molina, *Panke caulescens* J.F.Gmel., *Panke achilensis* (Lam.) Oerst. (Plant List 2013 – B); subspecies: *Gunnera tinctoria* var. *meyeri* (L.E.Mora) L.E.Mora, Pabón-Mora & F.González *Gunnera tinctoria* var. *tinctoria* (Plant List 2013 – B). Customary English names: Chilean Gunnera, Chilean Rhubarb, Giant Rhubarb (preferred name), nalca, Panque (GISD 2005 – B).

The English name of *G. tinctoria* “giant rhubarb” does not mean a relation with *Rheum rhabarbarum*, but only emphasises their visual similarity (CABI 2018 – B).

Polish name (synonym I)
Gunera chilijska

Polish name (synonym II)
Parzeplin brazylijski

Latin name (synonym I)
Gunnera chilensis

Latin name (synonym II)
Gunnera scabra

English name (synonym I)
Chilean Rhubarb

English name (synonym II)
Giant Rhubarb

a03. Area under assessment:

Poland

acommm03.

Comments:

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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
- alien, present in Poland in the environment, established

aconf01.

Answer provided with a

low	medium	high X
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level of confidence

acommm04.

Comments:

In Poland, assessed species, originating from southern regions of Chile, is known mainly from cultivation in botanical gardens, arboreta and private gardens. Based on a query

carried out in 31 botanical gardens and arboreta in January 2018, its occurrence (cultivation) was confirmed in 5 of these places, with a total number of 10 individuals (Pracownicy ogrodów... [Garden Workers...] 2018 – N).

The species has not been placed in lists of plant species occurring in Poland, even as a cultivated plant or a plant going back to the wild (Mirek *et al.* 2002– P, Tokarska-Guzik *et al.* 2012 – P).

Most often, gardening centres and Internet shops are offering 2-4-year old plants. *Gunnera tinctoria* is one of the quite popular ‘architectural’ garden plants (i.e. those with a distinctive size, having a characteristic shape, imposing decorative leaves and spectacular inflorescence, usually planted individually and properly displayed). It has been being promoted in the 1990s (and is promoted still) for use around ponds and in damp areas (Law 2003 – B).

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

<input checked="" type="checkbox"/>	the environmental domain
<input checked="" type="checkbox"/>	the cultivated plants domain
<input type="checkbox"/>	the domesticated animals domain
<input type="checkbox"/>	the human domain
<input checked="" type="checkbox"/>	the other domains

acomm05.

Comments:

In Poland, this South American species is known up to the present only from cultivation, and it seems that it does not revert to the wild. In north-western Europe (Great Britain, Ireland, France), under conditions of a mild and very humid climate, the species escapes from cultivation, establishes itself and, in some places, becomes an invasive species (Osborne *et al.* 1991 – P, Pilkington 2011 – B, Gioria and Osborne 2013 – P, Wyse Jackson 2014 – B). Within its secondary range, *Gunnera tinctoria* affects the natural environment, colonising coastal habitats (cliffs, sea coasts), shores and banks of inland reservoirs, humid non-forest habitats (peat bogs, meadows, moors) and forest habitats, in which it limits growth/development of other plant species (EPPO 2014, CABI 2018 – B). One can find reports indicating that the species affects other spheres too (plant crops and animal farms), reducing the productivity of agricultural areas (CABI 2018 – B).

Some authors (*e.g.* Gioria and Osborne 2013 –P, CABI 2018 – B) note the symbiotic cyanobacteria from the *Nostoc* genus present in tissues of *G. tinctoria* and that it produces the neurotoxin BMAA. So far, no influence of the neurotoxin on Europeans has been found, but the studies should continue. When more abundant, Chilean *Gunnera* may damage the infrastructure on river banks, and its presence may decrease the value of the land and real property (Pilkington 2011-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:

<input checked="" type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf02.

Answer provided with a

low	medium	high
		X

level of confidence

acommm06.

Comments:

Thus far, the species has not been found in the natural environment of the countries neighbouring Poland. In Europe, it is established – as a farm escapee – in the Azores, introduced in Madeira (Portugal), in France, Ireland and Great Britain and recorded in Spain. It is identified as an invasive species in Ireland’s western coast (Hickey and Osborne 2001. Weber 2003 – P), in the British Isles and Azores, and outside Europe, in New Zealand and California (Williams *et al.* 2005 – P, EPPO 2014, CABI 2018 – B). It should be emphasised that the secondary range of the species in Europe is still limited (EPPO 2014 – B). Emergence of new sites of the species on coastal cliffs is being indicated as a potential route of spontaneous spreading in association with migratory birds. However, the possibility has not been confirmed and requires further investigations (O’Rourke and O’Flynn 2014 – B). Chilean *Gunnera* occupies also other habitats, such as: streams and river banks, shores of lakes and ponds, arable lands, roadsides, quarries, trenches, waterways, moist meadows, peat bogs, moors, grasslands, pastures (Reynolds 2002 – I, Williams *et al.* 2005, Gioria and Osborne 2013 – P). *Gunnera tinctoria* reproduces very easily *via* seeds produced by it in large numbers (a single plant produces 250,000 seeds; Osborne *et al.* 1991 – P, Law 2003 – B, Williams *et al.* 2005 – P). The seeds are dispersed by wind, water and birds (Gioria and Osborne 2013 – P). Also, the species reproduces vegetatively by fragments of roots, rhizomes and leaves.

The probability of the emergence of the species in the natural environment of Poland owing to independent expansion from abroad is very low. The species does not occur in the neighbouring countries of Poland, except that there are several records on its emergence in Germany (GBIF 2016 – B). If the seeds of the species appeared in our country however, their germination would be possible, but any seedlings would survive the Polish winter (botanical garden workers – own observations).

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

<input checked="" type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf03.

Answer provided with a

low	medium	high
		X

level of confidence

acommm07.

Comments:

Under Polish climatic conditions, the spontaneous emergence of the species in the natural environment, as a result of unintended human actions, is rather unlikely. Even if the seeds appeared in Poland as a result of unintended human actions (e.g. vehicular traffic, accidental bringing along with some goods, including other plants), the probability that Chilean *Gunnera* individuals would survive under Polish climatic conditions after germination without being protected from frost is very low.

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

<input checked="" type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf04.

Answer provided with a

low	medium	high
		X

level of confidence

acommm08.

Comments:

The species is an intentionally transported good as an ornamental plant. It has been cultivated in botanical gardens and arboreta in Poland only recently (reported in 5 sites from 31 surveyed, in a total number of 10 individuals – (Pracownicy ogrodów botanicznych... [Botanical garden workers...] 2018 – N), and the oldest individuals have

been cultivated since 2003. The probability of escape from gardens is low, considering the fact that no spontaneous emergence of plants of this species in the vicinity of places of cultivation has been found hitherto (Pracownicy ogrodów botanicznych... [Botanical garden workers...] 2018 – N).

Also, *Gunnera tinctoria* is sometimes found in private gardens (Melon and Tokarska-Guzik 2018 – A). Individuals of this species are available on horticultural offer (gardening centres and Internet shops), where they are advertised as “extraordinarily exotic”, “the most original perennials”, which should be represented in collectors’ gardens as a necessity. It seems that the interest in this species is increasing steadily. However, there are no documented dates for the intentional introduction of the species into the natural environment, or for its escape from cultivations in Poland. Based on the exchanges of experience of Internet users, one can ascertain that in private cultivation, the plant requires special care to survive the unfavourable cold or dry periods of our country (analogous information comes from botanical gardens). There is a probability of removal of the plants from gardens by owners discouraged by failures or when the plant is growing excessively, but its survival without proper protection is unlikely dormant plants (require to be covered in the winter). On the other hand, escapes from cultivation as a route of penetration of the natural environment by the species are confirmed in the European part of its secondary range (EPPO 2014 – I, O’Rourke and O’Flynn 2014 – B, CABI 2018 – B). *Gunnera tinctoria* may escape from gardens outside Poland (Western Europe) and establish itself under conditions of favourable mild and humid climate (Gioria and Osborne 2013 – P). It should be added that it is one of the most popular plants used by landscape architects and garden designers, already by the 1990s recommended for planting around waterholes and in swampy sites (GISD 2005 – B). Until recently, despite its invasive potential, *G. tinctoria* (also *G. manicata*) has been advertised as a gigantic tropical garden plant, given the Award of Garden Merit by the Royal Horticultural Society in Great Britain in 2006 (Gioria and Osborne 2013 – P).

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:

<input checked="" type="checkbox"/>	non-optimal
<input type="checkbox"/>	sub-optimal
<input type="checkbox"/>	optimal for establishment of <i>the species</i>

aconf05.	Answer provided with a	low	medium	high X	level of confidence
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acomm09.	Comments:
	The natural range of the species, encompassing Chile and Andean regions of Columbia, Venezuela, Peru and Ecuador, is located in the moderate (Mediterranean and humid tropical) climatic zone with a high yearly precipitation level (> 2000 mm), and where the yearly-average temperatures are in the range of 10-14°C (Williams <i>et al.</i> 2005 – P). Outside the boundaries of its natural range, the species occurs in regions characterised by mild winters, abundant precipitation, and high air humidity (Gioria and Osborne 2013 – P). The results of modelling of the species’ ecological niche, carried out based on the GIBF sites, indicate that the western and middle parts of the European continent, being under the influence of humid air from the Atlantic Ocean, is characterised by conditions which favour the establishment of <i>G. tinctoria</i> (EPPO 2014 – B). Light frosts and low temperatures in the winter are limiting factors for the possibility of establishing Chilean <i>Gunnera</i> in Eastern and Northern Europe. In turn, high temperatures and summer droughts limit the possibility of its establishing in the Mediterranean region (EPPO 2014 – B). In other words, regions

characterised by moderate and abundant precipitation without light frosts almost throughout the year and relatively small temperature variations, seem to be optimal for establishing this species (CABI 2018 – B). On the basis of the model of climatic similarity of Poland in relation to the whole world, one may conclude that in our country, the conditions for the analysed species are unfavourable (too continental). However, this model should be interpreted cautiously, taking into account the conditions of the western part of Poland, which may be evaluated as moderately favourable for *G. tinctoria*. In western Ireland, where the species is invasive, average monthly temperatures amount to 5-7°C (January) and 14.5-15.5°C (July), while the yearly precipitation level exceeds 1200 mm (Collins and Cummins 1996 – B).

Poland has yielded no data on seed germination under a parent plant (Melon 2000-2017 – A, Pracownicy ogrodów botanicznych... [Botanical garden workers...] 2018 – N). Germination of seeds imported from abroad must take place under greenhouse conditions. Adult individuals die if left without a proper protection for the winter (Melon 2000-2017 – A).

a10. Poland provides **habitat** that is

<input type="checkbox"/>	non-optimal
<input checked="" type="checkbox"/>	sub-optimal
<input type="checkbox"/>	optimal for establishment of <i>the species</i>

aconf06.	Answer provided with a	low	medium	high X	level of confidence
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acomm10.	<p>Comments:</p> <p><i>Gunnera tinctoria</i> is a geophyte occurring in the moderate climate zone, in regions characterised by a high level of precipitation. Within its natural range western South America <i>G. tinctoria</i> grows at the edges of forests (deciduous and mixed) neighbouring areas of waterlogged habitats (swamps), and on shores and banks. In the European part of its secondary range (Ireland), it occurs on coastal cliffs, shores and banks, roadsides, on damp meadows, as well as in abandoned gardens and unused agricultural areas (Williams <i>et al.</i> 2005 – P, EPPO 2014 – B). It occurs on various types of soils; however, in Ireland, most often on mineral, acidic and humid soils (Gioria and Osborne 2009a and b, 2013 – P). Result of garden experiments carried out in Ireland confirmed that a lack of water may limit significantly or even preclude growth of <i>G. tinctoria</i> (O'Rourke and O'Flynn 2014 – B and the literature cited therein). Apart from the habitats identified as preferred, the species may colonise anthropogenic habitats, particularly if it overcomes climatic barriers limiting the development of its seedlings in early spring. Such conditions may occur in agricultural terrains or unused areas in infertile habitats, but having a high availability of water (O'Rourke and O'Flynn 2014 – B).</p> <p>Theoretically, similar soil conditions do occur in Poland, however, other factors may be limiting, such as frosty winters and variations of temperature and precipitation during the year. Under our habitat conditions, <i>G. tinctoria</i> grows relatively well in the vegetative season, reaching large sizes, flowering, forming (fertile?) fruits. However, spontaneous emergence of seedlings under the parent plant has not been observed (Pracownicy ogrodów botanicznych... [Botanical garden workers...] 2018 – N).</p>
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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:

<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf07.	Answer provided with a	low	medium	high X	level of confidence
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acomm11.	Comments: <p>In Poland <i>Gunnera tinctoria</i> is a cultivated species only (comp. a04). There have been no confirmed cases of the spontaneous spread of the species in the vicinity of cultivation positions yet. The ability of the species to spread may be evaluated based on its internal (biological) mobility (data type: C). The data gathered in investigations confirm that a single individual of the species may generate a high number of seeds, depending on the size of the plant and the availability of water (Osborne <i>et al.</i> 1991, Gioria and Osborne 2013, Fennell <i>et al.</i> 2013 – P). The authors quoted estimated the number of seeds produced by one plant per year – which reached 750,000 in the case of Irish populations. The seeds are characterised by a high germination capacity. Then, they are dispersed by wind, water and birds (Williams <i>et al.</i> 2005 – P, Plant and Robertson 2008 – B). Also, the plant reproduces vegetatively, spreading from fragments of shoots and rhizomes. A 15-cm growth of rhizomes per year has been observed in established plants (Gioria and Osborne 2013 – P, EPPO 2014 – B). In effective colonisation of new sites by <i>G. tinctoria</i>, the following features should be taken into account: the abilities for generative and vegetative reproduction, the high germination capacity of the seeds, and the early initiation of growth during the vegetative season (Skeffington and Hall 2011 – P). The species forms large and stable seed banks, playing an important role in the occupation of new sites, while the vegetative reproduction favours increasing and stabilising extant populations, leading to the formation of large and dense monocultural patches (Gioria and Osborne 2013 – P).</p> <p>Factors which limit the spread of <i>G. tinctoria</i> in many member countries of the European Unions, including Poland, are constituted by dry summers and harsh winters (Skeffington and Hall 2011 – B). Seedlings, saplings and adult individuals are not able to survive the winter without proper protection (Melon 2000-2017 – A). Considering the current status of the species in Poland, as well as its mobility, limited by climatic conditions significantly, its ability to spread without human participation should be estimated as very small.</p>
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a12. The frequency of the dispersal of *the species* within Poland by **human actions** is:

<input checked="" type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf08.	Answer provided with a	low	medium X	high	level of confidence
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acomm12.	Comments: <p>In Poland, cultivation of the species started probably in the second half of the last century, however, the oldest confirmed data on its cultivation originate from 2003 (Pracownicy ogrodów botanicznych... [Botanical garden workers...] 2018 – N). So far, sites for the species outside cultivation are not known. Thus, it is hard to estimate “the frequency of human-assisted movement of an individual or its diaspores to a distance longer than 50 km”. A probability of diaspore transfer beyond the cultivations positions (purposeful removal from private gardens), but due to the fact that the cultivation of this species is still rare, the frequency should be estimated as low. On the basis of the data from regions in which the species has been already established, it should be concluded that human activity connected with cleaning of drainage ditches, road construction and moving the ground can favour spreading of the diaspores (Maguire 2009 – I) – this situation does not pertain to Poland, however. The species forms a stable soil seed bank, which may favour its spreading together with the transport of soil containing the seeds (O’Rourke and O’Flynn 2014 – B). It</p>
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should be taken into account that botanical gardens or private collectors exchange seedling and young plants over large distances (Melon and Tokarska-Guzik 2018 – N), however, this has not affected the frequency of spread of the species in the territory of the country so far.

Even if we assume that the species occurs across the whole of Poland, the frequency of its human-assisted spread should be estimated sceptically. Generative and vegetative diaspores may be transferred by humans, but they will not survive the winter without human aid.

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 herbivory**:

- | | |
|-------------------------------------|--------------|
| <input checked="" type="checkbox"/> | inapplicable |
| <input type="checkbox"/> | low |
| <input type="checkbox"/> | medium |
| <input type="checkbox"/> | high |

aconf09.	Answer provided with a	low	medium	high	level of confidence
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acomm13.	Comments: A non-parasitic plant species.
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a14. The effect of *the species* on native species, through **competition** is:

- | | |
|-------------------------------------|--------|
| <input type="checkbox"/> | low |
| <input type="checkbox"/> | medium |
| <input checked="" type="checkbox"/> | high |

aconf10.	Answer provided with a	low	medium	high	level of confidence
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acomm14.	Comments: Assuming that the species could spread across the whole territory of Poland, it would affect the native species of humid habitats by competition (for light and food supply mainly). Such an effect has been confirmed in regions of its previous secondary range. The large-sized leaves (diameter approx. 1.5 m) of the plant hinder the development of other plant species and animal species in habitats colonised by Chilean Gunnera, by limiting their access to light. The formation of monocultural patches of large surface area leads to changes in composition and structure of plant communities (e.g. the data from western Ireland confirm a significant depletion of floristically-rich meadows and grasslands – Maguire 2009 – I). Also, the displacement of grey willow <i>Salix cinerea</i> (Salicaceae) bushes by <i>G. tinctoria</i> in Great Britain was observed, which disturbed the processes of natural plant succession (Gioria and Osborne 2013 – P). In New Zealand, the negative impact of <i>G. tinctoria</i> on
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species is of particular concern and the connection with coastal cliffs was confirmed (Williams *et al.* 2005 – P). At the same time, it should be emphasised that Chilean Gunnera, due to the symbiotic relationship with cyanobacteria occurring in its rhizomes, may positively affect the development of young plants (also of other species) on soils lean in nitrogen compounds (Osborne *et al.* 1991; Bergman and Osborne 2002; Gioria and Osborne 2013 – P). Within its previous secondary range, *G. tinctoria* colonises habitats with a high natural value: swamps, moors, humid meadows and riverside habitats (Great Britain and New Zealand) (Williams *et al.* 2005, Gioria and Osborne 2013 – P). In the Azores, the species is recorded from laurel forests and endemic juniper forests *Juniperus* spp. (Silva *et al.* 2008 – P). Because of its biological features, Chilean Gunnera is evaluated as an effective competitor, but latest studies indicate dislodgement and replacement of compact *G. tinctoria* populations surviving for many years by another invasive species –Japanese Knotweed *Reynoutria (Fallopia) japonica* (Gioria *et al.* 2011 – P).

Actually, the impact of *G. tinctoria* on native species, outside its cultivation spots, has not been observed in Poland (where it is cultivated, the impact is evident).

Assuming the spreading of the species across the whole territory of the country, it may be supposed that such a statuesque plant will limit growth of other plant in its vicinity, shade and dry the soil, change its pH (the afore-mentioned symbiosis with cyanobacteria and fixing of free nitrogen from the air). The effect is very evident in areas having mild, humid climates (*e.g.* Ireland, Azores), where the species strongly reduces the biodiversity and transforms plant communities significantly (Hickey and Osborne 1998a – I, 1998b – P, Law 2003, Pilkington 2011 – B).

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

<input checked="" type="checkbox"/>	no / very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf11.	Answer provided with a	low	medium	high X	level of confidence
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acommm15. Comments:
Native species of the *Gunnera* genus do not occur in Poland, so crossbreeding under natural conditions is not possible. There is no data confirming the possibility of generating fertile hybrids (Gioria and Osborne 2013 – P). However, the taxonomy of the species and the closely related *G. manicata* is unclear and requires further study.

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

<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf12.	Answer provided with a	low	medium	high X	level of confidence
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acommm16. Comments:
There is no data on the subject (Williams *et al.* 2005 – P, O’Rourke and O’Flynn 2014 – B, Gioria and Osborne 2013 – P). Fungi of the *Scutellinia* genus (*Ascomycota: Pezizales*) have been found to be present, probably *S. scutellata* (L.) Lamb. and ones of the *Nectria* genus (*Ascomycota: Hypocreales*), on the rhizomes of the plants originating from Ireland and Azores, respectively (Hickey 2002 – N, Silva *et al.* 1996 – P). The almost complete lack of pathogens and parasites made the species even more attractive for gardeners in New Zealand (CABI 2018 – B).

The lack of pathogens is confirmed also by workers of Polish botanical gardens and arboreta (Pracownicy ogrodów... [Garden Workers...]2018 – N, Melon 2000-2017 – A).

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

<input type="checkbox"/>	low
<input checked="" type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf13.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acomm17. Comments:
 Thus far, no influence of the species on abiotic factors has been found in Poland (it does not enter our ecosystems, it is unable to survive the winter). Assuming that the species begins to spread in Poland (however, only in humid habitats!), it will probably affect the ecosystem integrity there, by disturbing water flow (Weedbusters 2003 – B, Gloria and Osborne 2013 – P), influencing erosion processes (Gioria 2007 – N, Osborne *et al.* 1991, Williams *et al.* 2005 – P) and limiting the access of light (Law 2003 – B, National Botanic Gardens of Ireland 2009 – I). The ability to fix atmospheric nitrogen, resulting from the presence of symbiotic cyanobacteria, may change the abundance of nitrogen compounds in the soil.
 The invasion of *G. tinctoria* is accompanied by a significant increase in biomass, both over and under the ground surface, which may lead to changes in the courses of biogeochemical cycles, as well as in water circulation and availability.

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

<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

aconf14.	Answer provided with a	low	medium	high	level of confidence
			<input checked="" type="checkbox"/>		

acomm18. Comments:
 Thus far, no influence of the species on biotic factors has been found in Poland (it does not enter our natural ecosystems, it is unable to survive the winter).
 Assuming that the species begins to spread in Poland, we have no doubt it will affect the integrity of ecosystems. *Gunnera tinctoria* begins vegetative growth early, grows rapidly, and reaches a large size. Therefore, it is obvious that it would shade its competitors and limit their access to food supply. One should expect that it would reduce the number of native species significantly in places of its occurrence. As a result, an important and permanent transformation of the native seed banks in the soil would occur. It would be manifested by the depletion of the species composition typical for a given community.
 The symbiosis of Chilean *Gunnera* with cyanobacteria will lead to an increase in the role of nitrophilous and shade-tolerating species, which will change the character of the community fundamentally (a larger share of weeds and ruderals). The changes would affect the flora and vegetation of more humid habitats most of all. (Gloria and Osborne 2009a and b, 2010, 2013, Hickey and Osborne 2001 – P).

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:

<input type="checkbox"/>	inapplicable
<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf15.	Answer provided with a	low	medium	high X	level of confidence
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acomm19. Comments:
A non-parasitic plant species.

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

<input type="checkbox"/>	inapplicable
<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf16.	Answer provided with a	low	medium X	high	level of confidence
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acomm20. Comments:
Gunnera tinctoria is sometimes considered to be a weed having negative influences which should be examined in an economic context, manifesting in the decrease in the productivity of agricultural lands and forest areas, and the related removal costs. In Ireland, the species colonises floristically rich meadows, decreasing their grazing capacity (Hickey and Osborne 1998b – P, CABI 2018 – B).
In Poland, the species has no influence on the cultivation of plants important from the economic point of view, so it does not compete with them. Assuming that *G. tinctoria* were to spread across the territory of the whole country, it might be supposed that its survival chances in cultivated fields would be infinitesimal (it would not survive the winter or seasonal agricultural operations, or excessive insolation at a rather low humidity), thus it would not compete with cultivated plants (cereals, root crops). On the basis of our expertise, we ascertain that grasslands might be endangered to a certain degree (Hickey and Osborne 1998b – P) on humid grounds (provided that Chilean *Gunnera* would survive the Polish winter).

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

<input type="checkbox"/>	inapplicable
<input checked="" type="checkbox"/>	no / very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf17.	Answer provided with a	low	medium	high X	level of confidence
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acomm21. Comments:
There are no plants related with the *Gunnera* genus in Poland, so crossbreeding is impossible and in this sense, the species has no influence on cultivated plant species.

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

- very low
- low
- medium
- high
- very high

aconf18. Answer provided with a

low	medium	high X
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 level of confidence

acomment22. Comments:
Potentially large *G. tinctoria* sites located in the vicinity of crops may bring about a change in the cycles of chemical elements, hydrographic conditions or trophic properties of the soil; however, it requires further study (CABI 2018 – B). In Ireland, terrains where the species has overwhelmed grasslands exist (Hickey and Osborne 1998a – I, 1998b – P), thereby decreasing the value of the grazing grounds.
Assuming the spread of *G. tinctoria* across the whole territory of Poland, one may suppose that due to its requirements pertaining to habitat conditions, the species would disturb crop integrity to a slight degree. However, its impact on grasslands cannot be excluded.

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
- very high

aconf19. Answer provided with a

low	medium	high X
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 level of confidence

acomment23. Comments:
There are few substantive data on the subject (Williams *et al.* 2005 – P; O'Rourke and O'Flynn 2014 – B; comp. also a16).

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:

- inapplicable
- very low
- low
- medium
- high
- very high

aconf20. Answer provided with a

low	medium	high
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 level of confidence

acomment24. Comments:
The species is a plant.

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

- very low
- low
- medium
- high
- very high

aconf21. Answer provided with a

low	medium	high
-----	--------	------

 level of confidence

acomment25. Comments:
 There are few data on the impact of the species on farm animals. Williamson *et al.* (2005 – P) have ascertained that Chilean Gunnera overgrows grazed meadows in New Zealand. Cattle limits the occurrence of the invader by eating young individuals. Similarly in Ireland, cattle and sheep eat young plants in the spring (Gioria and Osborne 2013 –P). The authors do not mention any harmful influence of Chilean Gunnera on the grazing stock (on the other hand, it is known that it has been used by Native Americans in Chile as a medicinal and refreshing plant). Simultaneously, there is information on the neurotoxins formed in organs of older Chilean Gunnera individuals by their cyanobacteria (see question a28).
 So far, the species has not been found outside gardens in Poland, thus there is practically no chance of a direct contact with farm animals, so even more, the threat posed by the species seems very small.

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

- inapplicable
- very low
- low
- medium
- high
- very high

aconf22. Answer provided with a

low	medium	high
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 level of confidence

acomment26. Comments:
 The plants are no hosts or vectors of pathogens/parasites of animals.

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:

- inapplicable
- very low
- low
- medium
- high
- vert high

aconf23. Answer provided with a

low	medium	high
-----	--------	------

 level of confidence

acomm27. Comments:
The species is not parasitic.

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

- very low
- low
- medium
- high
- very high

acnf24. Answer provided with a

low	medium	high
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 level of confidence

acomm28. Comments:
The plant may pose a threat when it is removed, particularly if it becomes spread throughout the country. Chilean Gunnera has stiff leaf stalks and blades covered with thorny trichomes, which may injure skin in a direct contact (Pilkington 2011 – B).
The presence of symbiotic cyanobacteria of the *Nostoc* genus in tissue of older individuals of *G. tinctoria*, producing the neurotoxin 3-methylamine-L-alanine (BMAA) – an organic compound belonging to the amino acids – is connected with a possibility of a negative impact of the species on human health. There are premises to think that BMAA participates in the pathogenesis of a degenerative disease known as the lytico-bodig disease (Gioria and Osborne 2013 – P). However, the disease is of an endemic character and it does not appear to pose a threat for Europe.

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

- inapplicable
- very low
- low
- medium
- high
- very high

acnf25. Answer provided with a

low	medium	high
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 level of confidence

acomm29. Comments:
The plant does not transmit harmful pathogens or parasites.

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
- medium
- high
- very high

acnf26. Answer provided with a

low	medium	high
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 level of confidence

acomm30.

Comments:

Gunnera tinctoria may have a negative influence on areas used by humans: parks and gardens, communication network (roads and waterways), and the related infrastructure (EPPO 2014 – I). Plants of this species may block canals and streams, and hinder the access to tourist and recreational infrastructure or destroy it (Maguire 2009 – I, Gioria and Osborne 2013 – P). Perennials of such a large size may accelerate erosion of steep slopes and scarps, and increase the flood risk (Maguire 2009 –I). Their presence may decrease the value of land and real estate property (Pilkington 2011 – B).

Single individuals of Chilean *Gunnera* cultivated in gardens in Poland affect the infrastructure only slightly. However, if we assumed that the species had spread in Poland already, its impact on the infrastructure (from an expert’s point of view) should be evaluated as at least medium.

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
- significantly positive

aconf27.

Answer provided with a

low	medium	high
		X

level of confidence

acomm31.

Comments:

The biology of the species and its habitat requirements indicate that it remains neutral, it has no significant influence on the supply services such as the supply of food, materials and energy.

Gunnera tinctoria is sometimes considered to be a weed having a negative influence which should be considered in an economic context, manifesting in the decrease in the productivity of agricultural lands and forest areas, and the related removal costs. In Ireland, the species colonises floristically rich meadows, decreasing their grazing capacity (Hickey and Osborne 1998b – P, CABI 2018 – B; comp. a20).

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

- significantly negative
- moderately negative
- neutral
- moderately positive
- significantly positive

aconf28.

Answer provided with a

low	medium	high
	X	

level of confidence

acomm32.

Comments:

Due to the infrequent occurrence of the species and its intolerance of low air humidity, it has no significant impact on the climate, regulation of air composition, extreme phenomena, water self-cleaning processes etc.

The increase in biomass at large sites of *G. tinctoria* may affect regulation services, particularly physico-chemical changes in the soil (due to the contained cyanobacteria) and changes connected with water availability in the soil (Hickey and Osborne 1998 – P, Gioria 2007 – I). Potentially large *G. tinctoria* sites located in the vicinity of crops may bring about a change in the cycles of chemical elements, hydrographic conditions and soil richness; however, this requires further study (CABI 2018 – B).

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

- significantly negative
- moderately negative
- neutral
- moderately positive
- significantly positive

aconf29. Answer provided with a

low	medium	high X
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 level of confidence

acommm33. Comments:
 The species has no impact on cultural services in Poland: sciences, education, spiritual realm or artistic resources. However, when planted individually in gardens, it plays the role of an ornamental plant, providing aesthetic experience.
 On the other hand, in places of its more abundant occurrence, it may hinder recreation (Weedbusters 2003 – B), limit the access to areas of high natural value, and impair aesthetic experience. It is the case in the autumn particularly, in the time of leaf decay (National Botanic Gardens of Ireland 2009 – I), and also in the winter, when the large brown rootstock of *G. tinctoria* is exposed, and litter may be trapped in between. Sometimes, its rotting leaves emit an unpleasant smell (Invasive Species Action Plan 2018 – I). In New Zealand, the invasion of the species on coastal cliffs caused changes in the landscape.

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 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
- not change
- increase moderately
- increase significantly

aconf30. Answer provided with a

low	medium X	high
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 level of confidence

acommm34. Comments:
 An increase in the yearly average temperature will favour the introduction (as well as the establishment and spread) of the species, provided that the total yearly precipitation and

air humidity increased simultaneously (a decrease in the air humidity may distinctly limit the overcoming of the barrier). Milder winters may favour cultivation and encourage planting in gardens.

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
- not change
- increase moderately
- increase significantly

aconf31. Answer provided with a

low	medium X	high
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 level of confidence

acomment35. Comments:
 So far, the species has a secondary range limited to several regions of Western Europe. However, the range may be potentially expanded to other regions of the Atlantic part of Western Europe (EPPO 2014 – I).
 Predicted climate changes increase the probability that the species will overcome the barriers which precluded its survival and reproduction in Poland hitherto. Current analyses confirm that its present, but also future distribution depends, most of all, on three factors: total precipitation, temperature, and air humidity, and it does not depend significantly on the soil richness.
 The expansion of the range may be favoured by: increases in temperature and air humidity, as well as an increase in the total precipitation and its uniform distribution during a year (Gioria and Osborne 2009a and b – P). Changes in land use may affect the range expansion of the species too (Gioria and Osborne 2013 – P). The latest data suggest that predicted expansion may be connected with increasing level of genetic variability in the species (Fennell *et al.* 2012 – P).

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
- increase moderately
- increase significantly

aconf32. Answer provided with a

low	medium X	high
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 level of confidence

acomment36. Comments:
 The species has a potential to increase its secondary range (O’Rourke and O’Flynn 2014 – B).
 An increase in the yearly average temperature will favour the spread of the species, provided that the total yearly precipitation and air humidity increase simultaneously.

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
- increase moderately
- increase significantly

aconf33. Answer provided with a

low	medium X	high
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 level of confidence

acomm37. Comments:
An increase in the yearly average temperature would increase the impact of the species on the natural environment, provided that the total yearly precipitation and air humidity increase simultaneously. Under such conditions, the species would also colonise such habitats as, e.g.: humid meadows, pastures, scrub, forest edges, stream banks, ditches, roadsides, herb communities, and grasslands, and it would cause significant changes in the habitat (more nitrogen in the soil!), changes in species composition and the nature of the communities, competition relations (Hickey and Osborne 1998a – I, 1998b, Gioria and Osborne 2013 – P).

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
- not change
- increase moderately
- increase significantly

aconf34. Answer provided with a

low	medium X	high
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 level of confidence

acomm38. Comments:
Under the conditions of an increase in the yearly average temperature with a simultaneous increase in air humidity and total precipitation, the influence of the species on cultivated plants and plant production will not change significantly – agricultural operations will eliminate Chilean Gunnera in the fields. However, reduction or deterioration of grasslands cannot be excluded.

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
- not change
- increase moderately
- increase significantly

aconf35. Answer provided with a

low	medium X	high
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 level of confidence

acomm39. Comments:
Predicted climate change should not affect animal husbandry directly (possibly, it might affect the condition of grasslands indirectly).

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

- decrease significantly
- decrease moderately
- not change
- increase moderately
- increase significantly

aconf36. Answer provided with a

low	medium X	high
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 level of confidence

acom40.

Comments:

Assuming that climate changes consisting of both warming and humidity increase, it may be supposed that Chilean *Gunnera* would become a rather frequent species. Under such conditions, the impact of the species on humans would probably not increase. However, the studies of the presence of symbiotic cyanobacteria of the *Nostoc* genus, producing a neurotoxin (BMAA), in the plant's tissues should be continued. Its connection with development of human diseases is not formally excluded. The disease detected hitherto has an endemic character and does not currently pertain to Europe (Gioria and Osborne 2013 – P; comp. a29).

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
- increase moderately
- increase significantly

aconf37.

Answer provided with a

low	medium X	high	level of confidence
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acom41.

Comments:

The problems may pertain to humid habitats, particularly those located along watercourses. If the species occurred in such habitats as a result of the postulated climate change, then, while growing, it could obstruct the water flow, and even increase the flood risk locally (Skeffington and Hall 2011, Gloria and Osborne 2013 – P).

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.00	1.00
Establishment (questions: a09-a10)	0.25	1.00
Spread (questions: a11-a12)	0.00	0.75
Environmental impact (questions: a13-a18)	0.50	0.80
Cultivated plants impact (questions: a19-a23)	0.05	0.90
Domesticated animals impact (questions: a24-a26)	0.00	0.50
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.50	0.50
Invasion (questions: a06-a12)	0.08	0.92
Impact (questions: a13-a30)	0.50	0.74
Overall risk score	0.04	
Category of invasiveness	Slightly 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, that 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 regularly repeated.

acomm42.

Comments:

Gunnera tinctoria – originally an ornamental plant appearing in our botanical gardens in the second half of the 20th century. It may continue to be cultivated in these gardens and arboreta, but with a certain cautiousness in those areas with a greater influence of the Atlantic climate.

Our analysis allowed its definition as an “slightly invasive alien species” (value of the negative impact, or the degree of invasivity amounts to 0.50 at a certainty degree of 0.74).

Under current climatic conditions, more severe restrictions concerning the sale and cultivation of Chilean *Gunnera* in private gardens in Poland do not seem justified. This unusual plant is cultivated more and more often. It does not tolerate too well our rather dry summers, frosts in the winter, and deficiencies of precipitation and air humidity during the whole year. It requires very careful covering during winter. It reproduces generatively and vegetatively. It is unclear whether the seeds are fertile, but seedlings do not occur under the cultivated plants.

Depending on the direction of climate change and the results of these studies, it will be possible to consider whether restrictions on the sale and cultivation of Chilean *Gunnera* in private gardens in Poland would be justified.

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