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. Magdalena Szymura
2. Agnieszka Kompała-Bąba
3. Alina Urbisz

acomm01. Comments:

| | degree | affiliation | assessment date |
|---|---|---|---|
| (1) | dr hab. | Division of Grassland and Green Areas Management, Institute of Agroecology and Plant Production, Wrocław University of Environmental and Life Sciences | 29-03-2018 |
| (2) | dr hab. | Faculty of Biology and Environmental Protection, University of Silesia in Katowice | 29-03-2018 |
| (3) | dr hab. | Faculty of Biology and Environmental Protection, University of Silesia in Katowice | 11-04-2018 |

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

Polish name: Nawłoć wąskolistna

Latin name: ***Solidago graminifolia*** (L.) Elliott

English name: Flat-topped goldenrod

Współfinansowano w ramach projektu nr POIS.02.04.00-00-0100/16 pn. *Opracowanie zasad kontroli i zwalczania inwazyjnych gatunków obcych wraz z przeprowadzeniem pilotażowych działań i edukacją społeczną* ze środków Unii Europejskiej w ramach Programu Infrastruktura i Środowisko 2014-2020

acomm02. Comments:

The Latin and Polish names of the species are quoted from Flowering plants and pteridophytes of Poland – a checklist (Mirek et al. 2002 – P). The correct name of the described species is: *Euthamia graminifolia* (L.) Nutt. Rabitsch et al. 1981, 1984 – P, Flora of North America 2006, The Plant List 2013 – B). A commonly used name of the species both in Poland and in Europe is *Solidago graminifolia* (L.) Elliot. (Mirek et al. 2002 – P). However, based on DNA analyses and studies related to morphology and anatomy, conducted within the native range of the species (Semple et al. 1981 – P, 1984 – P), the genus *Euthamia* should be excluded from the genus *Solidago* and considered to be a separate genus. Synonyms of the Latin name: *Chrysocoma graminifolia* L.; *Euthamia floribunda* Greene; *Euthamia graminifolia* (L.) Nutt. var. *graminifolia*; *Euthamia graminifolia* (L.) Nutt. var. *nuttallii* (Greene) W.Stone; *Euthamia nuttallii* Greene; *Solidago graminifolia* (L.) Salisb.; *Solidago graminifolia* (L.) Salisb. var. *graminifolia*; *Solidago graminifolia* (L.) Salisb. var. *nuttallii* (Greene) Fernald; *Solidago graminifolia* (L.) Salisb. var. *polycephala* (Fernald) Fernald; *Solidago graminifolia* (L.) Salisb. var. *typica* Rosend. & Cronquist; *Solidago hirtella* (Greene) Bush; *Solidago nuttallii* (Greene) Bush; *Solidago polycephala* Fernald. Synonyms of English names: Common flat-topped goldenrod; Lanceleaf goldenrod; Lance-leaved goldenrod.

| Polish name (synonym I) | Polish name (synonym II) |
|---|---|
| nawłoć trawolistna | – |
| **Latin name (synonym I)** | **Latin name (synonym II)** |
| *Euthamia graminifolia* | *Solidago polycephala* |
| **English name (synonym I)** | **English name (synonym II)** |
| Bushy goldenrod | Grass-leaved goldenrod |

**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:

In Poland the grass-leaved goldenrod has the status of an invasive neophyte (Tokarska-Guzik 2005 – P). In 2012 it was included in the group of species of foreign origin established in the area of Poland and regionally invasive (Tokarska-Guzik et al. 2012 – P). The range of the grass-leaved goldenrod covers a small area in the south-western part of Poland (near Niemodlin) (Guzikowa and Maycock 1986, Weber 1998 – P). The grass-leaved goldenrod is an invasive species in the scale of Silesia. However, in recent years new sites of this species have been recorded (Tokarska-Guzik 2005, Dajdok and Nowak 2007, Kompała-Bąba and Bąba 2006, Urbisz and Urbisz 2006 – P). The species is cultivated in 4 botanical gardens in Poland, where it usually occupies small areas from 1 $m^2$ (Botanical Garden of the Wrocław University) to 6 $m^2$ (Botanical Garden of the A. Mickiewicz University in Poznań). In the Botanical Garden in Łódź there are 48 specimens of the plant. The species spreads spontaneously in the Lublin Botanical Garden, while it spreads spontaneously in three remaining gardens (Wrocław, Poznań, Łódź), seedlings and young plants are removed in all four botanical gardens (Employees of botanical garden … 2018 – N).

The grass-leaved goldenrod is a native species in the moderate part of North America. The secondary range cover, among others, central and southern regions of Europe. This species has been recorded so far in countries such as Austria, Germany, Poland, Romania, Switzerland, Hungary, and spreading in Poland (Dajdok and Nowak 2007, Szymura and Szymura 2013 – P, Tokarska-Guzik et al. 2015 – I), in Austria, Germany and Switzerland (Schmotzer 2008 – P).

**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 |
| **X** | the human domain |
| **X** | the other domains |

acomm05. Comments:

The grass-leaved goldenrod has a much lower ability to spread compared to the smooth goldenrod and Canadian goldenrod, however, study performed so far indicates that this is a species which in the future could negatively affect the colonized ecosystems (Weber 1998, Dajdok and Nowak 2007 – P). Due to its high competitiveness in relation to native species it is a threat for biodiversity (Szymura et al. 2016 a – P). The grass-leaved goldenrod may compete with native species, reaching a in high abundance in patches. Communities occupied by the grass-leaved goldenrod are characterized by a lower number of species compared to those without it (Dajdok and Nowak 2007 – P). The goldenrod is considered to generate very significant ecological threats (Tokarska-Guzik et al. 2012 – P). The species has a high ability to adapt to various habitat conditions compared to other alien species (Lauerer and Woltas 2004 – P). The impact of the goldenrod on plant cultivation is related to the forming of monospecific stands in meadow habitats, due to which it may diminish the quality of hay (Szymura et al. 2016a – P). The grass-leaved goldenrod also appears in forest plantations, increasing weed infestation and decreasing the supply of light to tree seedlings (Szymura 2012 – A). Impact on other objects involves the spreading of the grass-leaved goldenrod along forest and field roads, which negatively affects aesthetics and may make more difficult to move along roads and tourist trails. It is a species heavily spreading by rhizomes, what may result in the destruction of road surfaces (Szymura 2012 – A). The species also causes reduction of the tourist attractiveness of the area by negative impact on the landscape (Szymura and Wolski 2006 – P), as well as reduction of the investment attractiveness of the given area (land parcel). Experimental research has indicated that the species spreads quickly and it is hard to remove from the given place (Szymura et al. 2016 b – P).

## 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 | level of confidence |
|---|---|---|---|
| | | **X** | |

acomm06. Comments:

The grass-leaved goldenrod is an established species which spreads by light seeds with pappus, and subsequently occupies infested habitats by growth via rhizomes (Szymura and

Szymura 2016b – P). The energy and capacity of grass-leaved goldenrod seeds germination is definitely lower than in the case of the smooth goldenrod and the Canadian goldenrod (Szymura 2012 – P); however, the ability to grow vegetatively and regenerate from rhizome fragments is very high (Szymura and Szymura 2016b – P). In the recent years, the considerable increasing of the area of its occurrence has been observed in Poland. There are known sites in Opolski Silesia, as well as, Lower and Upper Silesia and in Małopolska, on meadows and pastures which are extensively used or abandoned after cultivation. It still appears rarely in forest communities, rather in the ecotone (Dajdok and Nowak 2007 – P). Outside the area of Poland the plant occupies similar types of habitats. It has been also observed in riverside communities (Lohmeyer and Sukopp 1992 – P). Outside Poland the species has been recorded in Austria, the Czech Republic, Germany, Romania, Switzerland, Italy and Hungary (Tokarska-Guzik et al. 2015 – I). The species may be transported accidentally from the neighbouring countries in the form of seeds which are small, have a pappus and easily attach to human clothes or animal fur. Rhizomes of the species may be transported with soil or materials used for the renovation of roads. Soil properties do not limit of the occurrence of the species (Szymura and Szymura 2013 – P).

**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:

First reports about the occurrence of the species in Poland originate from Niemodlin (1885). In the 19th a plantation of trees and shrubs functioned there, near the arboretum in Lipno. The species could have been transported or delivered into the arboretum of the school in Prószków-Pomologia, which worked since 1868. The seeds of the plant could have been transported accidentally along with plant material directly from America (Dajdok and Nowak 2007 – P). Spreading of the species is connected with transport routes: roads and railways, as well as watercourses. This is related to the production of a high number of light seeds and the strong ability to regenerate from rhizomes (Szymura et al. 2016a – P). The spreading process of the grass-leaved goldenrod is also promoted by habitats as roadsides, where irregular disturbances (mowing, trampling) limit the growth of native species, leaving space for the goldenrods. The grass-leaved goldenrod is also transported during renovation works on the roadsides of unpaved and forest roads, where the rhizomes and seeds of the goldenrod may be accidentally spread with construction material (Szymura 2012 – 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:

The grass-leaved goldenrod was most likely transported accidentally with ornamental tree species into a newly established arboretum in Lipno (Dajdok and Nowak 2007 – P). According to other sources the species was introduced in Europe in the 18th century (about 1758) as a ornamental plant (Weber 1998 – P). Nowadays it is not planted purposefully as a ornamental and honey plant. However, according to the *Harmonia*$^{+PL}$ procedure, since it is

| | |
|---|---|
| | a species permanently established in Poland, a high probability of introduction has been assumed with a high degree of certainty. |

## 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:

The grass-leaved goldenrod is an established species in the analyzed area. The plant is associated with the moderate climate zone. Appropriate conditions are present on the entire continent, except its northern- and southernmost areas. Its potential range described based on climatic conditions in Europe is wider than the current one (Weber 2001 – P). The whole lowland part of Poland is convenient in terms of climate for the grass-leaved goldenrod (Szymura et al. 2016 a – P). The values of climatic similarity (according to the report adopted for the *Harmonia*$^{+PL}$ project) of the ranges of the native and invasive species are in the range of 94-100%.

**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:

Within its natural range the grass-leaved goldenrod occurs on meadows, prairies, roadsides, in drainage ditches, sandy moist shores of lakes and swamps. It also occurs in shaded areas like forest edges. It prefers habitats with an acidic pH (Abrahamson 2005 – P) and soils rich in clays. It is associated with stable moisture conditions (Werner and Platt 1976 – P).

The grass-leaved goldenrod is a species established in Poland, occupying semi-natural habitats (moist meadows of the order *Molinetalia*, marshes of the *Caricion davallianae* alliance), banks of watercourses as well as segetal and ruderal habitats (sand-pits, quarries, railway embankments, abandoned lands) (Rostański 1971, Guzikowa and Maycock 1986, Urbisz 2001, Kompała-Bąba and Bąba 2006, Szymura and Wolski 2006, Nowak and Kącki 2009, Fojcik 2012, Chmura et al. 2015 – P). It also appears in pine forests (Szymura and Wolski 2006 – P). The species occurs in locations with good or moderate insolation, in meso- or eutrophic habitats, on soils of various particles sizes (sands, clays, organic soils) both well developed and on initial substrates. It occurs at roadsides and in forest plantations more commonly that the smooth goldenrod and the Canadian goldenrod. This is related to the fact that available habitats, like wastelands, abandoned arable fields and meadows are occupied by more widespread goldenrods (Szymura and Szymura 2016b – P). Suitable habitat conditions are in whole area of Poland (Szymura and Szymura 2016b, Zając and Zając 2015, Szymura et al. 2018 – P). The plant is tolerant for soil moisture and reaction (Dajdok and Nowak 2007, Nowak and Kącki 2009, Szymura and Szymura 2013 – P).

## 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 |
| | low |
| | medium |
| **X** | high |
| | very high |

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

acomm11. Comments:

Population expansion (B-type data):
The grass-leaved goldenrod was most likely transported accidentally with ornamental tree species into a newly established arboretum in Lipno (Kącki 2009 – P). For many years its range covered small areas near the location of its first introduction (Niemodlin, Opole, Lower Silesia) (Guzikowa and Maycock 1986 – P). In the mid-20th century, the species was known in Poland only from 5 locations (Guzikowa and Maycock 1986 – P), while in 2003 it was already recorded in 27 locations (10 × 10 km) (Tokarska-Guzik 2005 – P). In 2007 there were approximately 50 known locations (Dajdok and Nowak 2007 – P) and this number is successively increasing. According to Dajdok and Nowak (2007 – P), the area occupied by the species increased from 3 $km^2$ to 300 $km^2$ during the time period analyzed by the Authors. The grass-leaved goldenrod has the lowest rate of colonization (128 $km^2$/year) (Weber 1998, 2001 – P), comparing to the remaining goldenrod species of alien origin: the Canadian goldenrod *Solidago canadensis* and the smooth goldenrod *S. gigantea*.

Estimation (C-type data):
Because the percentage of germinating seeds of the species is low compared to other goldenrod species, this limits its long-distance dispersal (Szymura 2012 – P). On the other hand, short-distance dispersal is very efficient, because the grass-leaved goldenrod has the ability to allocate biomass in rhizomes, and because of this – to reproduce vegetatively (Szymura and Szymura 2015 – P). Features as: a low stem height, lower ability of seeds to spread and germinate and a lower frequency of planting in gardens may influence lower spreading of this species comparing to other alien goldenrod species (Weber 1998, Price et al. 2004 – P). The grass-leaved goldenrod may still remain in the early phase of invasion, in w period between the introduction and intense increase of population number (lag phase), and its range is limited by other factors than related to climate (Weber 2001 – P). The species spreads along transport routes (Szymura and Wolski 2006 – P).

Considering the available data (expansion of population and estimation of the internal mobility of the species), the species' ability to spread in Poland may be assessed as high.

**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:

The way of introduction of the grass-leaved goldenrod in Europe is unclear (Weber 1998, Kącki 2009 – P). Its further spreading was probably unrelated to purposeful human activity. It is used neither as a ornamental plant in gardens nor as a honey plant, unlike other goldenrod species introduced for this purpose from America. However, it spreads along transport routes – roads, railways and watercourses, which is related to human impact. An increase in the number of its sites is also caused by the abandonment of cultivation of arable lands and meadows. It is present in ruderal habitats transformed by humans, at the roadsides of forest roads, where its rhizomes are transported during road maintenance operations and in new forest plantations (Guzikowa and Maycock 1986, Urbisz and Urbisz 2006, Kompała-Bąba and Bąba 2006, Dajdok and Nowak 2007, Szymura and Szymura 2011, Szymura et al. 2016b, Szymura and Szymura 2016b, Budzik and Stachurska-Swakoń 2014 – P).

## 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 is**:

| | |
|---|---|
| **X** | inapplicable |
| | low |
| | medium |
| | high |

aconf09. Answer provided with a

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

level of confidence

acomm13. Comments:

The species is a plant. It does not affect native species by predation, parasitism and herbivorousness.

**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:

The grass-leaved goldenrod is a strongly competitive species for native plant species as well as other invasive goldenrods (Szymura and Szymura 2016a – P). Compared to native species, it is characterized by higher growth dynamic of, as well as the ability to better usage of existing habitat resources (Szymura and Szymura 2016a – P). In spite of its lower height, it can competitively replace the Canadian goldenrod *Solidago canadensis* and the smooth goldenrod *S. gigantea* due to the strong growth of underground parts (roots and

rhizomes) (Szymura and Szymura 2016a – P). In occupied habitats it forms dense, single-species aggregations (Dajdok and Nowak 2007, Szymura and Szymura 2011 – P). Its potential competitive abilities may be similar to the remaining invasive goldenrods which block the germination and growth of other plant species, causing a decreasing of vascular plants biodiversity (Hejda et al. 2009, Szymura and Szymura 2011, 2016b, Fenesi et al. 2015a and b – P). Experiments have proven that by the allelopathy (direct or indirect impact of certain plants on others by chemical substances, e.g. secondary metabolites released into the environment; Encyklopedia Biologiczna 1998 – P). Moreover, the competitive impact of the grass-leaved goldenrod on native meadow species also include the decreasing of numbers of visits of pollinators to native flowers, like in the case of other goldenrod species (Moroń et al. 2009, Hurej et al. 2012, Fenesi et al. 2015a – P). This impact may be particularly strong, since the flowering period of the grass-leaved goldenrod is earlier and lasts longer than in case of *Solidago candensis* and *S. gigantea*, overlaps with native meadow species (Szymura and Szymura 2015a and b – 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:

There is currently no data from the area of Poland related to the hybridization of the grass-leaved goldenrod and native species. The species *Euthamia hirtipes* present in North America is considered as a hybrid between the *Solidago graminifolia* (*Euthamia graminifolia*) and the *E. caroliniana* (Fernald 1946 – P). This plant has wide, hairy leaf blades and several head-shaped inflorescences. In Poland, the probability of hybridization with native species could be assumed as low, and the possible effect as minor, which according to the procedure results in no impact/very low impact.

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

| | |
|---|---|
| **X** | very low |
| | low |
| | medium |
| | high |
| | very high |

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

acomm16. Comments:

There is no data in the literature regarding the impact of the species on native species by the transmission of pathogens and parasites harmful for these species.

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

| | |
|---|---|
| | low |
| | medium |
| **X** | high |

| | | | | | |
|---|---|---|---|---|---|
| aconf13. | Answer provided with a | low | medium | high **X** | level of confidence |

| | |
|---|---|
| acomm17. | Comments:<br>Similar to other invasive goldenrods, the grass-leaved goldenrod may potentially affect changes in chemical (the organic matter, nitrogen, potassium and manganese contents and pH), as well as in microbiological properties (biomass, the diversity and activity of microorganisms) of soils (Jianzhong et al. 2005, Chapuis-Lardy et al. 2006, Scharfy et al. 2010 – P). The impact of the goldenrod on the concentration of nutrients in soil and the increased dynamics of nitrogen conversion are associated with higher productivity of invasive species compared to natives (Vanderhoeven et al. 2006 – P), although this impact is specific for the species and for the habitat type. |

**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<br>**X** | level of confidence |

| | |
|---|---|
| acomm18. | Comments:<br>The grass-leaved goldenrod forms aggregations covering large areas which affect a numerous biotic factors. It invests in generative reproduction more than other goldenrod species. It exhibits phalanx-type strategy, which means that it exploits space by maximizing the occupied area and prevent the invasion of other species (Jacquemyn and Honnay 2008 – P). The species produces a high number of ramets (meaning individual rooted shoots which constitute fragments of a modular plant organism spreading vegetatively, Falińska 2004 – P), a high number of flowering shoots, and it forms dense aggregations in sites where it enters (Szymura and Szymura 2013 – P). The delivery of nitrogen affects an increase plant size (height of the stem, number of leaves, shoots diameter). The species has a delayed reaction to nitrogen and it may accumulate the overabundance of N during winter in rhizomes (Pratt 1998 – P). It the second year the increasing in the density of shoots is observed, which cause the decreasing of the species diversity (Sheahan 2012 – P). There are no more precise studies on the impact of the grass-leaved goldenrod on ecosystems, however, due to strong competitive abilities it may be expected that its impact will be similar to two remaining invasive goldenrod species. Invasive goldenrods cause a decrease in vascular plants biodiversity (Hejda et al. 2009, Szymura and Szymura 2011, Fenesi et al. 2015a – P), birds (Skórka et al. 2010 – P) and ants (Lenda et al. 2013, Trigos-Peral et al. 2018 – P). It has been proven that the composition of ant communities differed in sites without presence the goldenrods and dominated by the goldenrods. In the second case the abundance of ants was lower, as well as the diversity of ant species. This was probably caused by modification of the micro-habitat by *Solidago* (decreasing of soil moisture) as well as the reduction of biomass and the distribution of predatory invertebrates (Trigos-Peral et al. 2018 – P). Invasion of the goldenrod causes a decrease of the number and diversity of wild pollinators (Moroń et al. 2009 – P) and affects relations between wild pollinators and the local flora (Fenesi et al. 2015a – P). Invasion of the goldenrod also blocks the process of spontaneous succession in forests (Bornkamm 2007 – P) and in abandoned fields (Bartha et al. 2014 – 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:

| | |
|---|---|
| | inapplicable |
| **X** | very low |
| | low |
| | medium |
| | high |
| | very high |

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

acomm19. Comments:

The species is a plant, it has no parasitic properties

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

| | |
|---|---|
| | inapplicable |
| | very low |
| | low |
| | medium |
| **X** | high |
| | very high |

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

acomm20. Comments:

The grass-leaved goldenrod does not appear on arable fields as a crop weed. The species may impede the growth of other plants possessing strong allelopathic potential. Data originating from the natural range indicate that its leaf extracts may hinder the germination of seeds and the growth of roots of other plants. Root/rhizome extracts in turn hinder the growth of roots, but they do not affect the germination of plants. The species may negatively affect arable crops (Butcko and Jenses 2002 – P). There are also known cases of a negative impact of the species on berry crops (Boyd and White 2009 – I). Experimental studies have also indicated that the grass-leaved goldenrod affects negatively the cultivation of lettuce and radish, inhibiting the germination of seeds (Pisula and Meiners 2010 – P). The species locally occupies moist meadows and marshes. High competitive impact of the goldenrod involves penetration of meadow communities and replacement of species native to these habitats, which leads to lowering the forage values of meadows (Szymura and Szymura 2011, Szymura et al. 2016a and b – P). The species has a similar flowering period as native species which are weaker competitors(e.g., of the genus clover *Trifolium* or melilot *Melilotus*), hence it may compete with them for pollinators (Gross and Werner 1983 – P). The probability of affecting crops has been assessed as high, and the effect as average, which according to the procedure results in a high impact.

**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 known hybrids of the grass-leaved goldenrod with species native to Europe, including arable crops (probability: low × minor effect = no impact/very small impact).

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

| | |
|---|---|
| | very low |
| | low |
| **X** | medium |
| | high |
| | very high |

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

| | |
|---|---|
| acomm22. | Comments: |

The grass-leaved goldenrod penetrates meadow communities and replaces the native species of these habitats, due to it lowers the forage values of meadows (Fenesi et al. 2015a, Świerszcz et al. 2017 – P). In invaded areas it forms dense, almost monodominant aggregations (Dajdok and Nowak 2007, Szymura and Szymura 2011 – P). Its potential competitive abilities may be similar to the remaining invasive goldenrods which impede the germination and growth of other plant species, causing a decrease in biological diversity of vegetation (Hejda et al. 2009, Szymura and Szymura 2011, 2016b, Fenesi et al. 2015a and b – P). Moreover, the competition of the grass-leaved goldenrod directed towards native species may involve drawing pollinators away from them, like in the case of other goldenrod species (Moroń et al. 2009, Fenesi et al. 2015a – P). It may be particularly strong, since the grass-leaved goldenrod started to flower at the same time as for native meadow species and the flowering period lasts longer than that of *Solidago canadensis* and *S. gigantea* (Szymura and Szymura 2015a and b – P). The impact of the grass-leaved goldenrod is probably similar to the impact of the Canadian goldenrod and the smooth goldenrod, which cause changes in soil conditions (Jianzhong et al. 2005, Chapuis-Lardy et al. 2006, Scharfy et al. 2010 – P). It may affect a drop in bacterial biomass and an increase in fungal biomass in soil (Scharfy et al. 2010 – P). The plant may also affect biogeochemical cycles in ecosystems which it enters (changing soil pH and fraction of organic and inorganic P) (Herr et al. 2007 – P).

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

| | |
|---|---|
| **X** | very low |
| | low |
| | medium |
| | high |
| | very high |

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

| | |
|---|---|
| acomm23. | Comments: |

No species which is a pathogen or a parasite of the grass-leaved goldenrod has been transported from its native range of occurrence. No pathogens or parasites specific for the grass-leaved goldenrod have been observed in Europe either. In its native range the species is a carrier of parasitic fungi, e.g. *Cercosporella virgaureae, Phyllachora solidaginum, Coleosporium asterum;* however, they have not been transported to Europe along with the species. Also, these fungi are not placed on the EPPO1 or EPPO2 lists. Therefore, no impact of the species on plant crops caused by it being a host or vector of pathogens and parasites harmful for these plants has been observed.

## 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:

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 |
| **X** | low |
| | medium |
| | high |
| | very high |

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

acomm25. Comments:

In Poland there are currently no documented cases of the species' impact on the health of a single animal or livestock production due to the possessed properties. From the native range, there are cited cases of beetles from the family Meloidae (blister beetles) feeding on the plant, which produce cantharidin, a poisonous substance which may poison animals grazing the plant (Sheahan et al. 2012 and the literature cited therein – P). The presence of the grass-leaved goldenrod may indirectly negatively affect animal husbandry – by decreasing the nutritional value of feed obtained from meadows where the goldenrod is present.

**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 species is a plant which is neither a vector of animal parasites nor pathogens.

## 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:

The species does not affect humans health, because it is not a parasite.

**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 **X** | high | level of confidence |

acomm28. Comments:

In humans, the grass-leaved goldenrod may cause hay fever; however, these cases are rare (Frankton 1963 – P). There are no other known negative effects for human health (NOBANIS 2010 – B).

**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:

The species is a plant which is neither a vector of human parasites nor pathogens.

## 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 |
| X | low |
| | medium |
| | high |
| | very high |

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

acomm30. Comments:

Alien goldenrods cause a decrease in the area of meadows and pastures, on meadows considered as valuable for nature, and they may hinder agrotechnical treatments (Development programme for rural areas 2014-2020: package 4 and 5 – I). They also cause reduction of the tourist attractiveness of the area by negative impact on the landscape (Szymura and Wolski 2006 – P), as well as reduction of the investment attractiveness of the given area (land parcel). Experimental research has indicated that the species spreads quickly and it is hard to remove from the given place. Therefore, it should be eradicated in an active way (Świerszcz et al. 2017 – P). Removal of the goldenrod from the given area as well as restoration of meadows are associated with high costs (Szymura et al. 2016 b – P).

## 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 |
| X | moderately negative |
| | neutral |
| | moderately positive |
| | significantly positive |

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

acomm31. Comments:

There has been no direct research within the discussed scope. Mass occurrence of the species in some regions of Poland may lead to a decrease in the production value of meadows and pastures (Szymura et al. 2016b – P). In some countries the species is considered a valuable honey plant (Stefanic et al. 2015 – P).

**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 X | high | level of confidence |

| | |
|---|---|
| acomm32. | Comments: |

The impact of the grass-leaved goldenrod is probably similar to the impact of the Canadian goldenrod and the smooth goldenrod, which cause changes in soil conditions (Jianzhong et al. 2005, Chapuis-Lardy et al. 2006, Scharfy et al. 2010 – P). Invasion of the goldenrod affects relations between wild pollinators and the local flora (Fenesi et al. 2015a – P). While searching for nectar, the specimens of *Solidago* may be visited by many more species of pollinators, which may decrease the pollination of native species (Hilty 2002-2008 – B, Sheahan 2012 – P). The species also blocks the process of spontaneous succession in woody areas (Bornkamm 2007 – P) and in abandoned fields (Bartha et al. 2014 – P). Invasive goldenrods also affect biogeochemical cycles and the primary production of infested communities (Vanderhoeven et al. 2005, Vanderhoeven et al. – 2006, Chapuis-Lardy et al. 2006, Scharfy et al. 2010 – 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: |

In general, the invasion of the goldenrods negatively affects landscape aesthetics (Szymura and Wolski 2006 – P). In ruderal habitats (quarries, sand-pits, railway areas) in the flowering period, as well as due to its different stature compared to other goldenrod species, this species may be periodically perceived as an aesthetic element 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 |
| **X** | not change |
| | increase moderately |
| | increase significantly |

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

| | |
|---|---|
| acomm34. | Comments: |

It is believed that climate is not a factor limiting the colonization of new sites by the grass-leaved goldenrod (Weber 1998, 2001 – P). The species already occurs in the area the country (Tokarska-Guzik et al. 2012 – P).

**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:

The impact of climate on the colonization of new sites is of minor importance (Weber 1998, 2001 – P). The species is already established in the area of Poland (Dajdok and Nowak 2007, Tokarska-Guzik et al. 2012 – P). It has already overcome barriers related to reproduction and spreading and it is gradually increasing the number of locations. It can be assumed that over time its range will expand into other regions of the country, however, it will not be related to climatic changes. Currently it is established mainly in the south-western part of the country. It is also reported in the Upper Silesia, and recently also in the Carpathians (Zając and Zając 2015 – P). With time, it can modify habitat conditions.

**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 |
| **X** | not change |
| | increase moderately |
| | increase significantly |

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

acomm36. Comments:

The potential range of occurrence of the grass-leaved goldenrod in Europe, associated with climatic conditions and the presence of habitats, is larger than the current one (Weber 2000 – P). The species is currently established in some regions of the country (south-western Poland, near Niemodlin) (Guzikowa and Maycock 1986, Tokarska-Guzik 2005, Tokarska-Guzik et al. 2012 – P). For a long time the species was in the early phase of invasion (the so-called *lag phase*), in a period between the introduction and the intense increase of population (Weber 2001 – P). In the recent years, this species has most likely overcome another barrier in the invasion process – the dispersal barrier, and thus the phase of adaptation (*lag phase*) has finished (Szymura et al. 2015 – P). Features such as: lower spreading and germination capability of seeds, a low stem and a lower frequency of seeding in gardens are threated to be the causes of smaller distribution of the species compared to the Canadian goldenrod *S. canadensis* and the smooth goldenrod *S. gigantea* (Weber 1998, Price et al. 2004, Szymura and Szymura 2013 – P). Its spreading into various habitats in the south-western part of the country has been observed in the recent years (Kompała-Bąba and Bąba 2006, Dajdok and Nowak 2007, Szymura and Szymura 2013, Urbisz and Urbisz 2006 – P). Research has proven that soil properties have no impact on its distribution (Szymura and Szymura 2013 – P). The species has also appeared in the Carpathians (central part of the Rożnowskie Foothills; Budzik and Stachurska-Swakoń 2014 – P, the Przemyskie Foothills; Wolanin 2014 – P). In the following years the species will most likely occupy new sites; however, in this case climate has no impact on its distribution.

**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 |
| **X** | not change |
| | increase moderately |
| | increase significantly |

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

acomm37. Comments:

The species is already established in the area of Poland (Tokarska-Guzik et al. 2012 – P), and its locations are limited mainly to Silesia. In the consecutive years, an increase in the number of locations of the species has been observed in anthropogenic habitats, i.e. ruderal or semi-natural habitats (Guzikowa, Maycock 1986, Kompała-Bąba and Bąba 2006, Szymura and Wolski 2006, Urbisz and Urbisz 2006, Szymura and Szymura 2011, Fojcik 2012, Chmura et al. 2015 – P). Therefore, it can be assumed that its impact on natural environment will increase, but this is due to the fact that the species has already overcome barriers related to reproduction or spreading and it is currently increasing the number of locations. It has also a wide tolerance with respect to habitat conditions. A high increase in the species' impact on natural environment is related mainly to the expected extension of its range and the occupation of new habitats, such as pond levees or the surroundings of drainage ditches. Since that an influence of species on the environment is not connected with predicted climatic changes we marked the answer "not change".

**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 species is already established (Tokarska-Guzik et al. 2012 – P), and its locations are limited mainly to Silesia, however, the number of recorded observations raised in the recent years (Guzikowa and Maycock 1986, Kompała-Bąba and Bąba 2006, Urbisz and Urbisz 2006, Dajdok and Nowak 2007, Szymura and Szymura 2011 – P). The expected considerable increase in the number of locations of this species may also cause an increase in its impact on plant cultivations, mainly meadows; however, in this case climate has no influence on the species' impact on arable crops or crop production in Poland. There is no detailed research on the subject.

**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 **X** | high | level of confidence |

| | |
|---|---|
| acomm39. | Comments:<br>The species is already established in Poland (Tokarska-Guzik et al. 2012 – P). Its sites are limited mainly to Silesia, however, the number of recorded observations raised in the recent years (Guzikowa and Maycock 1986, Kompała-Bąba and Bąba 2006, Dajdok and Nowak 2007, Urbisz and Urbisz 2006 – P). However, there is no detailed research on the subject. It can be predicted that climatic changes will not change the influence of a species on domesticated animals and animal production. |

**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<br>**X** | high | level of confidence |

| | |
|---|---|
| acomm40. | Comments:<br>The species is already established (Tokarska-Guzik et al. 2012 – P). It is assumed that climatic changes will not change the species' impact on humans in Poland. However, there is no detailed research on the subject. |

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

| | |
|---|---|
| | decrease significantly |
| | decrease moderately |
| **X** | not change |
| | increase moderately |
| | increase significantly |

| | | | | | |
|---|---|---|---|---|---|
| aconf37. | Answer provided with a | low | medium<br>**X** | high | level of confidence |

| | |
|---|---|
| acomm41. | Comments:<br>It can be predicted that the influence of species on other domains in Poland will not change as a result of climatic changes. The species is already established (Tokarska-Guzik et al. 2012 – P), it has no direct impact on infrastructure. Alien goldenrods cause a decrease in the area of meadows and pastures, as well as reduction of the investment attractiveness of the given area (land parcel). Experimental research has indicated that the species spreads quickly and it is hard to remove from the given place. Removal of the goldenrod from the given area as well as restoration of meadows are associated with high costs (Szymura et al. 2016 b – P). |

## Summary

| Module | Score | Confidence |
|---|---|---|
| Introduction (questions: a06-a08) | 1.00 | 1.00 |
| Establishment (questions: a09-a10) | 1.00 | 1.00 |
| Spread (questions: a11-a12) | 0.88 | 1.00 |
| Environmental impact (questions: a13-a18) | 0.60 | 0.90 |

| | | |
|---|---|---|
| Cultivated plants impact (questions: a19-a23) | 0.25 | 0.80 |
| Domesticated animals impact (questions: a24-a26) | 0.25 | 0.50 |
| Human impact (questions: a27-a29) | 0.00 | 0.50 |
| Other impact (questions: a30) | 0.25 | 0.50 |
| Invasion (questions: a06-a12) | 0.96 | 1.00 |
| Impact (questions: a13-a30) | 0.60 | 0.68 |
| Overall risk score | 0.58 | |
| Category of invasiveness | moderately invasive alien speciesp | |

## 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:

In the performed risk assessment *Solidago graminifolia* has been described as a medium invasive alien species. Because the species is already established in Poland and it has overcome barriers related to reproduction and distribution (a11-a12, result 0.88), and in the recent years an increase in the number of its locations has been recorded, it has reached a high result of 0.96 in the invasion process module (a06-a12). The generally negative environmental impact of the species (a13-a18) has been assessed as average (0.60). The plant may successfully compete both with native species (including protected ones) as well as other alien goldenrod species, reaching high coverage. It is a threat to valuable natural habitats, mainly Molinia meadows (6410), hydrophilous tall herb fringe communities of plains and from the montane to alpine levels (6430) and extensively used lowland hay meadows (6510).

## Data sources

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