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. Wojciech Adamowski
2. Anna Krzysztofiak
3. Zygmunt Dajdok

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr	Białowieża Geobotanical Station, Faculty of Biology, University of Warsaw	25-01-2018
(2)	dr	Wigry National Park	15-01-2018
(3)	dr	Department of Botany, Institute of Environmental Biology, University of Wrocław	01-02-2018

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

Polish name: Niecierpek gruczołowaty

Latin name: ***Impatiens glandulifera*** Royle

English name: Himalayan balsam

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:

Nomenclature accepted based on the work of Mirek et al. (2002 – P). The Latin name is widely accepted (The Plant List 2013 – B).

Synonyms of the Latin name: *Impatiens roylei* Walp., *Balsamina glandulifera* (Royle) Ser., *Balsamina macrochila* Ser., *Balsamina roylei* (Walp.) Ser., *Impatiens candida* Lindl., *Impatiens cornigera* Hook., *Impatiens glanduligera* Lindl., *Impatiens macrochila* Lindl., *Impatiens moschata* Edgew., *Impatiens royleana* Payer (GBIF 2016, Pisarczyk and Tokarska-Guzik 2015 – I).

English names: Himalayan balsam, Policeman's Helmet, Bobby Tops, Copper Tops, Gnome's Hatstand, Kiss-me-on-the-mountain, Ornamental jewelweed, Jumping Jack.

Synonyms of the Polish name: niecierpek himalajski, niecierpek Roylego.

Polish name (synonym I)	Polish name (synonym II)
Niecierpek himalajski	Niecierpek Roylego
Latin name (synonym I)	Latin name (synonym II)
Impatiens roylei	*Balsamina glandulifera*
English name (synonym I)	English name (synonym II)
Policeman's Helmet	Bobby tops

a03. **Area** under assessment:

Poland

acomm03. 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
X	alien, present in Poland in the environment, established

aconf01. Answer provided with a

low	medium	high	level of confidence
		X	

acomm04. Comments:

*Impatiens glan*dulifera was first observed in the present territory of Poland in 1890 and has been constantly spreading ever since. In Poland this species is considered an invasive kenophyte (Tokarska-Guzik 2005 – P). In 2012 it was included in the group of established and invasive alien species (Tokarska-Guzik et al. 2012 – P). The species can be found throughout the country (Zając A. and Zając M. 2001, Tokarska-Guzik 2005 – P), although it occurs most frequently in the southern and western parts. Further spread of *I. glandulifera* is almost certain, especially in view of subsequent reports about its occurrence (see Sobisz and Truchan 2008, Śliwiński 2008, Pliszko 2011P, Zając A. and Zając M. 2015a – 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
X	the domesticated animals domain
X	the human domain
X	the other domains

acomm05. Comments:

Impatiens glandulifera can quite strongly influence the natural environment: it is a tall annual plant, capable of effective competition even with native perennial species, such as ground elder *Aegopodium podagraria*, hedge bindweed *Calystegia sepium* and common nettle *Urtica dioica* (Koenies and Glavac 1979, Tickner et al. 2001, Kowarik 2003 – P, Helmisaari 2010 – B). *Impatiens glandulifera* often creates single-species communities, and large numbers of seedlings appear almost simultaneously (Beerling and Perrins 1993, Krzysztofiak A. and Krzysztofiak M. 2015 – P), thus it may monopolize access to light. However, long-term observations on permanent plots have shown significant fluctuations in its size, mainly related to fluctuations in water levels in the watercourse (Kasperek 2004 – P). Catastrophic floods are able to reduce its numbers significantly (Dajdok et al. 2003 – P). This species can compete with native plants for pollinators (Prowse and Goodridge 2000, Chittka and Schürkens 2001 – P), although the final result of this competition largely depends on the context – Cawoy et al. (2012 – P) observed more frequent visits of bumblebees to native plant species in the presence of *I. glandulifera*, and a reduced number of visits by honeybees. In central Europe *I. glandulifera* is the host of the *Aphis fabae* aphid, which also attacks *Impatiens noli-tangere*, which is native to Polish lands (Starý et al. 2014 – P). Other sources (CABI 2016, Aphids 2018 – B) also mention *Impatientinum asiaticum*, *Impatientinum balsamines* and *Impatientinum impatiens* as aphids attacking both *I. glandulifera*, as well as *I. noli-tangere*, however there is no information from which region of the world the observations come from. In Germany, Schmitz (2007 – P) found a geometer moth *Xanthorhoe biriviata* on *I. glandulifera*, a moth which typically feeds on *I. noli-tangere* in continental Europe (Hatcher 2003 – P). The fly *Phytoliriomyza melampyga* and the elephant hawk moth *Deilephila elpenor* have been found to be feeding on the leaves of both *Impatiens* species (Hatcher 2003, Buszko 2016 – P). It is possible to further exchange monophagic herbivores between individual species of *Impatiens*. The *Podosphaera balsaminae* fungus, associated with *I. glandulifera* in western Himalayas (Tanner 2011 – N), is known in Poland as the *I. noli-tangere* parasite (Kozłowska et al. 2015 – P). It is possible that pathogens appearing on *I. glandulifera* have a wider spectrum of hosts, which in the case of the spread of *I. glandulifera* throughout Poland could contribute to the spread of these pathogens. Ruckli et al. (2013 – P) showed the impact of the invasion of *I. glandulifera* on soil moisture and temperature – on surfaces dominated by *Impatiens* the soil was more humid and cooler, while Pattison et al. (2017 – P) confirmed the impact on the intensification of the invasion of both *I. glandulifera* and other alien species, associated with increased erosion of the banks and control by non-native species of places, in which the eroded material is accumulated. Results obtained by Pattison et al. (2017 – P) suggest that invasion can uncouple the processes that contribute to resilience in dynamic habitats (like river valleys) making already invaded habitats vulnerable to further invasions. The increased erosion of the banks of watercourses under the influence of *I. glandulifera* invasions have already been reported by Greenwood and Kuhn (2014 – P). They also reported blocking of watercourses by an increased amount of mineral material dragged over the bottom or biomass produced by specimens of this species. Čuda et al. (2017 – P) did not find a clear impact of this plant on soil properties or on the forest cover. Among the possible effects of *I. glandulifera* invasion Matthews et al. (2015 – P) mention changes in the vegetation structure adversely affecting insects requiring an open water surface and the quality of the bottom as a spawning place for fish. Opinions on the impact of *Impatiens* on the integrity of the ecosystem by interfering with its biotic characteristics are divided: Hulme and Bremner (2006 – P) and Tanner (2011 – N) observed a reduction in the number of species on surfaces covered by *Impatiens*, while Hejda and Pyšek (2006 – P) and Čuda et al. (2017 – P) did not notice such dependence. It seems, however, that evidence for the strong impact of *I. glandulifera* on living organisms prevails: Tanner (2011 – N) and Rusterholz et al. (2014 – P) observed differences in the abundance and composition of selected groups of invertebrate fauna, both above ground and in soil between the areas occupied by *I. glandulifera* and areas without this plant. Ruckli et al. (2013 – P) showed the impact of *I. glandulifera* invasion on the composition and abundance of terrestrial molluscs. Substances released into the soil by roots, or getting into it as a result of decomposition of *I. glandulifera*, may inhibit germination of other plant species (Ruckli et al. 2014b – P). In laboratory conditions *I. glandulifera* was the strongest of the

three *Impatiens* species tested in this respect (*I. glandulifera, I. noli-tangere*, *I. parviflora*; Vrchotová 2011 – P). Most recently Ruckli et al. (2014a, 2016 – P) experimentally proved the negative impact of the presence of *I. glandulifera* in the forest community on the mycorrhiza of two native tree species: *Fagus sylvatica* and *Acer pseudoplatanus*, and Gaggini et al. (2017 – P) confirmed the influence on the composition and functioning of soil bacteria and fungi. Rusterholz et al. (2017 – P) showed an increasing year by year impact of *I. glandulifera* presence on the composition of vegetation and soil seed bank. This species can compete with native plants for pollinators (Chittka and Schürkens 2001 – P). The impact of *I. glandulifera* on the number of pollinators, especially bumblebees (Starý and Tkalců 1998 – P) is not always positive. Observations conducted in the Wigry National Park showed that bumblebees squeezing through the narrow entrance to the flower of this species lose their hair on the trunk and the front part of the abdomen. As a result, they bring less pollen to the nest, they become less resistant to low temperatures, moisture and parasite attack (Krzysztofiak A. and Krzysztofiak M. 2015 – A). *I. glandulifera* is rarely a weed on cultivated fields (Śliwiński 2008, Kirpluk and Bomanowska 2015 – P), but this can change, if it begins to colonize drier and less fertile habitats – the possibility was shown experimentally by Skálová et al. (2013 – P). Weakening the yield of flowering crops is also possible at the same time as *I. glandulifera* together with plants adjoining this species. This is connected with impatiens pulling pollinators away from crops, as is the case with native plants (Chittka and Schürkens 2001 – 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 Polish territory is:

	low
	medium
X	high

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

acomm06. Comments:

Impatiens glandulifera is already settled in Poland, therefore the probability of its emergence as a result of independent expansion is high, with a high degree of certainty (see instruction of *Harmonia*$^{+PL}$ survey). *Impatiens glandulifera* was first found in the present territory of Poland in 1890 and has been constantly spreading since then (Zając A. and Zając M. 2001, Tokarska-Guzik 2005 – P). This plant is widespread in all neighboring countries of Poland (Parfenov 1999 – P, Helmisaari 2010, DAISIE 2018 – B), and can spontaneously migrate on the territory of our country, e.g. along river valleys – in river channels seeds can be transported through water on long distances without loss of germination capacity (Love et al. 2013 – P, Krzysztofiak A. and Krzysztofiak L. 2015 – A), or on animals with thick fur (e.g. beavers, raccoon dogs, boars), in which the seeds are temporarily trapped and transported to new locations (Krzysztofiak A. and Krzysztofiak L. 2015 – A).

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:

Impatiens glandulifera is already settled in Poland, therefore the probability of its occurrence due to unintended human activities is high, with a high degree of certainty (see instruction of *Harmonia*$^{+PL}$ survey). This plant is widespread in all countries neighboring with Poland and in the greater part of Europe (Parfenov 1999 – P, Helmisaari 2010, DAISIE 2018 – B) and can be unknowingly carried into the territory of our country, e.g. with the transport of crops from areas where the species appears in the fields, on vehicles, etc.

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:

Impatiens glandulifera is already settled in Poland, therefore, the probability of its occurrence as a result of intentional human activities is high, with a high degree of certainty (see instruction of *Harmonia*$^{+PL}$ survey). A species valued and actively spread by beekeepers (Hartmann et al 1995, Starý and Tkalců 1996 – P) and butterfly lovers (Helmisaari 2010 – B), cultivated as an ornamental plant, in some parts of the country, e.g. in the Białowieża Forest in the last several years it has gone out of fashion (Adamowski 1988-2017 – A), however there are still cases of seed exchange between owners of home gardens or allotments, despite placing the species in the Regulation of the Minister of Environment of 9 September 2011 on the list of non-native species of plants and animals, which in the case of release into the environment can threaten native species or natural habitats – P. A survey conducted in England (Rotherham 2005 – P) showed a huge scale of deliberate transfer of *I. glandulifera* and release into the environment, including importing and exporting it outside the country.

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 **a 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:

Impatiens glandulifera is already settled in Poland, therefore, climatic conditions are optimal for its occurrence, with a high degree of certainty (see instruction of *Harmonia*$^{+PL}$ survey). *Impatiens glandulifera* spreads in climates much more severe than the climate of Poland (southern Alaska, Carlson et al. 2008 – P, southern Siberia, Ebel et al. 2014 – P). In its secondary geographical distribution, *I. glandulifera* is not confirmed at high altitudes and is also spreading in warmer regions (northern Italy, Celesti-Grapow et al. 2010 – P,

northern Spain, Clavell and Izuzquiza 2015 – P). *Impatiens glandulifera* blooms over a longer period in Poland – i.e. from June to October (Puza and Krzysztofiak 2015 – P) than in its homeland, where it blooms from July to August (Nasir 1980 – P).

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:

Impatiens glandulifera is already settled in Poland, therefore, the habitat conditions are optimal for its occurrence, with a high degree of certainty (see instruction of *Harmonia*$^{+PL}$ survey). The species is naturally found in the western part of the Himalayas, where it is a component of high-mountain meadows, riverside communities, deciduous forests; it also occurs in anthropogenic habitats (roadsides, riverbeds, edges of farmlands, landfills; Nasir 1980 – P, Tanner 2011 – N). The altitude range covers areas between 1800 and 4000 m above sea level (Polunin and Stainton 1984 – P). In Poland, favourable habitat conditions prevail practically throughout the country, although in the mountains it does not spread beyond 800 m above sea level (Zając A. and Zając M. 2015a and b – P). In the Carpathians it occurs mainly in the Beskids and Pogórze, but its spread continues (Zając A. and Zając M. 2015a – P). Populations of the species appear on fertile and moist habitats, both anthropogenic (landfills, roadsides, less often cultivated fields), as well as semi-natural or natural (gravel banks, river banks with riparian tall herb fringe or reed communities, wet meadows, riparian forests (Dajdok 2009, Adamowski et al. 2014, Krzysztofiak A. and Krzysztofiak L. 2015 – P). Recently, the species appeared in the Sudetes in communities associated with bog-springs and meadow ground-water seepages (Dajdok 2017 – A). Results of experimental research indicate the possibility of the species spreading into more dry and less fertile habitats than before (Skálová et al. 2013 – P, Krzysztofiak 2015 a – A).

A3 | Spread

Questions from this module assess the risk of *the species* 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:

Dispersion from a single source (data type A): seeds are ejected as a result of rapid cracking of ripe fruit (the process called autochory) to a distance of up to 5 m (Beerling and Perrins 1993 – P). Fresh seeds of the *Impatiens glandulifera* become submerged and can be spread over long distances by material being dragged along the bottom of the watercourse, and over smaller distances by small mammals (Trewick and Wade 1986,

Beerling and Perrins 1993 – P, Krzysztofiak 2015a and b, Krzysztofiak A. and Krzysztofiak M. 2015 – A, Puza and Krzysztofiak 2015 – P). A small percentage of seeds survive the passage through the digestive tract of fish (Boedeltje et al 2015 – P). Trewick and Wade (1986 – P) pointed to the possibility of the distribution of the seeds of *I. glandulifera* by water birds. The rate of spread of the species in Great Britain has been estimated (data type C) at 3-5 km/year (Beerling and Perrins 1993 – P).

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:

Introducing *Impatiens glandulifera* to new positions has been legally banned (Regulation... 2011 – P). Due to its attractive and melliferous flowers (Hartmann et al. 1995 – P) it cannot be ruled out that this species is deliberately spread by humans. *Impatiens glandulifera* is still recommended as a melliferous plant in the literature and on websites dedicated to beekeeping (Lipiński 2010 – P, Beekeeping Portal 2018, Rejonowe... 2018, Pożytki... 2018 – I); it is also available in e-commerce in Poland (olx 2018 – I) and other European countries (ebay 2018 – I, Lenda et al. 2014 – P). The scale of conscious transfer of *I. glandulifera* by humans is probably not too different from that described by Rotherham (2005 – P) for Western Europe. Social awareness of threats resulting from the maintenance or spread of invasive species, including *I. glandulifera* and knowledge of the law in this area is small.

An important role in the spread of the species can also be played by the accidental transfer of seeds on vehicles, clothing and footwear, as well as with soil or material taken from the bottom of the watercourses during their regulation and deepening (Adamowski et al. 2014, Matthews et al. 2015 – P), and with soil during line investments – eg. road or sewage system construction (Krzysztofiak A. and Krzysztofiak L. 2015 – A). Other accidental introductions are very likely.

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:

Impatiens glandulifera is a green plant and is nourished autotrophically.

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

	low
	medium
X	high

aconf10. Answer provided with a

low	medium	high	level of confidence
		X	

acomm14. Comments:

Impatiens glandulifera is a tall annual herbaceous plant that is capable of effective competition even with native perennial species such as *Aegopodium podagraria* ground elder, *Calystegia sepium* hedge bindweed, *Urtica dioica* common nettle, *Stellaria nemorum* wood stitchwort and *Lamium maculatum* spotted dead-nettle (Tickner et al. 2001, Kowarik 2003 – P, Helmisaari 2010 – B). *Impatiens glandulifera* often creates single-species communities, and most seedlings appear almost simultaneously (Beerling and Perrins 1993, Krzysztofiak A. and Krzysztofiak L. 2015 – P), with the result that it may monopolize access to light. Furthermore, its rapid growth and shading by other plants, causes serious limitation of their ability to conduct photosynthesis, and hence also to reproduce (Helmisaari 2010 – B, Krzysztofiak A. and Krzysztofiak L. 2015 – P). However, long-term observations on permanent plots have shown significant fluctuations in its abundance, mainly related to fluctuations in water levels in the watercourse (Kasperek 2004 – P). Catastrophic floods are able to significantly reduce its number (Dajdok et al 2003 – P). This species can compete with native plants for pollinators (Prowse and Goodridge 2000, Chittka and Schürkens 2001 – P), and as a result can displace, for example, *Stachys palustris* marsh woundwort. Cawoy et al. (2012 – P) discovered more frequent visits of bumblebees to native plant species in the presence of *I. glandulifera*, and a reduced number of visits by honeybees.

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	level of confidence
		X	

acomm15. Comments:

There is no information in literature on outcrossing of *Impatiens glandulifera* with plant species native to Poland (Matthews et al. 2015 – P, see also point 21).

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

	very low
	low
	medium
X	high
	very high

aconf12. Answer provided with a

low	medium	high	level of confidence
	X		

acomm16. Comments:

In central Europe *Impatiens glandulifera* is the host of the *Aphis fabae* aphid, which also attacks the species *Impatiens noli-tangere* native to Poland (Stary et al. 2014 – P). Other sources (CABI 2016, Aphids 2018 – B) also mention *Impatientinum asiaticum, I. balsamines* and *I. impatiens* as aphids attacking both *I. glandulifera* and *I. noli-tangere*, however there is no information from which region of the world the observations come. In Germany, Schmitz (2007 – P) found a geometer moth *Xanthorhoe biriviata* on *I. glandulifera*, a moth feeding on *I. noli-tangere* in continental Europe (Hatcher 2003 – P). The fly *Phytoliriomyza melampyga* and the elephant hawk moth *Deilephila elpenor* were feeding on the leaves of both *Impatiens* (Hatcher 2003, Buszko 2015 – P). It is possible to further exchange monophagic herbivores between individual species of *Impatiens*. The fungus *Podosphaera balsaminae* associated with *I. glandulifera* in western Himalayas (Tanner 2011 – N), is known in Poland as an *I. noli-tangere* parasite (Kozłowska et al. 2015 – P). It is possible that the pathogens appearing on *I. glandulifera* have a wider spectrum of hosts, which in the case of its spread throughout Poland could contribute to the spread of these pathogens.

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	level of confidence
		X	

acomm17. Comments:

Ruckli et al. (2013 – P) showed the influence of *Impatiens glandulifera* on soil moisture and its temperature – on surfaces dominated by *I. glandulifera*, soil was more humid and colder, and Pattison et al. (2017 – P) confirmed the influence on the intensity of invasion of both *I. glandulifera*, and other alien species, associated with increased erosion of the vegetation margins and the dominance by non-native species of the places in which the previously eroded material accumulates. Greenwood and Kuhn (2014 – P) have already reported an increased erosion of the banks of watercourses under the influence of *I. glandulifera* invasion. Čuda et al. (2017 – P) did not find a clear impact of this plant on soil properties or litter. Among the possible effects of the *I. glandulifera* invasion Matthews et al. (2015 – P) mention changes in the vegetation structure adversely affecting insects requiring an open water table and the quality of the bottom as a spawning place for fish.

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	level of confidence
	X		

acomm18. Comments:

Opinions on the impact of *Impatiens glandulifera* on the integrity of ecosystem by interfering with its biotic factors are divided: Hulme and Bremner (2006 – P) and Tanner (2011 – N) observed a reduction in the number of species on surfaces covered by *Impatiens*, while Hejda and Pyšek (2006 – P) and Čuda et al. (2017 – P) did not notice such dependence. It seems, however, that evidence of the strong impact of *I. glandulifera* on living organisms prevails: Tanner (2011 – N) and Rusterholz et al. (2014 – P) observed differences in the abundance and composition of selected groups of invertebrate fauna, both above ground and within the soil, between plots occupied by *I. glandulifera* and those without this plant. Ruckli et al. (2013 – P) showed the impact of the *I. glandulifera* invasion on the composition and abundance of terrestrial molluscs. Substances released

into soil by roots or getting into it as a result of decomposition of *I. glandulifera* inhibit germination of other plant species (Ruckli et al. 2014b – P). In laboratory conditions *I. glandulifera* was the strongest of the three *Impatiens* species tested in this respect (*I. glandulifera*, *I. noli-tangere*, *I. parviflora*; Vrchotová 2011 – P). Most recently Ruckli et al. (2014a, 2016 – P) experimentally proved the negative impact of the presence of *I. glandulifera* in the forest community on the mycorrhiza of two native tree species: common beech *Fagus sylvatica* and sycamore *Acer pseudoplatanus*, and Gaggini et al. (2017 – P) confirmed the imact on the composition and functioning of soil bacteria and fungi. Rusterholz et al. (2017 – P) showed an increasing year by year impact of the presence of *I. glandulifera* on the composition of vegetation and on the soil seed bank. This species can compete with native plants for pollinators (Chittka and Schürkens 2001 – P), reducing their reproductive success, although the final result of this competition depends largely on the context (Cawoy et al. 2012 – P). The impact of *I. glandulifera* on the number of pollinators, especially bumblebees (Starý and Tkalců 1998 – P) is not always positive. Observations conducted in the Wigry National Park showed that bumblebees squeezing through the narrow entrance to the flower of this species lose the hair on their trunk and the front part of their abdomen. As a result, they bring less pollen to the nest and they become less resistant to low temperatures, moisture and parasite attack (Krzysztofiak A. and Krzysztofiak L. 2015 – A). It is worth emphasizing that the impact of the species concerns particularly the leading communities of natural habitats protected in EU countries. These are mainly hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (code 6430), and those of alpine rivers and the herbaceous vegetation along their banks (3220). In the case of forest habitats, the impact mainly affects willow, poplar, alder and ash forests (91E0). In Poland there were also instances of the appearance of *I. glandulifera* in the patches of unused meadows, including those classified as protected types of natural habitats, such as *Molinia* meadows (6410). Furthermore, the presence of *I. glandulifera* has been observed in other protected types of natural habitats, including: raised bogs with peat-forming plants (active) (7110), transition mires and quaking bogs (7140), calcareous fens (7210), mountain and lowland alkaline fens (7230), and bog woodlands (91D0). Based on the results of research and field observations published so far, it is difficult to state clearly how many changes to these habitats of particular concern are completely reversible. Due to its occupation of leading plant communities from the foregoing natural habitats, *I. glandulifera* constitutes a direct or indirect threat to the following protected and endangered plant species: *Viola epipsila* marsh violet – EN category, strict protection (SP); *Malaxis monophyllos* white adder's mouth – VU, SP; *Epipactis palustris* marsh helleborine – NT, SP; *Liparis loeselii* fen orchid – VU, SP and other marsh- orchids: *Dactylorhiza baltica* – VU, OS; *Dactylorhiza ruthei* orchid – EN, OS; *Dactylorhiza majalis* orchid – NT, SP. In addition, the species poses a direct threat to bumblebees (genus *Bombus*) covered by partial species protection, because its trap-like flowers weaken the condition of bumblebees (Krzysztofiak A. and Krzysztofiak L. 2015 – A).

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 plants 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:

Impatiens glandulifera is a green plant and is nourished autotrophically.

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

	inapplicable
	very low
	low
X	medium
	high
	very high

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

acomm20. Comments:

Literature presents a few instances of the occurence of *Impatiens glandulifera* as a weed in crops (Śliwiński 2008, Kirpluk and Bomanowska 2015 – P). Tanner (2011 – N) also found it in the western Himalayas on field edges within its natural range. The impact of this species as a weed may increase if it begins to occupy drier and less fertile habitats than previously – this possibility was demonstrated experimentally by Skálová et al. (2013 – P). It is also possible that *I. glandulifera* will weaken the yield of flowering crops growing close by. This is connected with *Impatiens* diverting pollinators from the crops, as is the case with native plants (Chittka and Schürkens 2001 – P).

a21. The effect of the *Species* on cultivated plants 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:

In the literature, only one reference was found concerning the possible outcrossing of *Impatiens glandulifera* with a related species, *Impatiens balfourii*, which is rarely grown in Poland (Ugoletti et al. 2013 – P).

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 literature presents a few instances of the occurence of *Impatiens glandulifera* as a weed in crops (Śliwiński 2008, Kirpluk and Bomanowska 2015 – P). The incidence of this species as a weed may increase if it begins to control drier and less fertile habitats than previously – this possibility was demonstrated experimentally by Skálová et al. (2013 – P). This possibility is confirmed by observations of *I. glandulifera* at the edge of fields within its natural range (Tanner 2011 – N).

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

	very low
	low
X	medium
	high
	very high

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

acomm23.	Comments: *Impatiens glandulifera* is cultivated as an ornamental and melliferous plant (Beerling and Perrins 1993, Hartmann et al 1995 – P). Attacks of fungi and insects can move between cultivated and spontaneous populations. In Great Britain a fungus *Puccinia komarowii var. glanduliferae* has been released to the environment as a potential control for *I. glandulifera* (Tanner et al. 2015 – P). Among all the ornamental plants grown in Poland, *Impatiens balsamina* is sensitive to this fungus. The nominal form of *P. komarowii* has been present in Poland since the 1930s (Majewski 1979 – P), and most recently it was found on *Impatiens parviflora* in the Wigry National Park (Pusz 2017 – N). *Impatiens glandulifera* is the host of *Aphis fabae* aphid, transmitting cucumber mosaic virus (Nehring et al. 2013 – P). However, this aphid attacks many species of plants, thus the spread of *Impatiens* will not have a significant impact on spreading this virus.

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: *Impatiens glandulifera* is a green plant and is nourished autotrophically.

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

X	very low
	low
	medium
	high
	very high

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

acomm25. Comments:

There is no information in the literature on properties of *Impatiens glandulifera* threatening the health of animals (Matthews et al. 2015 – P, Equines & Toxic Plants 2018, Guide to Poisonous Plants 2018 – I). This species can be grazed by herbivores without visible negative effects (Equines & Toxic Plants 2018, Guide to Poisonous Plants 2018 – I).

This information seems to be important due to the fact that in regions where *I. glandulifera* is frequent in river valleys, it can also appear in masse in boggy wastelands or in meadow communities (Dajdok and Bena 2009 – A) and poorly used agricultural areas, however without hindering grazing by animals (Krzysztofiak A. and Krzysztofiak L. 2015 – P). It should be added that grazing of animals is considered as one of the possible methods for its eradication (Dajdok 2009, Krzysztofiak A. and Krzysztofiak L. 2015 – P).

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:

Impatiens glandulifera does not carry pathogens and parasites harmful to animals (Matthews et al. 2015 – P).

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:

Impatiens glandulifera is a green plant and is nourished autotrophically.

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

	very low
X	low
	medium
	high
	very high

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

acomm28. Comments:

There is no information in the literature on properties of *Impatiens glandulifera* threatening the health of humans (Matthews et al. 2015 – P, AlergenOnline 2018, FDA Poisonous Plant Database 2018 – B). However it may cause respiratory allergies in a certain parts of society, because this plant produces large amounts of pollen, its pollen yield is 400 kg per hectare (Beekeeping Portal 2014 – I). The problem of health-threatening allergenic effect of *I. glandulifera* needs to be resolved by research in this area.

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:

Impatiens glandulifera does not carry pathogens and parasites harmful to humans (Matthews et al. 2015 – P).

A4e | Impact on other domains

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

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

	very low
	low
X	medium
	high
	very high

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

acomm30. Comments:

Tickner et al. (2001 – P) indicates a possibility of accelerated erosion of the banks of watercourses caused by the presence of *Impatiens glandulifera*. This phenomenon was confirmed by Greenwood and Kuhn (2014 – P) in their research. Accelerated erosion occurred mainly in the autumn and winter season, after the plant's death. Massive occurrence of *I. glandulifera* may lead to damage, and even the breaking of dykes and floodbanks, as well as the blocking of watercourses by biomass produced by *I. glandulifera* species, or an increased amount of mineral material dragged along the bottom.

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:

No direct data in the discussed area. The negative impact of *Impatiens* on the mycorrhiza of two native tree species has been demonstrated by Ruckli et al. (2014a, 2016 – P). It seems also possible that it could reduce the yield of seeds and fruit, due to the extraction of pollinators from crops, similarly as in the case of wild plants (Chittka and Schürkens 2001 – P). Occurrence of this species can be perceived as beneficial by owners of apiaries due to the melliferous properties of the plant – honey yield is as much as 700 kg of nectar and 400 kg of pollen per hectare (Hartmann et al. 1995 – P, Beekeeping Portal 2018 – I).

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:

No direct data in the discussed area. The presence of *Impatiens glandulifera* may affect changes in physical, chemical and biological properties of soil (see question a17). River banks, on which the species occurs are subject to erosion (see question a17), which may cause changes in the nature of the river bottom, important for spawning fish. In search of nectar, *I. glandulifera* plants are visited by many species of insects, which may reduce the chances of pollination of native plant species (see question a18). *Impatiens glandulifera* has a negative impact on the stability of ecosystems (see question a14 and a16).

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 **X**	high	level of confidence

acomm33.	Comments: No direct data in the discussed area. *Impatiens glandulifera* may limit access to river banks or tourist areas and thus impede recreation (DAISIE 2018 – B). Its value as an ornamental plant is diminished by its propensity for uncontrolled spreading (Tokarska-Guzik et al. 2012 – P). However, it should be noticed that some social groups, including owners of small backyard gardens, still perceive this species as a plant with great decorative qualities (see Rotherham 2005 – P).

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
X	increase moderately
	increase significantly

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

acomm34.	Comments: With anticipated changes in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P) *Impatiens glandulifera* will most likely not overcome any further barriers because it has found climatic and habitat conditions in Poland close to optimal (compare questions 09 and 10). However, the altitude range for this species may shift in mountain areas (Willis and Hulme 2002 – P). Transferring to less damp habitats (see Skálová et al. 2013 – P) – e.g. in forest communities from riverside forests to hornbeam-oak forest is also possible, with a concomitant reduction in the size of plants.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm35.	Comments: With anticipated changes in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P) *Impatiens glandulifera* will most likely not

	overcome any further barriers because it has found climatic and habitat conditions in Poland close to optimal (compare questions 09 and 10).

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: With anticipated changes in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P) *Impatiens glandulifera* will most likely not overcome any further barriers because it has found climatic and habitat conditions in Poland close to optimal (compare questions 09 and 10).

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: Expected changes in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P) are unlikely to affect the impact of *Impatiens glandulifera* on wild flora and fauna.

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 **X**	high	level of confidence

acomm38.	Comments: The impact of *Impatiens glandulifera* on plant production is unlikely to change due to the expected change in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P).

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:

Impatiens glandulifera has no visible impact on domestic animals, and the expected climate change will not affect the existing state of affairs (Matthews et al. 2015 – P, see also question 25).

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 X	high	level of confidence

acomm40. Comments:

Impatiens glandulifera has no significant impact on humans health, and the expected climate change will not affect the existing state of affairs (Matthews et al. 2015 – P, see also question 28).

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 X	high	level of confidence

acomm41. Comments:

The expected change in climate (Bartosz et al. 2012 – I, Anders et al. 2014 – P) and the hydrological regime (Stagl et al. 2014 – P) in Central Europe are complicated and do not allow the drawing of clear conclusions on this topic. Therefore, it has been established, as in case of other studies (Matthews et al. 2015 – P), that the impact of *Impatiens glandulifera* on other domains will not change due to climate change.

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)	0.75	0.80

Cultivated plants impact (questions: a19-a23)	0.30	0.70
Domesticated animals impact (questions: a24-a26)	0.00	1.00
Human impact (questions: a27-a29)	0.25	0.50
Other impact (questions: a30)	0.50	1.00
Invasion (questions: a06-a12)	0.96	1.00
Impact (questions: a13-a30)	0.75	0.80
Overall risk score	0.72	
Category of invasiveness	moderately invasive alien species	

A6 | Comments

This assessment is based on information available at the time of its completion. It has to be taken into account, however, 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 is regularly repeated.

acomm42. Comments:

The foregoing risk assessment considers that *Impatiens glandulifera* is a moderately invasive alien species due to high values of assessment in the module describing the impact on the natural environment (questions: a13-a18) – 0.75 and moderate – 0.5, in question a30 (impact on other domains). In other modules, the species obtained quite low ratings: impact on crops (questions: a19-a23) – 0.30, impact on human health (questions: a27-a29) – 0.25, impact on animal husbandry (questions: a24-a26) – 0.0.

In view of the fact that this species is established in Poland and has a great ability to spread, the score obtained for this assessment in the modules related to the invasion process (questions: a06-a12) is very high and amounts to 0.96.

The assessment was based on expert knowledge and available sources. Due to the invasiveness and strong impact on the natural environment, it is recommended to remove it on valuable natural areas (Tokarska-Guzik et al. 2015 – I). However, in remaining areas, due to the scale of the species spread, activities should focus on prevention and influencing the opinion of garden owners and apiaries through educational activities. Lack of any activity limiting the occurrence and/or eliminating the presence of this plant, may promote its further invasion and increase its abundance. The threat to native flora and vegetation should be an additional argument for considering the species as a priority and requiring eradication, at least when present on protected types of natural habitats.

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