



Appendix A

## Harmonia<sup>+PL</sup> – 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. Edyta Sierka
2. Maciej Gąbka – external expert
3. Alina Urbisz

acomment01.	Comments:	degree	affiliation	assessment date
	(1)	dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	28-01-2018
	(2)	dr hab.	independent expert	31-01-2018
	(3)	dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	28-01-2018

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

Polish name: Wywólcznik brazylijski

Latin name: ***Myriophyllum aquaticum*** (Vell.) Verdc.

English name: Parrot feather

acommm02.

Comments:

Currently used Latin name: *Myriophyllum aquaticum* (Vell.) Verdc.

Latin synonyms (The Plant List 2013 – B): *Enydria aquatica* Vell., *Myriophyllum brasiliense* Cambess., *Myriophyllum proserpinacoides* Gillies ex Hook. & Arn.

Polish name: wywłócznik brazylijski

English name: preferred Parrot's-feather; other: parrot feather, parrotfeather, Brazilian water milfoil, parrot feather watermilfoil, parrot's-feather (CABI 2017 – B).

Polish name (synonym I)

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Polish name (synonym II)

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Latin name (synonym I)

*Myriophyllum brasiliense*

Latin name (synonym II)

*Enydria aquatica*

English name (synonym I)

Parrot feather watermilfoil

English name (synonym II)

Brazilian watermilfoil

**a03. Area under assessment:**

**Poland**

acommm03.

Comments:

–

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

- |                                     |  |
|-------------------------------------|--|
| <input type="checkbox"/>            | native to Poland   |
| <input type="checkbox"/>            | alien, absent from Poland                                    |
| <input checked="" type="checkbox"/> | alien, present in Poland only in cultivation or captivity    |
| <input type="checkbox"/>            | alien, present in Poland in the environment, not established |
| <input type="checkbox"/>            | alien, present in Poland in the environment, established     |

aconf01.

Answer provided with a

low

medium

high

**X**

level of confidence

acommm04.

Comments:

Parrot's-feather is native to the tropical lowland areas of South America. The species has spread in subtropical and tropical regions across the world, and is also found in warmer regions of the temperate zone (e.g. Casper and Krausch 1981, Hussner and Champion 2012 – P). Parrot's-feather was introduced in Europe in 1880; currently it is found, among others, in Portugal, Spain, France, the Netherlands, Austria, Belgium, Germany and Great Britain (e.g. Gassmann et al. 2006, Hussner 2006, Sheppard et al. 2006 – P EPPO 2015 – B). In Portugal, Great Britain and the Netherlands, it is considered an invasive or potentially invasive species (EPPO 2015 – B). The closest sites of this plant are located in Germany in waters of altered temperature (Hussner and Lösch 2005 – P). According to the visualization of *Myriophyllum aquaticum* sites prepared by the National Biodiversity Data Centre (Millane and Caffrey 2014 - B) and our own observations (Gąbka 2018, Sierka 2018, – A), no sites of this species were identified in the natural environment of Poland. In Poland, the species is known only from botanical gardens. The plant has been grown in an isolated pond in the Botanical Garden of the University of Wrocław since the 1970s and covers an area of about 0.5m<sup>2</sup>. It used to be in the collection in the Botanical Garden in Bolestraszyce, but it died out (Botanical Garden employees...2018 – N). The species is grown in greenhouses and open tanks in some horticulture farms (nurseries). It is used in aquaristics as an ornamental plant and is widely available on the market. It is also marketed under a different name, as *Myriophyllum elatinooides* (Sidorkewicz et al. 2000 – I). This plant species does not survive winter in the Polish climate.

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

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

acom05.

Comments:

*Myriophyllum aquaticum* affects:

1. Environment, because of its impact on local populations of aquatic plants and animals (Hussner and Champion 2012 – P) including fish. Its abundant occurrence is associated with the production of a large amount of biomass. It successfully competes with other species of aquatic plants, including *Potamogeton xfluitans*, *Potamogeton crispus*, *Myriophyllum spicatum*, leading to their elimination and decrease in biodiversity (Millane and Caffrey 2014 – B), usually through shading (Moreira et al. 1999 – P). Parrot's-feather has a significant effect on the physico-chemical parameters of water: the abundant occurrence of this species is associated with decreased oxygen concentration in water and a decrease in water pH (e.g. Bernez et al. 2006 – P). *Myriophyllum aquaticum* has the capacity to lower total phosphorus (TP) (Luo et al. 2018 – P) and total nitrogen (TN) levels (Liu et al. 2016 – P) in natural water/wastewater. *Myriophyllum aquatica* is a host to '*Candidatus* Phytoplasma asteris', infesting aquatic and terrestrial plants (Mitrovic et al. 2011 – P).
2. The abundant occurrence of *Myriophyllum aquaticum* limits the suitability of water bodies for recreational and economic use, for example, it creates an obstacle to angling and fishing, and limits the use of other resources for economic purposes. It creates safe niches for the reproduction of mosquitoes, which are troublesome for people and animals (e.g. Hussner and Champion 2012 – P and literature cited there).
3. Because of abundant presence *Myriophyllum aquaticum* can clog drainage canals, contributing to floods (Acosta et al. 1999 – P), and creates problems in navigation, e.g. by disturbing the operation of boat engines (Hussner and Champion 2012 – P and literature cited there).

## A1 | Introduction

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

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

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

aconf02.

Answer provided with a

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

level of confidence

acom06.

Comments:

The probability of *Myriophyllum aquaticum* occurrence in the natural environment in Poland as a result of self-propelled expansion is very low. Plants in the Polish climate do not reproduce sexually, and there is no possibility of the seeds spreading with the assistance of animals or water (zoo- and hydrochory). The dominant way of reproduction of *Myriophyllum aquaticum* is mainly asexual (Hussner 2008 – N, Hussner and Champion 2012 – P), and it is generally the only method, ensuring the rapid spread of species in warm temperate regions. The dispersal of plant fragments from Germany is possible (North

Rhine-Westphalia, mainly sites with altered water temperature, e.g. Hussner and Lösch 2005 – P, Hussner 2008 – N), e.g. by migrating birds or with flood waters (but there is no direct connection via waterways). In Europe, sites of this species located at a 120 km distance from each other were reported, and plants there most likely grew from fragments of rhizomes. It should be emphasized, however, that the plants are not resistant to frost and die in winter (CABI 2017 – B). For this reason, in Polish horticulture farms, plants grown in the summer in open tanks are moved for the winter to tropical or cool greenhouses; in the Polish climate the survival of this plant has not been reported even in the mildest winters (Gąbka 2018 – A and interviews at horticulture farms). Nevertheless, the presence of *Myriophyllum aquaticum* has to be monitored in thermally polluted waters, e.g. power plant cooling systems (Gąbka 2018 – A).

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

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

aconf03.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acomm07. Comments:  
 The species is grown in aquariums and greenhouses, and has been introduced in garden ponds (open areas) as an ornamental plant (Moreira et al. 1999 – P). The plants or their fragments may escape to surface waters with water discharged from ponds or tanks. However, there are no data indicating that *Myriophyllum aquaticum*, which inadvertently got into the environment, can survive the winter period, although the species overwinters in Great Britain. However, the presence of this species in thermally polluted aquatic ecosystems, e.g. those connected with the cooling systems of power plants, or springs is possible (Gąbka 2018, Sierka 2018 – A), where it can be reached with animals, e.g. birds.

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

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

aconf04.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acomm08. Comments:  
 A survey carried out in January 2018 in Polish botanical gardens revealed that *Myriophyllum aquaticum* is currently in the collection of only one botanical garden (in Wrocław; it also used to be kept in the Botanical Garden in Bolestraszyce), and in one horticulture farm near Międzychód; the plant is offered for sale (Botanical Garden employees...2018 – N, Gąbka 2018 – A). The species is used in aquaristics as an ornamental plant and is widely available on the market, including in online shops.  
 So far, *Myriophyllum aquaticum* has not been found in the natural environment in Poland due to too low temperature of surface water. No information is available on the survival of winters by plants occasionally grown in open areas. In places where industrial heated water is discharged to water bodies, there is a chance for the species to survive in the environment, and its presence may be associated with intentional and/or unintentional introduction of plants of this species from garden ponds or aquariums (Gąbka 2018, Sierka 2018 – A).

## A2 | Establishment

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

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

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

aconf05.	Answer provided with a	low	medium	high	level of confidence
				<b>X</b>	

acomm09.	Comments:
	<i>Myriophyllum aquaticum</i> has a wide ecological amplitude. In its natural range the plant occurs mainly in subtropical and tropical regions. The physiological optimum for the growth of this plant is 27-37°C (Moreira et al. 1999, Hussner 2009 – P). According to the global map showing areas of climate similarity, prepared by modelling with an emphasis on Mahalanobis distances, climate conditions in Poland are different from those in areas of the natural occurrence of <i>Myriophyllum aquaticum</i> ; 0-45% of similarity with climate conditions in the distribution range for Parrot's-feather (CABI 2017 – B). And although in Great Britain this species can survive winters (Gillard et al. 2017 – P), it does not tolerate low winter temperatures in Central Europe. As the practice of Polish growers shows, plants have to be moved for the winter to rooms with a temperature of approx. 18°C, which is the threshold for dormancy. Potentially, the species may occur in thermally polluted aquatic ecosystems.

a10. Poland provides **habitat** that is

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

aconf06.	Answer provided with a	low	medium	high	level of confidence
				<b>X</b>	

acomm10.	Comments:
	The species grows in slow flowing streams, rivers, ponds and lakes. It grows in water bodies below the water line (submerged forms), as well as on their banks and in wet areas (emerged forms). The species has a wide ecological range in terms of habitat requirements: it usually grows in alkaline water rich in calcium (Hussner and Champion 2012 – P), with different concentrations of nutrients, from mesotrophic to strongly eutrophic (e.g. Hussner 2008 – N, Hussner and Champion 2012 – P). Because most water bodies in Poland are cool, plants of this species are unable to accumulate phosphorus in their rhizomes and show retarded growth (Luo et al. 2018 – P). The inability to accumulate phosphorus in overwintering rhizomes may limit the spread of this species in colder areas with oligotrophic water, but overwintering in eutrophic ponds is possible due to compensatory continued uptake of P in the next season (Sytsma and Anderson 1993 – P). However, in some areas of Poland, there are shallow water bodies, approx. 2 m in depth (Wersal et al. 2011 - P), where the temperature is higher and water is sometimes saline; these are optimal habitats for the establishment of <i>Myriophyllum aquaticum</i> . Water salinity is not a limiting factor for the occurrence of <i>Myriophyllum aquaticum</i> , because this species can survive in coastal water bodies which often get flooded by saline water (Wersal et al. 2011, Hussner and Champion 2012 – 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:

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

aconf07.	Answer provided with a	<table><tr><td>low</td><td>medium</td><td>high</td></tr><tr><td></td><td><b>X</b></td><td></td></tr></table>	low	medium	high		<b>X</b>		level of confidence
low	medium	high							
	<b>X</b>								

acomm11.	Comments: Assessment (data type C). <i>Myriophyllum aquaticum</i> can spread only through the transport of fragments of rhizomes by water birds, and due to floods (e.g. Hussner and Champion 2012 – P). Considering the relatively small number of sites with favourable habitat conditions for <i>M. aquaticum</i> (Les and Mehrhoff 1999 – P) throughout the country, the capacity of the species to disperse with no human assistance is low. In the temperate climate of Central Europe, Parrot's-feather does not reproduce sexually and is not resistant to winter frost. Because of these features it is unable to establish stable populations in Poland. However, disturbance in the environment, such as elevated temperature of water in man-made reservoirs, increases the chance of the species spreading across the country and gives grounds for assessing the capacity of this species to disperse as low.
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**a12.** The frequency of the dispersal of *the species* within Poland by **human actions** is:

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

aconf08.	Answer provided with a	<table><tr><td>low</td><td>medium</td><td>high</td></tr><tr><td></td><td><b>X</b></td><td></td></tr></table>	low	medium	high		<b>X</b>		level of confidence
low	medium	high							
	<b>X</b>								

acomm12.	Comments: Because of the asexual reproduction, it is possible in the case of intentional or unintentional (e.g. when cleaning aquariums) transfer of a plant fragment to warmer water bodies, and the species has a chance to occupy new areas. It can also be spread by watercraft. So far, no stable populations of this species have been identified in Poland (Global Invasive Species Database 2018 – B, Sierka 2018, Gąbka 2018 – A), but assuming that the species already occurs in the country, the probability of its accidental or intentional introduction is increasing. It can be expected that the individuals or propagules will disperse at a distance of over 50 km with the medium frequency, i.e. 1 to 10 recorded cases per decade.
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## 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/EEC 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/EEC 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:

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

aconf09.	Answer provided with a	low	medium	high	level of confidence
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acomm13. Comments:  
This is not a parasitic plant species.

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

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

aconf10.	Answer provided with a	low	medium	high	level of confidence
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acomm14. Comments:  
The species creates very strong competition and reduces the diversity of native aquatic plants. Its presence leads to the elimination of coexisting species, e.g. *Potamogeton natans*, by blocking access to oxygen and light (Moreira et al. 1999 – P). Extracts of *Myriophyllum aquaticum* tissues have an allelopathic effect on species from the *Lemna* genus (Elakovich and Woofen 1989 – P) and some cyanobacteria (Saito et al. 1989 – P). Assuming the occurrence of *Myriophyllum aquaticum* in Poland, which has not been reported, it would successfully compete with coexisting native species, including those of special conservation concern.

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

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

aconf11.	Answer provided with a	low	medium	high	level of confidence
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acomm15. Comments:  
No information was found in the literature suggesting that in areas where the species occurs as an invasive plant it created hybrids with native species (Moreira et al. 1999 – P); the species reproduces asexually in most area of its secondary distribution range (CABI 2017 – B).

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

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

aconf12.	Answer provided with a	low	medium <b>X</b>	high	level of confidence
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a16.16. Comments:  
*Myriophyllum aquaticum* is a host to fungus *Pythium carolinianum* (CABI 2017 – P), bacterium *Xanthomonas campestris* (CABI 2017 – B) and pathogen ‘*Candidatus Phytoplasma asteris*’ (Hussner and Champion 2012 – P, CABI 2017 – B). Cases of pathogen transmission from invasive to native species have not been reported (Moreira et al. 1999 – P). Hosting pathogens common for representatives of the genus cannot be ruled out, so the impact of the species is low. In addition, most plants sold for aquarium culture that could escape into the natural environment are propagated in vitro (Gąbka, an interview with an aquatic plant grower). Hence, the potentially lower risk of pathogen transmission. The pathogens listed above create a hazard mainly to cultivated plants (cf. Q a23). *Xanthomonas campestris* causes bacterial diseases in many plant species, primarily from the family *Brassicaceae*, and some grass species (Hauben et al. 1997, Browning et al. 2002 – P).

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

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

aconf13.	Answer provided with a	low	medium <b>X</b>	high	level of confidence
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a17.17. Comments:  
 There are no significant disturbances of abiotic properties of water bodies in the areas of *Myriophyllum aquaticum* occurrence. Studies revealed that *Myriophyllum aquaticum* changes the chemical composition of water because it assimilates significant amounts of nitrogen and phosphorus from water (Millane and Caffrey 2014 – B); the abundant occurrence of the species can also reduce water pH and concentration of dissolved oxygen (Bernez et al. 2006, Hussner and Champion 2012 – B). Depending on the amount of *Myriophyllum aquaticum* biomass, the integrity of the ecosystem may be disturbed (Hussner and Champion 2012 – P), but this mainly concerns habitats that are not of special conservation concern, so the changes will be easily reversible.

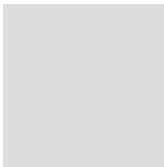
a18. The effect of *the species* on ecosystem integrity, by **affecting its biotic properties** is:

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

aconf14.	Answer provided with a	low	medium <b>X</b>	high	level of confidence
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a18.18. Comments:  
*Myriophyllum aquaticum* competing for resources (nutrients and light) limits/eliminates other plant species, e.g. *Potamogeton* spp., *Myriophyllum* spp. (Moreira et al. 1999 – P). *Myriophyllum aquaticum* growing abundantly forms floating mats that cover the water surface (Xie et al. 2013 – P), disturbs the function of aquatic ecosystems, and causes loss in their integrity (through the change in the dominance structure of submerged plant species,





as well as related organisms from other taxonomic groups). Dense patches of *Myriophyllum aquaticum* reduce the concentration of oxygen dissolved in water, which can be harmful to fish (Fonseca 1984 – P). As a result, in the worst case scenario, the species causes hard to reverse changes in habitats that are not of special conservation concern, or easily reversible changes in habitats of special concern.

## A4b | Impact on the cultivated plants domain

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

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

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

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

aconf15.	Answer provided with a	low	medium	high X	level of confidence
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acomm19.	Comments: <i>Myriophyllum aquaticum</i> is a plant that does not have the characteristics of a parasite and is an autotrophic organism.
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**a20.** The effect of *the species* on cultivated plant targets through **competition** is:

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

aconf16.	Answer provided with a	low	medium X	high	level of confidence
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acomm20.	Comments: Because of the occupied aquatic habitats, mainly reservoirs, <i>Myriophyllum aquaticum</i> will not compete for resources with cultivated plants. In Poland, there are no open aquatic plant cultivations which could be affected by the species, so it has no direct impact on crops through interspecies competition.
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**a21.** The effect of *the species* on cultivated plant targets through **interbreeding** with related species, including the plants themselves is:

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

aconf17. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm21. Comments:  
The species has no effect on cultivated plant targets through interbreeding with related species, including cultivated plants, because the species mainly reproduces asexually and occupies different types of habitats than cultivated species.

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

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

aconf18. Answer provided with a 

low	medium	high <b>X</b>
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 level of confidence

acomm22. Comments:  
*Myriophyllum aquaticum* occurs in habitats that have no direct contact with cultivated plants. Therefore, it does not affect individual plants and the cultivation system’s integrity. So far, reports indicate that *Myriophyllum aquaticum* is a weed in rice fields in Indonesia and Cambodia (CABI 2017 – B). In South Africa farmers noticed red discolourations on tobacco plants (reducing the crop value) when they were irrigated with water from an area colonized by *Myriophyllum aquaticum* (Cilliers 1999 – P).

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

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

aconf19. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm23. Comments:  
*Myriophyllum aquaticum* is a host to fungus *Pythium carolinianum* (CABI 2017 – P), bacterium *Xanthomonas campestris* (CABI 2017 – B) and pathogen ‘*Candidatus Phytoplasma asteris*’ (Hussner and Champion 2012 – P, CABI 2017 – B). Many species of the *Pythium* genus pose a threat to economically important crops. *Pythium carolinianum* was identified as a pathogen causing root rot of cotton, *Gossypium hirsutum*, in Egypt (Abdelzaher and Elnagh 1998 – P). Bacteria from the genus *Xanthomonas*, pathogenic to plants, cause serious losses worldwide, posing a threat to over 350 species of crops, including banana, tomato, pepper, sugar cane and many cereals (Jacobs et al. 2015 – P). *Xanthomonas campestris* causes bacterial diseases in many plant species, primarily from the family Brassicaceae, and some grass species (Hauben et al. 1997, Browning et al. 2002 – P). At least some of the listed plant species are cultivated in Poland.

## 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:

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

aconf20.	Answer provided with a	low	medium	high	level of confidence
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acomm24. Comments:  
*Myriophyllum aquaticum* is a plant, so no effect on animal health through predation/ parasitism has been observed.

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

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

aconf21.	Answer provided with a	low	medium	high	level of confidence
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acomm25. Comments:  
*Myriophyllum aquaticum* has no negative effect on individual animal health or animal production by having properties that are hazardous upon direct contact. It may, however, affect farmed fish because the growing biomass of *M. aquaticum* can cause mechanical limitation of living space and elimination of native species that are the food base for fish. The presence of *M. aquaticum* can also change the physical and chemical properties of water, which can reduce the productivity of fish farming.

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

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

aconf22.	Answer provided with a	low	medium	high	level of confidence
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acomm26. Comments:  
 There are no known pathogens/parasites shared by the species under assessment, production animals and companion animals.

## A4d | Impact on the human domain

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

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

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

aconf23. Answer provided with a 

low	medium	high
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 level of confidence

acomm27. Comments:  
Parrot's-feather is a plant and does not parasitize on humans.

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

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

aconf24. Answer provided with a 

low	medium	high <b>X</b>
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 level of confidence

acomm28. Comments:  
*Myriophyllum aquaticum* has no negative effect on human health by having properties that are hazardous upon direct contact.

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

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

aconf25. Answer provided with a 

low	medium	high
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 level of confidence

acomm29. Comments:  
There are no known pathogens/parasites shared by the species under assessment and humans.

## A4e | Impact on other domains

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

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

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

aconf26. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acom30. Comments:  
Abundantly growing biomass of *Myriophyllum aquaticum* can clog hydraulic engineering structures and drive mechanisms in boats (Moreira et al. 1999, Hussner and Champion 2012 – 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
- moderately negative
- neutral
- moderately positive
- significantly positive

aconf27. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acom31. Comments:  
If we assume that ecosystem services are benefits provided by the ecosystem to the society and economy (Fisher et al. 2009 – P) *Myriophyllum aquaticum* has no significantly negative effect and is not of major economic importance. At the same time, it disturbs the functioning of aquatic ecosystems, and due to the production of large biomass deteriorates the quality of water and causes problems, for example, with the operation of hydropower plants. Whereas although it is becoming more and more popular (experimental studies) in the remediation of soils and waters polluted with chlorinated solvents, trinitrotoluene (TNT) and other explosive/aromatic nitride compounds (Medina et al. 2000, Nwoko 2010 – P).

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

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

aconf28. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acom32. Comments:  
Biomass of *Myriophyllum aquaticum* can disturb ecosystem function and lead, for example, to floods, problems in water transport, etc. (Hussner and Champion 2012 – P).

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

- significantly negative
- moderately negative
- neutral

- moderately positive
- significantly positive

aconf29. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm33. Comments:  
The species has no direct and clear effect on cultural services. However, the excess biomass formed by this species leads to changes in the ecosystem, and also disturbs their perception by humans, reducing the aesthetic value of waters (Bossard et al. 2000 – P).

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

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

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

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

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

aconf30. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm34. Comments:  
Climate warming will make thermal conditions in water more favourable to the assessed species. The optimal temperature for the growth of *Myriophyllum aquaticum* is 16-23°C (Ferreira and Moreira 1999 – P). The expected rise in temperature by 1-2°C will increase the probability for the species to overcome barriers to its cultivation in Poland.

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

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

aconf31. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm35. Comments:  
Climate change, e.g. an increase in temperature, can promote the formation of stable populations of *Myriophyllum aquaticum*, e.g. in reservoirs. At the same time it will not affect the reproduction of the species, due to the fact that it reproduces only asexually through fragments of rhizomes (Ferreira and Moreira 1999 – P).

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

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

aconf32. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm36. Comments:  
Climate change can lead to an increase in the temperature of water bodies and contribute to the formation of stable populations of *Myriophyllum aquaticum*, which will not only overwinter, but will be able to further spread and colonize subsequent water bodies.

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

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

aconf33. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm37. Comments:  
Under conditions of climate change the impact of *Myriophyllum aquaticum* will probably increase moderately, mainly with respect to aquatic-marshy habitats and aquatic ecosystems. Increased temperature and higher concentration of CO<sub>2</sub> in the air will increase the intensity of photosynthesis (Hussner 2009 – P), and species such as *Myriophyllum aquaticum* will have a chance to dominate aquatic ecosystems. The quality of water may deteriorate indirectly, e.g. because of the increased content of suspended organic matter (Moreira et al. 1999 – P).

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

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

aconf34. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acomm38. Comments:  
No direct impact on cultivated plants has been reported. Indirectly, *Myriophyllum aquaticum* causes damage to rice and tobacco crops when water from reservoirs colonized by this plant is used for irrigation (Cilliers 1999 – P). Climate change will not change the impact of the assessed species on cultivated plants and plant production in Poland.

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

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

aconf35. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acommm39. Comments:  
Due to climate change, the species, when dominant in aquatic ecosystems, e. g., may cause problems with access to water resources, although this is very unlikely (Moreira et al. 1999), and have a limiting effect on fish farming, particularly on native fish species.

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

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

aconf36. Answer provided with a 

low	medium <b>X</b>	high
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 level of confidence

acommm40. Comments:  
No direct impact of *Myriophyllum aquaticum* on the human domain has been reported, and climate change is not expected to change this. As with the indirect impact, it is possible that the intensive growth of biomass of the species can cause changes in the quality of water in water bodies, and fish farming.

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

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

aconf37. Answer provided with a 

low	medium <b>X</b>	high
-----	--------------------	------

 level of confidence

acommm41. Comments:  
The potential invasive success of the species when the temperature rises may cause additional nuisance to humans when using water bodies. The abundant growth of the species has a negative effect on recreation, the maintenance and use of water facilities, etc. (e.g. Moreira et al. 1999, Kelly and Maguire 2009 - P). It is possible that the intensive growth of biomass of the species will create costs associated with its removal.



## Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.33	0.50
Establishment (questions: a09-a10)	0.50	1.00
Spread (questions: a11-a12)	0.38	0.50
Environmental impact (questions: a13-a18)	0.35	0.60
Cultivated plants impact (questions: a19-a23)	0.15	0.70
Domesticated animals impact (questions: a24-a26)	0.25	0.50
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.50	1.00
Invasion (questions: a06-a12)	0.40	0.67
Impact (questions: a13-a30)	0.35	0.66
Overall risk score	0.14	
Category of invasiveness	potentially invasive alien species	

## A6 | Comments

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

acom42.

Comments:

*Myriophyllum aquaticum* should be classified as a species with low invasiveness in Poland. Although the species has been grown for several decades in greenhouses in botanical gardens (now only in the Botanical Garden in Wrocław) and in one horticulture farm (Gorzycko Stare k. Międzychodu) and is imported for commercial purposes (sale for use in aquatic gardens and aquariums), there is no information on its overwintering or finds in the natural environment. The species does not withstand low temperatures; the growth of plants stops at temperatures below 8°C, and plants exposed to frost die. The risk of forming stable populations in Poland is low and exists only in thermally altered (heated) waters, e.g. those connected with power plant cooling systems. These ecosystems should be under continuous monitoring. The results of assessment in modules related to the invasion process indicate that the risk of introduction (questions: a06-a08 - 0.33), establishment (questions: a09-a10 - 0.50) and spread (questions a11-a12 – 0.38) of *Myriophyllum aquaticum* in Poland is relatively low. All the assessed aspects should be considered when making decisions on the management of this species.

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