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. Maciej Gąbka – external expert
2. Edyta Sierka
3. Alina Urbisz

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	independent expert	30-01-2018
(2)	dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	01-02-2018
(3)	dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	04-02-2018

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

Polish name: Wywłócznik różnolistny

Latin name: ***Myriophyllum heterophyllum*** Michx.

English name: Broadleaf water-milfoil

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: Latin name: *Myriophyllum heterophyllum* Michx. No synonyms of Latin name (The Plant List 2013 – B). Polish name: wywłócznik różnolistny English name: broadleaf watermilfoil (others: American water-milfoil, variable watermilfoil, variable-leaf water milfoil, two-leaf water milfoil, broadleaf water milfoil).

Polish name (synonym I) –	Polish name (synonym II) –
Latin name (synonym I) –	Latin name (synonym II) –
English name (synonym I) Broadleaf watermilfoil	English name (synonym II) American water–milfoil

a03. **Area** under assessment:

Poland

acomm03.	Comments: –

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

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

aconf01.	Answer provided with a	low	medium	high **X**	level of confidence

acomm04.	Comments: The species originating from North America (Canada, the USA, Mexico), reported mainly in the eastern part of the United States. However, it is considered invasive for New England (Thum et al. 2010 – P, invasive.org – B). Broadleaf watermilfoil was brought to, among others, China and Central America and Europe (EPPO 2016 – B). Most likely, it reached Europe in the second half of the 20th century. First reports about its appearance in Europe come from Great Britain and Germany from the 60s of the past century (Stricker 1962 – P,,BSBI 2012 –B). Reports about the first record in other European countries come from e.g. Belgium from 1993 (Bouxin and Lambinon 1996 – P), the Netherlands from 2009 (van Valkenburg et al. 2011 – P) and France from 2011 (Lebreton 2013 – P). This species is also known in Austria, Hungary, Spain, Croatia and Switzerland (EPPO 2016, CABI 2018 – B). In Europe, broadleaf watermilfoil is cultivated mainly in aquariums. In Poland, the species is only known from sporadic cultivations in household gardens and as an aquarium plant. Currently, there is no information on the occurrence of the species in the natural environment (in domestic sites) except for cultivation (Gąbka 2018 unpublished data – A).

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

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

acomm05. Comments:

It is a clonal plant, with huge possibilities of reproduction of vegetative progeny and creation of large-scale clusters overgrowing the water level. Through extensive development, it can affect local populations of aquatic plants and animals (Carpenter and Lodge 1986 – P, EPPO 2016 – B). The effect of dense mats of *Myriophyllum heterophyllum* on e.g. reduction of light for other aquatic plants, deterioration of aerobic conditions has been reported, which results in the fact that fish and invertebrates avoid sites of the occurrence of this species (EPPO 2016 – B). In the study of Matthews et al. (2013 – P), the effect of dense concentrations of this species on the decrease in turbidity and increased sedimentation rate in the Oranje canal (the Netherlands), which resulted in the coverage of the fish spawning ground with organic sediments, was demonstrated. The presence of this species in rivers and lakes worsens their ecological status, a hazard to the native rare and endangered species of plants and protected areas is also addressed (EPPO 2016 – B).

Myriophyllum heterophyllum may reduce aesthetic value of water reservoirs. In the case of extensive development, it may create difficulties in the recreational and commercial use of reservoirs, leads to pipe clogging, impaired operation of boat engines, hinders recreational and commercial fishing (EPPO 2016 – B).

In the territory of Poland, the effect of the species on the natural environment is minimal and is limited only to water reservoirs, in which it is cultivated; there, the effect of the species may be very strong, especially if its growth will not be under control. There are no reliable reports of the species's impact on human health.

A1 | Introduction

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

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

	low
X	medium
	high

aconf02. Answer provided with a

low	medium	high
		X

level of confidence

acomm06. Comments:

The probability for the species to expand into Poland's natural environments, as a result of self-propelled expansion (spontaneously) is medium. Under the conditions of European climate, this species does not form seeds (EPPO 2016 – B). The dominant method of reproduction – is vegetative reproduction (Hussner and Krause 2007 – P, EPPO 2016 – B), which ensures fast occupation of the space. Strong characteristics of clonal multiplication and the ability to regenerate new plants, even from 1 cm fragments, which contain at least one node has been demonstrated (EPPO 2016 – B). Moreover, it should be emphasized that the plants survive winter period under European conditions and are resistant to frost, therefore at the moment of self-propelled expansion e.g. by birds of plant fragments, there is a potential possibility for creation of perennial (long-term) populations also in Poland.

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

	low
X	medium
	high

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

acomm07. Comments:

The species is present under aquarium and greenhouse cultivation, it has been introduced to household waterholes (open areas) (EPPO 2016 – B). *Myriophyllum heterophyllum* is found in trade as an ornamental plant, but most often it is sold under other names. In the Netherlands, it was demonstrated (van Valkenburg and Boer 2014 – P) that this species was present in trade under mistaken or incorrect names, i.e. *M. hippuroides* Torr. & Gray, *M. propinquum* Cunn. and *M. scabratum* Michx. In Belgium, the Netherlands, Germany and Great Britain legal restrictions concerning the trade of this species have been imposed, however legal restrictions do not have to constitute an effective protection against invasion (EPPO 2016 – B).

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

	low
X	medium
	high

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

acomm08. Comments:

It Poland, this species is present in trade (however often not under its proper name, vide van Valkenburg and Boer 2014 – P, Gąbka 2018 unpublished data – A) and is used as an aquarium plant or cultivated in household reservoirs. It has not been recorded in botanical gardens. In Europe, the main way of introduction of broadleaf watermilfoil is the trade of aquarium and ornamental species for waterholes. It is the most effective way of expansion of this species into territories, where it has not yet been established. The intentional introduction of *Myriophyllum heterophyllum* to surface water is unlikely (Gwiazdowicz 2014 – N). The release of plants due to the release of water from reservoirs with fragments of the plant into waters can also take place in Poland.

A2 | Establishment

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

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

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

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

acomm09. Comments:

Myriophyllum heterophyllum is highly adaptable to a wide range of environmental conditions, it prefers a temperate, warm or continental climate. According to literature data (e.g. Hussner and Krause 2007, Brunel et al. 2010, Hussner and Jahns 2015 – P, EPPO 2016 – B), this watermilfoil tolerates high temperatures in summer, as well as frosty winters (it also hibernates under the conditions of ice cover) The optimal temperature for the growth of *M. heterophyllum* is approximately 20°C (Hussner and Jahns 2015 – P). Based on the literature review, it can be concluded that climatic conditions prevailing in Poland vary from moderately

favourable to optimal for broadleaf watermilfoil (Gąbka 2018 unpublished data – A). According to the map of Poland's climatic similarity in relation to the whole world, developed by a method of modelling with the use of Mahalanobis distance, climatic conditions in Poland in 45-94% correspond to the conditions prevailing in the area of natural occurrence of broadleaf watermilfoil (CABI 2018 – B). Therefore, they can be considered as at least moderately favourable (no data on the occurrence of the species in Poland), however, taking into account information on the conditions of the occurrence of broadleaf watermilfoil from the area of Germany (e.g. Hussner 2008 – N, Hussner and Jahns 2015 – P) – optimal for the establishment of the species.

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:

Myriophyllum heterophyllum occurs mainly in slowly flowing rivers, canals, lakes, ponds and wetlands (e.g. Hussner et al. 2005, De Beer and De Vlaeminck 2008 – P, Hussner 2008 – N, CABI 2018 – B). It mainly inhabits shallow reservoirs, although in Germany it was found at a depth of 9.5 m (Hussner et al. 2005 – P). Hussner (2008 – N), also indicates the occurrence of emerged (immersed) forms of this species on the exposed banks of rivers and water reservoirs. Broadleaf watermilfoil is characterized by a wide tolerance in relation to habitat conditions; it occurs in water usually rich in calcium, with high electrolytic conductivity, but with different content of nutrients, from mesotrophic to highly eutrophicated (e.g. Gerber I Les 1996, Hussner et al. 2005 – P, Hussner 2008 – N, Thum and Lennon 2010 – P, EPPO 2016, CABI 2018 – B). In numerous studies from the area of the USA, a significant role of high water pH, high alkalinity and high electrolytic conductivity as factors determining the occurrence and expansion of this species or its regional genetic lines, is emphasized (Gerber and Les 1996,; Thum and Lennon 2010 – P). Detailed studies of the environmental requirements of *M. heterophyllum* conducted in the area of Germany, indicate, among others, that plants grow best under conditions of high availability of carbon dioxide (relative to a bicarbonate form) and this species tolerates low light availability (Hussner 2008 – N, Hussner and Jahns 2015 – P). According to the information contained in the *M. heterophyllum* file from the EPPO website (2016 – B), it should be assumed that this species may become invasive throughout Europe, especially in shallow reservoirs, lakes and canals, finding there optimal conditions for establishment.

A3 | Spread

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

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

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

	very low
	low
X	medium
	high
	very high

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

acomm11. Comments:

Estimation (type C data):
This species reproduces vegetatively through fragmentation (Hussner 2008 – N); High ability to regenerate, event from plant fragments <1 cm, which contain at least one node, has been demonstrated (EPPO 2016 – B). Propagules disperse passively with the water current, while in this form of expansion, the factor conditioning or limiting its spread, is the hydrological connectivity/isolation of ecosystems. Therefore, flowing waters are usually more exposed to a spontaneous expansion than lakes, especially those more isolated, located in a periphery of the outflow region. A factor, which can also spread this species in river valleys are floods. Active vectors for the spread of this species are also animals related to the aquatic environment, mainly birds (e.g. EPPO 2012, 2016 – B).

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

X	low
	medium
	high

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

acomm12. Comments:

In Poland, the occurrence of *Myriophyllum heterophyllum* in natural conditions has not been reported to date, the presence of this species in the country should not be excluded because of e.g. identification problems (high similarity to the native species *M. verticillatum*). The species is cultivated in horticultural farms (nurseries) for commercial purposes and sometimes is imported from subtropical regions by commercial companies (Gąbka 2018 unpublished data – A). Based on the official information, the occurrence of this species in botanical gardens in Poland has not been confirmed (Botanical Gardens employees ...2018 – N). Human contribution in the expansion of this species may be of unintentional and accidental nature, e.g. related to transport of the species for commercial purposes, as well as potentially it can be a result of transport of plant fragments by vessels; maintenance works in ports, conservation works in navigation canals and other watercourses. There is no information from Poland concerning the possibilities of expansion of this species from breeding and cultivations (analysis of data related to aquarium plant trade).

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:

Myriophyllum heterophyllum is a plant species and does not show such interactions.

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

	low
	medium
X	high

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

acomm14. Comments:

The species has strong competitive characteristics and affects a reduction in diversity of native aquatic plants, including protected species and habitats (EPPO 2016 – B). Assuming the occurrence of *Myriophyllum heterophyllum* in the area of Poland, which has not been reported, it can be supposed that it would be a species effectively competing with coexisting native species.

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

X	no / very low
	low
	medium
	high
	very high

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

acomm15. Comments:

Myriophyllum heterophyllum has the ability to hybridise with other species of the genus *Myriophyllum*, e.g. *M. pinnatum*. Hybridization of *M. heterophyllum* x *pinnatum* was confirmed in the area of the USA, based on DNA analysis. This hybrid is considered to be a potentially more aggressive invasive plant than the parent species (Thum and Lennon 2006, Tavalire et al. 2012, Hussner and Jahns 2015 – P). In the area of Poland, *Myriophyllum pinnatum* does not occur in the natural environment. It has not been demonstrated on an European scale, where the species occurs as an invasive plant so that it can form hybrids with native species of watermilfoils.

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

X	very low
	low
	medium
	high
	very high

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

acomm16. Comments:

Broadleaf water-milfoil hosts pathogens that do not pose a threat to human health. The sources of information are few and at a high level of generality.

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

	low
X	medium
	high

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

acomm17. Comments:

In places of expansion broadleaf water-milfoil forms compact and dense monoculture communities having a large biomass (up to 4 kg of mass per m^2 (Hussner 2008 – N, EPPO 2016 – B). In Europe and the USA, a significant effect of such dense concentrations on physico-chemical conditions of water was demonstrated, they, among others, reduce light, lower the oxygen content or affect water pH (increase in water pH up to 10.7). These changes are reflected by the reduction in the occurrence or development of invertebrates and fish (e.g. Carpenter and Lodge 1986 – P).

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

	low
	medium
X	high

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

acomm18. Comments:

The effect on the disturbance of biotic factors of the species is potentially large, if it establishes in the territory of Poland (there is no information on the occurrence of the species to date). The effect of dense mats of *Myriophyllum heterophyllum* on e.g. reduction of light for other aquatic plants, deterioration of aerobic conditions has been reported, which results in the fact that fish and invertebrates avoid sites of the occurrence of this species (EPPO 2016 – B). In the study of Matthews et al. (2013 – P), the effect of dense concentrations of this species on the decrease in turbidity, increased sedimentation rate in the Oranje canal (the Netherlands), which resulted in the coverage of the fish spawning ground with organic sediments, was demonstrated. The presence of this species in rivers and lakes worsens their ecological status, a hazard to the native rare and endangered species of plants and protected areas is also addressed (EPPO 2016 – B).

A4b | Impact on the cultivated plants domain

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

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

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

	inapplicable
X	very low
	low
	medium
	high
	very high

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

acomm19. Comments:

A species of aquatic, non-parasitic plant.

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

- [ ] inapplicable
- [**X**] very low
- [ ] low
- [ ] medium
- [ ] high
- [ ] very high

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

acomm20. Comments:

Gatunek zasiedla zbiorniki wodne – brak interakcji z uprawami roślin.

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

- [ ] inapplicable
- [**X**] no / very low
- [ ] low
- [ ] medium
- [ ] high
- [ ] very high

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

acomm21. Comments:

Myriophyllum heterophyllum does not show a tendency to interbreed with related species cultivated in Poland due to e.g. the habitat barrier.

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

- [**X**] very low
- [ ] low
- [ ] medium
- [ ] high
- [ ] very high

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

acomm22. Comments:

Myriophyllum heterophyllum, due to the specificity of the habitat in which it occurs, has little chance for a direct contact with plants cultivated in Poland. Therefore, without effect on individual specimens, it does not affect the cultivation system's integrity.

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

- [**X**] very low
- [ ] low
- [ ] medium

	high
	very high

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

acomm23.	Comments: Information sources indicate that pathogens and parasites associated with *Myriophyllum heterophyllum* are not harmful to other plants or animals, hence it can be assumed with a medium level of confidence that they do not threaten the cultivated plants.

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: A species of aquatic plant.

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 **X**	high	level of confidence

acomm25.	Comments: The species does not have properties that are hazardous to animals upon a direct contact.

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:

Plants are not hosts or vectors of animal pathogens/parasites.

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:

A species of non-parasitic plant.

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

- [X] very low
- [ ] low
- [ ] medium
- [ ] high
- [ ] very high

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

acomm28. Comments:

Myriophyllum heterophyllum is an aquatic plant, with no properties that are hazardous to humans upon a direct contact.

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:

Plants are not hosts or vectors of human pathogens/parasites.

A4e | Impact on other domains

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

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

	very low
X	low
	medium
	high
	very high

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

acomm30. Comments:

Myriophyllum heterophyllum in the case of extensive development, may create difficulties in the recreational and commercial use of reservoirs, leads to pipe clogging, impaired operation of boat engines, hinders recreational and commercial fishing (EPPO 2016 – B).

A5a | Impact on ecosystem services

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

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm31. Comments:

Based on the biology of the species and its habitat requirements, it results that it remains neutral – has no effect on provisioning services, such as provision of food, materials and energy (Gąbka 2018 unpublished data – A).

Theoretically, only the extensive development of *Myriophyllum heterophyllum*, e.g. in dam reservoirs etc. may hinder water intake for supplying humans with water for consumption and other needs and negatively affect other infrastructure related to water intake (EPPO 2016, CABI 2018 – P). Suggested effect assessment – because of its rare occurrence, the species has no major effect, or this effect will be moderately negative.

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm32. Comments:

The development of the species in water may contribute to the deterioration of the ecological status of water as a result of the intensification of eutrophication processes in the case of extensive death of populations, observed e.g. in Germany (Hussner 2008 – N). This results in changes in the chemical composition of water and physical properties of water.

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:

The effect of broadleaf water-milfoil, through the biomass produced, on water quality may lead to a deterioration of conditions for recreation.

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

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

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

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

- [ ] decrease significantly
- [ ] decrease moderately
- [X] not change
- [ ] increase moderately
- [ ] increase significantly

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

acomm34. Comments:

Current climatic conditions in Poland are similar to those prevailing in the region of origin of the species (North America) and optimal for its development (vide Brunel et al. 2010, Hussner and Jahns 2015 – P). *Myriophyllum heterophyllum* can tolerate high temperatures in summer, as well as frosty winters (including ice cover) (EPPO 2016 – B). Currently, there are no geographical barriers related to climatic conditions, however there are no reports on the occurrence of this species in Poland (authors' own observations – A).

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:

Current climatic conditions in Poland are similar to those prevailing in the region of origin of the species (North America) and optimal for its development (e.g. EPPO 2016, CABI 2018 – B). Currently, there are no barriers that prevent a survival and reproduction of the species.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm36. Comments:

Current climatic conditions in Poland are similar to those prevailing in the region of origin of the species (North America) and optimal for its development. Currently, there are no barriers related to climatic conditions. Results of the studies indicating a significant tolerance of *Myriophyllum heterophyllum* to temperature rise may suggest a potential lack of change in the range in the situation of climate change (e.g. Brunel et al. 2010, Hussner and Jahns 2015 – P).

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm37. Comments:

Under conditions of climate change, the effect of *Myriophyllum heterophyllum* is likely to moderately increase, mainly in aquatic ecosystems. Due to the increase in temperature and CO_2 content in the air, the intensity of photosynthesis will increase (Hussner 2008 – N), and therefore species such as *Myriophyllum heterophyllum* have a chance to dominate aquatic ecosystems. A significant effect on natural habitats and species with a narrow ecological amplitude cannot be excluded.

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:

No direct effect on cultivated species was observed, therefore there is little probability that the effect on cultivations will appear as a result of climate change.

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:

The effect of climate change can be a very unlikely impediment to the access of water resources by domination of the species in ecosystems (EPPO 2016 – B).

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:

No direct effect of broadleaf watermilfoil on humans was observed, climate change will not alter the existing situation. Indirectly, it may occur that the intensity of grow of the biomass of the species will generate costs of removing its excess.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm41. Comments:

The potential invasive success of the species at the temperature rise may cause additional nuisance for humans when using waters. The extensive development of the species hinders recreation, has a negative effect on the maintenance and use of aquatic equipment etc. (EPPO 2016, CABI 2018 – B).

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.50	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.25	0.50
Environmental impact (questions: a13-a18)	0.55	0.70
Cultivated plants impact (questions: a19-a23)	0.00	0.50
Domesticated animals impact (questions: a24-a26)	0.00	0.50
Human impact (questions: a27-a29)	0.00	0.50
Other impact (questions: a30)	0.25	0.50
Invasion (questions: a06-a12)	0.58	0.83
Impact (questions: a13-a30)	0.55	0.54
Overall risk score	0.32	
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.

acomm42. Comments:

There is no date on the occurrence of *Myriophyllum heterophyllum* in the natural environment in the area of Poland. Potentially, its presence should not be excluded, it could have been overlooked in routine water monitoring studies (high similarity to the native *M. verticillatum*). Analysis of environmental conditions, especially of climatic ones of the natural and secondary range, indicates a high similarity to the conditions prevailing in Poland. *Myriophyllum heterophyllum* can tolerate high temperatures in summer, as well as frosty winters (including ice cover) (EPPO 2016 – B). Currently, there are no barriers related to climatic and habitat conditions. It can be assumed that as a species similar in its habitat requirements to native watermilfoils, it may occur a hardly invasive species, non-aggressively integrating into the native flora of Polish waters. Monitoring, especially of shallow reservoirs in river valleys and hard water lakes as potential sites for the appearance (or presence) of broadleaf watermilfoil, is required.

Data sources

1. Published results of scientific research (P)

Bouxin G, Lambinon J. 1996. Bouxin G & Lambinon J. 1996. Deux xenophytes aquatiques nouveaux pour la Belgique, *Myriophyllum heterophyllum* et *Lagarosiphon major*, dans la Meuse a Lives-sur-Meuse (province de Namur). Natura Mosana 49: 94-97

Brunel S, Schrader G, Brundu G, Fried G. 2010. Emerging invasive alien plants for the Mediterranean Basin. EPPO Bulletin 40: 219-238

Carpenter SR, Lodge DM. 1986. Effects of submerged macrophytes on ecosystem processes. Aquatic Botany 26: 341-370

De Beer D, De Vlaeminck R. 2008. *Myriophyllum heterophyllum*, een nieuwe invasieve waterplant. Dumortiera 94: 8-13

EPPO. 2018. *Myriophyllum heterophyllum* Michaux Data sheets on pests recommended for regulation. Bulletin OEPP/EPPO 46: 20-24

Gerber D, Les D. 1996. Habitat differences among seven species of *Myriophyllum* (Haloragacea) in Wisconsin and Michigan. Mich Botanist 35: 75-86

Hussner A, Jahns P. 2015. European native *Myriophyllum spicatum* showed a higher HC03- use capacity than alien invasive Myriophyllum heterophyllum. Hydrobiologia 746: 171-182

Hussner A, Krause T. 2007. Zur Biologie des aquatischen Neophyten *Myriophyllum heterophyllum* Michaux in Duusseldorfer Stadtgewuassern. Acta Biologica Benrodis 14: 67-76

Hussner A, Nienhaus I, Krause T. 2005. Zur Verbreitung von *Myriophyllum heterophyllum* Michx. in Nordrhein-Westfalen. Floristische Rundbriefe 39: 113-120

Lebreton A. 2013. *Myriophyllum heterophyllum* Michaux [Haloragaceae] en Haute-Vienne (Limousin, France), et situation de cette plante invasive en France et en Europe. EPPO Bulletin 43: 180-192

Matthews J, Beringen R, Lamers LPM, Ode B, Pot R, der van Velde G i in. 2013. Knowledge document for risk analysis of the non-native Fanwort (*Cabomba caroliniana*) in the Netherlands. Sylwan

Stricker W. 1962. Das Leipziger Hafengel€ande – Einwanderungstor seltener und fremder Pflanzenarten. Sachsisches Heimatblatt 8: 464-473

Tavalire HF, Bugbee GE, LaRue EA, Thum RA. 2012. Hybridization, cryptic diversity, and invasiveness in introduced variable-leaf watermilfoil. Evolutionary Applications 14: 892-900

Thum RA, Lennon JT. 2006. Is hybridization responsible for invasive growth of non-indigenous water-milfoils? Biological Invasions 8: 1061-1066

Thum RA, Lennon JT. 2010. Comparative ecological niche models predict the invasive spread of variable-leaf milfoil (*Myriophyllum heterophyllum*) and its potential impact on closely related native species. Biological Invasions 12: 133-143

Van Valkenburg JLCH, Roijackers RMM, Leonard R. 2011. *Cabomba caroliniana* Gray in The Netherlands. 3rd International Symposium on Weeds and Invasive Plants, October 2-7, Ascona, Switzerland.

2. Databases (B)

BSBI. 2012. *Myriophyllum heterophyllum*. (http://www.bsbi.org.uk) Date of access: 2018-02-10

CABI. 2018. Datasheet *Myriophyllum heterophyllum* (broadleaf watermilfoil). (https://www.cabi.org/isc/datasheet/34940) Date of access: 2018-02-19

EPPO. 2012. *Myriophyllum heterophyllum* (Haloragaceae). Invasive Alien Plants. Paris, France: European and Mediterranean Plant Protection Organization. (http://www.eppo.int/INVASIVE_PLANTS/iap_list/Myriophyllum_heterophyllum.htm)

EPPO. 2016. *Myriophyllum heterophyllum* Michaux. Data sheets on pests recommended for regulation. Bulletin OEPP/EPPO 46: 20-24 Data sheets on pests recommended for regulation Fiches informatives sur les organismes recommandes pour reglementation (http://onlinelibrary.wiley.com/doi/10.1111/epp.12277/full) Date of access: 2018-02-10

invasiveorg (Center of Invasive Species and Ecosysem Health). 2018. Twoleaf watermilfoil *Myriophyllum heterophyllum* Michx. (https://www.invasive.org/browse/subinfo.cfm?sub=12803) Date of access: 2008-02-19

The Plant List. 2013. A working list of all plant species. (http://www.theplantlist.org/tpl1.1/record/kew-2366595) Date of access: 2018-02-12

3. Unpublished data (N)

Gwiazdowicz M. 2014. nwazyjne gatunki obce. NFOS BIURO ANALIZ SEJMOWYCH (http://orka.sejm.gov.pl/WydBAS.nsf/0/76F0DA9DD555D052C1257CEB0049BB07/$file/Infos_171.pdf)

Hussner A. 2008. Ökologische und ökophysiologische Charakteristika aquatischer Neophyten in Nordrhein-Westfalen. PhD Thesis, Universität Düsseldorf, Germany.

Botanical Gardens employees… 2018. Pracownicy ogrodów botanicznych i arboretów 2018 Ankieta dotycząca utrzymywania inwazyjnych gatunków roślin obcego pochodzenia w uprawie

4. Other (I)

van Valkenburg JLHC, Boer E. 2014. Cabomba and *Myriophyllum* in trade: What's in a name? (www.robsonmeeting.org) Data dostepu: 2018-02-12

5. Author's own data (A)

Gąbka M. 2018. Own unpublished data.