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. Agnieszka Kolada
2. Maciej Gąbka – external expert
3. Alina Urbisz

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	Department of Freshwater Protection, Institute of Environmental Protection, National Research Institute	25-01-2018
(2)	dr hab.	independent expert	29-01-2018
(3)	dr hab.	Faculty of Biology and Environmental Protection, University of Silesia in Katowice	01-02-2018

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

Polish name: Moczarka delikatna

Latin name: ***Elodea nuttallii*** (Planch.) H. St. John

English name: Nuttall's waterweed

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:

Currently valid Latin name: *Elodea nuttallii* (Planch.) H. St. John. Earlier, till 1848, this species was known under the name *Anacharis nuttallii* Planchon, reclassified to the *Elodea* genus (St John 1920) in 1920.

Latin name synonyms (The Plant List 2018 – B): *Anacharis nuttallii* Planch., 1848 *Anacharis occidentalis* (Pursh) Victorin, *Elodea columbiana* H. St. John, *E. minor* (Engelm. ex Caspary) Farw., *E. occidentalis* (Pursh) H. St. John, *E. canadensis* var. *angustifolia* (Muhlenbeck) Ascherson et Graebner, *Philotria angustifolia* (Muhl.) Britton ex Rydb., *Philotria minor* (Engelm. ex Caspary) Small *Philotria nuttallii* (Planch.) Rydb., *Philotria occidentalis* (Pursh) House, *Udora verticillata* var. *minor* (l. f.) Spreng. Engelm. ex Caspary, *Serpicula occidentalis* Pursh.

Polish name: moczarka delikatna

English name: Nuttall's waterweed (other: free-flowered waterweed, Nuttall's pondweed, slender waterweed, western elodea, western waterweed)

Polish name (synonym I)	Polish name (synonym II)
Moczarka nuttalla	–
Latin name (synonym I)	Latin name (synonym II)
Anacharis nuttallii	*Elodea columbiana*
English name (synonym I)	English name (synonym II)
Free-flowered waterweed	Nuttall's pondweed

a03. **Area** under assessment:

Poland

acomm03. Comments:

–

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

	native to Poland
	alien, absent from Poland
	alien, present in Poland only in cultivation or captivity
X	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:

A species originating from North America, which arrived in Europe most probably only in the 20th century, According to the information gathered in the NOBANIS questionnaire (Josefsson 2011 – B), first reports on its emergence in Europe originate from Great Britain, 1914 (originally incorrectly identified as *Hydrilla verticillata*, correct identification only in 1974); reports on first observation in other European countries originate from Belgium, 1939 (with confirmed identification in 1955, Simpson 1984, Cook and Urmi-Konig 1985a – P), Holland, 1941, Germany, 1953, Denmark, 1974, Ireland, 1984, Sweden, 1991 (Anderberg 1992 – P), and Norway, 2008 (Imesland 2008 – P). In 1998, the species was observed in the Danube delta (Sarbu *et al.* 2006 – P), where it spread and got to Slovakia (Otahelova and Valachovic 2002 – P), Hungary (Mesterházy *et al.* 2009 – P), and Romania (Sarbu *et al.* 2006 – P). According to the DAISE database (2018-B), it occurs in 12 European countries.

In the territory of Poland, Nuttall's waterweed was identified for the first time in Biebrza old river bed near Goniądz in the years 1990-1993 (Barendregt and Wassen 1994 – P). In 2007, it was found in the waters of the Vistula (Kamiński 2010 -P). Detailed studies on the distribution of this species carried out in the country since 2012 (Gąbka 2018 – A) indicate a strongly invasive character. *Elodea nuttallii* spreads mostly in the valleys of large rivers: (1)

The Vistula (mainly in its middle course), (2) The estuary of the Oder, and (3) sporadically in the Warta (Middle Warta Valley region). The presence of *E. nuttallii* was proved also in five lakes, *e.g.* Ryńskie Lake, Mikołajskie Lake, and Lake Kuc (data from the State Monitoring Programme); the species occurs in old river beds and dam reservoirs connected with river valleys. The majority of the sites in our country have been identified since 2000. At present, the largest population of Nuttall's waterweed exists in the lowest part of the Oder – from Dąbie Lake, to the Świna river, to the Szczecin Lagoon (Gąbka 2018 – A).

It is very probable that because of its similarity to a more common species, Canadian waterweed *E. canadensis*, *E. nuttallii* has been and is mistaken for it, thus the reports on its occurrence in Poland (similarly in other European countries) may be underestimated, and the species may occur more abundantly and in a larger number of sites than commonly thought. Sporadically, co-occurrence of the two waterweed species at a single site has been noted (*e.g.*, Oder channels; Gąbka 2018 – A)

The authors of the present elaboration consider *E. nuttalli* to be an alien species, occurring in the territory of Poland in the natural environment, not established at the country scale. Based on the current observations, the species occurs in highly eutrophic (and strongly modified) waters, and it has not formed an unambiguous "ecological niche" in the natural environment, while compared with, *e.g.*, *E. canadensis*, its establishment may be observed only at a local scale.

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
	the human domain
X	the other domains

acomm05. Comments:

Nuttall's waterweed is an aquatic species (hydrophyte), occurring in natural and artificial reservoirs (*e.g.* dam reservoirs), lakes, ponds and old river beds, pits, slowly flowing rivers and channels. Also, it occurs in coastal lakes and bays. Due to its mass growth, it may affect local populations of aquatic plants and animals. Our observations indicate a decrease in the diversity of aquatic plants under conditions of the mass occurrence of Nuttall's waterweed, *e.g.* in the valleys of the Oder and Vistula rivers. In other European countries, displacement of native species of aquatic flora by mass emergence of the Nuttall's waterweed. The species reproduces effectively vegetatively by fragmentation of shoots (Barrat-Segretain 2001, Barrat-Segretain and Elger 2004, James *et al.* 2006 – P); it develops its vegetation earlier and forms more side shoots than Canadian waterweed, which is shaded and displaced in eutrophic habitats by Nuttall's waterweed. In addition, reports of the adverse impact of Nuttall's waterweed on populations of zooplankton or fish are known. The majority of environmental problems posed by Nuttall's waterweed result from its ability for mass growth. Abundant populations generate large amounts of biomass and are able to overgrow the whole water column or form separate freely floating mats. It impedes recreational and aquacultural use of reservoirs, causes pipe blocking, impairs operation of boat engines, hinders angling and fishing. Locally, Nuttall's waterweed forms mass agglomerations in dam reservoirs, river ports and in the Szczecin Lagoon ports, as well as in waterways and irrigation canals (separated floating mats with a surface area of even several thousand square metres; Authors' observations). It poses a real problem and causes the necessity for maintenance work. In addition, *Elodea nuttallii* may reduce the aesthetic value of reservoirs. Due to its mass growth, it may hinder the recreational use of lakes and rivers.

A1 | Introduction

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

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

	low
	medium
X	high

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

acomm06. Comments:

Nuttall's waterweed spreads in our country, most of all in a spontaneous way, and its sites are rather incidental. However, in the recent period, an increase in local populations and a regionally invasive character have been identified (Authors' observations). Soon, this plant may enter natural habitats, mostly meso- and eutrophic lakes. The species reproduces vegetatively by fragmentation. Its propagules spread passively with the water current; the factor controlling this expansion route is the hydrological connectivity/isolation of the ecosystems (Sand-Jensen 2000 – P). The transport of vegetative plant fragments by water currents of rivers, the communication of channels in river valleys and the natural dynamics of the main river (i.e. flood propensity) should be considered basic factors supporting colonisation by this species (comp. Tokarska-Guzik *et al.* 2015 – P). Therefore, flowing waters are usually more exposed to spontaneous expansion than lakes, particularly more isolated lakes located at the edges of drainage basins. *Elodea nuttallii* inhabits the following types of waters: river bays, dam reservoirs, old river beds, channels, coastal bays and lakes of various trophic levels. , Nuttall's waterweed colonises marginal lakes of large rivers, then old river beds. In special cases, it colonises lakes located in the vicinity of river valleys (Authors' observations). Active vectors for spreading the species also include aquatic animals, mainly birds. The species is also spreading in neighbouring countries of Poland: Germany, the Czech Republic and Slovakia (CABI 2018 – B), from where it may be introduced into Poland, mostly by birds. Polish populations are in a condition of rapid colonisation.

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:

The species occurs in neighbouring countries of Poland (Germany, the Czech Republic, Slovakia) and others located relatively close (France, Denmark, Austria, Croatia) (EPPO 2015, CABI 2018 – B). Reports of the mass occurrence of Nuttall's waterweed in Germany and France are known. Propagules of the species (plant fragments) might (and may) be brought along into Poland inadvertently, e.g. on watercraft.

Despite the fact that the plant is spreading in water because of its flow, human actions are also considered a main factor explaining the high invasion rate – including transport of plant fragments between reservoirs together with water equipment. Observations carried out in the country indicate the occurrence of large populations in places highly modified by humans, connected in particular with barriers in large rivers (Authors' observations). Also,

	the spread may be associated with repair works in, e.g., harbour basins, and maintenance works in waterways and irrigation canals (Authors' observations).

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:

In Poland, the species is not present in the market and is used as an aquarium plant or is farmed in household reservoirs and botanical gardens only to a slight degree. Sometimes, the trade name "Nuttall's waterweed" is applied to Brazilian waterweed (*Egeria densa*), which has a similar appearance. In Poland, as in Estonia, Spain or Switzerland, Nuttall's waterweed is one of the species having its trade regulated (EPPO 2015 – B, Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of alien species that could be a threat to native species or natural habitats in case of their release into the natural environment – P), however, legal limitations are not necessarily an efficient protection from invasions, as it has been observed in Switzerland (where the species is black-listed as a priority).

The main introduction route of Nuttall's waterweed in Europe is by accidental transport in operations connected, *e.g.*, with maintenance works, water equipment and in the trading of aquarium and ornamental species for waterholes (Preston and Croft 1997 – P). This is the most effective spreading route of this species to hitherto uninhabited territories.

A2 | Establishment

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

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

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

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

acomm09. Comments:

The species originates from North America, from regions with a temperate climate. It prefers a warm temperate climate or continental climate, enduring drought periods poorly; however, waterweed species are known for their high adaptivity to a broad range of environmental conditions. According to the climatic similarity map of Poland in relation to the rest of the world, a modelling method developed using the Mahalanobis distance, the climatic conditions in Poland are 100% compatible with those in the natural rangeland of Nuttall's waterweed (CABI 2018 – B). On the basis of a literature review, one may conclude that the climatic conditions in Poland oscillate between moderately favourable and optimal for the Nuttall's waterweed, however, the actual behaviour of a species cannot be predicted without an analysis of the data from the territory of the country. In the case of *E. canadensis*, works by Kolada and Kutyła (2016 – P) indicate a shift in habitat preference of this species towards water having lower seasonal water temperatures and harsher climatic conditions than commonly thought. In the case of *E. nuttallii*, some authors point

to its higher tolerance to elevated temperatures (McKee *et al.* 2002, Greulich and Trémolieres 2006 – P), which may indicate a lack of adverse responses to climate warming for the further spread and population growth of the species. In the case of Poland, the current vast spreading may be connected with climate changes, particularly with the lack of frigid winters.

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:

The waterweeds (*Elodea canadensis* and *E. nuttallii*) are adapted to a broad range of environmental conditions (Cook and Urmi-König 1985b, Simpson 1990 – P); they occur in waters usually rich in calcium, with moderate or high alkalinity, various nutrient concentrations, from mesotrophic to highly eutrophic waters (Pokorný *et al.* 1984, Madsen *et al.* 1991, Thiébaut 2005, Hérault *et al.* 2005 – P). Comparative research of Greulich and Trémolieres (2006 – P) on the habitat requirements of waterweed species in Alsace indicate that Nuttall's waterweed exhibits preferences towards more nutrient-rich waters than Canadian waterweed. This may explain the replacement of Canadian waterweed observed currently in Europe; the species is receding because of a water eutrophication increase, being replaced by Nuttall's waterweed, which is more tolerant of water eutrophication and elevated temperature. *Elodea nuttallii* is able to grow in turbid, highly eutrophic waters (Cook and Urmi-König 1985b, Ozimek *et al.* 1993, Thiébaut and Muller 1999), as well as in oligo-mesotrophic waters (Thiébaut *et al.* 1997, Barrat-Segretain 2001, Nagasaka 2004 – P) with a certain degree of organic pollution (Best *et al.* 1996). Often, the growth of *E. nuttallii* is stimulated by nitrogen fertilisation, and the species benefits from an ammonia excess (Dendene *et al.* 1993 – P). In Poland, optimal conditions occur for establishing Nuttall's waterweed. In our country, this species occurs mostly in eutrophic and highly eutrophic waters, sometimes saline waters; usually those having a low transparency (even below 0.5 m SD; Gąbka 2018 – A). It inhabits alkaline waters with pH of 7.5-8.6 and high electrolytic conductivity (640-2500 µS/cm). It is found less often in clear-water oxbows and mesotrophic lakes, (Gąbka 2018 – A).

A3 | Spread

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

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

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

	very low
	low
	medium
	high
X	very high

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

acomm11. Comments:

Estimation (data type: C). The species reproduces vegetatively by fragmentation (*e.g.* Simpson 1984 – P). Its propagules spread passively with the water current; the factor controlling this expansion route lies in the hydrological connectivity/isolation of ecosystems. Therefore, flowing waters are usually more exposed to its spontaneous expansion than lakes, particularly more isolated lakes located at the edges of drainage basins. Another factor which may spread this species in river valleys is constituted by floods. Also, animals associated with the aquatic environment, mainly birds, are active vectors for spreading this species (*e.g.* Simpson 1984, Barrat-Segretain 2001 – P).

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

	low
X	medium
	high

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

acomm12. Comments:

Participation of humans in the expansion of these species has a character of unaware and random actions, *e.g.* as a result of transport of plant fragments by watercraft, repair works in ports, maintenance works in waterways and other watercourses (Authors' observations). At a local scale, anglers and fishermen are also a frequently observed vector. Spreading of this species from farms and crops is marginal in Poland (from the analysis of data of aquarium plants trade, from gardening centres and nurseries).

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 and ponds that have natural banks, and estuaries (Annex I of the 92/43/EWG Directive).

Native species population declines are considered at a local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as (near) extinction. Similarly, limited ecosystem change is considered as transient and easily reversible; severe change is considered as persistent and hardly reversible.

a13. The effect of *the species* on native species, through **predation, parasitism or herbivory is**:

X	inapplicable
	low
	medium
	high

aconf09.	Answer provided with a	low	medium	high	level of confidence

acomm13. Comments:

The species does not exhibit such interactions – it is an autotrophic photosynthetic plant.

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, if it becomes established in the territory of the country, may form dense monospecific clusters, often overgrowing the whole water column or a significant part, dislodging native species and contributing to a reduction of taxonomic diversity of aquatic vegetation. Strong allelopathic properties of this species are also known. Because of abundant synthesis of phenolic compounds (allelopathic effect) (Newman 1991, Lemoine *et al.* 2009 – P), *E. nuttallii* actively combats algae and cyanobacteria (Erhard and Gross 2006, Hilt and Gross 2008, Wu *et al.* 2009 – P). The presence of the allelopathic chemical substances of *E. nuttallii* is a strong feature protecting the plant from herbivores, and it may additionally enhance the invasiveness of this species (Erhard *et al.* 2007 – P). Locally, the species has an invasive and aggressive character – it grows in masses and its adverse impact by competing for light and nutrients with the native aquatic flora is already being observed at the country scale (Authors' observations). Moreover, Nuttall's waterweed is characterised by a higher growth rate and ability to regenerate from shoot fragments in comparison with Canadian waterweed, which is displaced by it efficiently (CABI 2018 – B).

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:

In Europe (also in Poland), native species of the *Elodea* genus, with which *E. nuttallii* could crossbreed, do not occur. There are no reports on the possibility of crossbreeding with native species; however, there are reports available of crossbreeding of *E. nuttallii* with *E. canadensis* (Josefsson 2011 – B). Thus far, no flowering individuals of the Nuttall's waterweed have been observed in our country (Authors' observations).

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

X	very low
	low
	medium
	high
	very high

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

acomm16. Comments:

There are no reports on pathogens transmitted by the Nuttall's waterweed.

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

	low
	medium
X	high

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

acomm17. Comments:

The species, if established in a territory and moving on to the aggressive expansion phase, may grow in reservoirs in masses, forming compact and dense monospecific communities. Such a form of occurrence may affect some ecosystem elements positively on one hand (*e.g.* forming refuges and feeding places for animals), but it may also have a very negative impact – strong shading effects on other plant species, a limitation or inhibition of water circulation. Abrupt breakdowns of Nuttall's waterweed populations, observed for instance in Sweden every few years (Sand-Jensen 2000 – P), and degradation of the large quantity of biomass connected with them, cause a release of significant quantities of biogenic substances and organic matter to the environment, oxygen depletion and drop in pH of waters, favouring an intensification of eutrophication. However, this phenomenon is not very specific to Nuttall's waterweed, and similar events may be observed in mass emergences of other aquatic species.

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:

An influence on the disturbance of biotic factors of the species is strong potentially, if it establishes itself in the territory of the country and enters an aggressive expansion phase. The species forms dense monospecific communities, often overgrowing the whole water column or its significant part, displacing native species and contributing into a reduction in the taxonomic diversity of aquatic vegetation. A negative impact of Nuttall's waterweed on populations of aquatic animals, *i.e.* fish, zooplankton or benthic macroinvertebrates is also known (a review of the issue in Simpson and Duenas 2011 – B, as well as Erhard *et al.* 2007, Schulz and Dibble 2012 – P). The results cited pertain mostly to studies on the effect of allelopathic substances on aquatic organisms. This subject is very difficult to interpret unambiguously and simplify. *Elodea nuttallii* also exhibits allelopathic properties limiting the growth of cyanobacteria (Erhard and Gross 2006, Hilt and Gross 2008 – P).

A4b | Impact on the cultivated plants domain

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

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

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

X	inapplicable
	very low
	low

	medium
	high
	very high

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

acomm19.	Comments: A non-parasitic aquatic plant species.

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	high **X**	level of confidence

acomm20.	Comments: The species inhabits waterbodies – no interaction with plant crops.

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

	inapplicable
X	no / very low
	low
	medium
	high
	very high

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

acomm21.	Comments: The species inhabits waterbodies– no interaction with plant crops. In Europe, only male individuals have been found, so the plant reproduces only vegetatively by small fragments of shoots rooting in nodes (Cook and Urmi-König 1985b); in this connection, crossbreeding with related species is not possible.

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

	very low
X	low
	medium
	high
	very high

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

acomm22.	Comments: The species inhabits waterbodies– no interaction with plant crops. In cases of massive emergences of Nuttall's waterweed *e.g.* locally in the delta of the Świna River, an influence of this species on the condition of pastures and meadows is possible by a slowdown of water flow, and ultimately, by blocking irrigation canals (Authors' observations).

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:
There are no reports on transmission of pathogens or parasites harmful for plants or animals by Nuttall's waterweed.

A4c | Impact on the domesticated animals domain

Questions from this module qualify the consequences of *the organism* on domesticated animals (e.g. production animals, companion animals). It deals with both the well-being of individual animals and the productivity of animal populations.

a24. The effect of *the species* on individual animal health or animal production, through **predation or parasitism** is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf20.	Answer provided with a	low	medium	high	level of confidence

acomm24. Comments:
The Nuttall's waterweed is a plant and it does not exhibit such influences.

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:
The species has no properties which could pose a hazard for animals in direct contact. However, report on the adverse impact of Nuttall's waterweed on zooplankton or fish populations are known (by forming floating mats, it may hinder fishing).

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

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf22.	Answer provided with a	low	medium	high	level of confidence

acomm26. Comments:

The plants are not hosts or vectors of pathogens/parasites of animals.

A4d | Impact on the human domain

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

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

X	inapplicable
	very low
	low
	medium
	high
	vert high

aconf23.	Answer provided with a	low	medium	high	level of confidence

acomm27. Comments:

A non-parasitic plant species.

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	high **X**	level of confidence

acomm28. Comments:

The Nuttall's waterweed is an aquatic plant species having no properties which may pose a threat for humans in 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:

The plants are not hosts or vectors of pathogens/parasites of 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
X	medium
	high
	very high

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

acomm30. Comments:

Locally, in case of an aggressive mass population growth, Nuttall's waterweed affects hydrological objects adversely, hindering their use, *e.g.* blocking pipes, impairing operation of boat engines, overgrowing underwater elements of aquatic constructions, river dams, power stations *etc.* Similarly to Canadian waterweed, Nuttall's waterweed may overgrow pipes drawing water for industrial and household purposes, effectively limiting its uptake (Sand-Jensen 2000 – P, Josefsson 2011 – B). In addition, mass growth hinders recreational use of reservoirs, *i.e.* sailing, swimming, motor boat use, and angling. This impact is decidedly stronger than those observed in mass emergences of native aquatic species.

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:

Mass growth of Nuttall's waterweed may hinder retrieval of waters to supply populace with potable water and water for other purposes, and adversely affect the infrastructure connected with water intakes.

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:

In cases of less than mass emergence, or in the initial phase of the invasion of a site, the growth of the species in water may contribute to an improvement of water quality, as is the case in the emergence of other/native macrophyte species in a reservoir (gathering of biogenic substances from sediments, allelopathic impact on cyanobacteria, competition with phytoplankton, stabilisation of a clear-water state dominated by macrophytes). However, the excessive growth of the species, particularly in the case of mass death of the population, which is observed *e.g.* in Scandinavian countries (Sand-Jensen 2000 – P), may cause the degradation of water quality as a result of intensification of eutrophication.

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf29.	Answer provided with a	low	medium	high **X**	level of confidence

acomm33. Comments:

Mass growth of Nuttall's waterweed may hinder the recreational use of reservoirs, *i.e.* swimming, sailing, motor boat use, angling. Also, it may decrease the aesthetic values of the reservoir.

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:

The present climatic conditions in Poland are close to those in the region of the species' origin (North America) and optimal for its development (comp. Sand-Jensen 2000 – P, Josefsson 2011 – B). At present, there are no geographical barriers connected with climatic conditions, however, the lack of frigid winters decidedly favours the spread of Nuttall's waterweed in Poland (Authors' observations).

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm35. Comments:

The present climatic conditions in Poland are close to those in the region of the species' origin (North America) and optimal for its development (*e.g.* Sand-Jensen 2000 – P, Josefsson 2011 – B). At present, there are no barriers precluding survival and reproduction of the species. The predicted climate changes will not affect this situation.

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:

Present climatic conditions of Poland are close to those in the region of the species' origin (North America) and optimal for its development. Currently, there are no geographical barriers connected with climatic conditions. Research findings indicating a significant tolerance of the Nuttall's waterweed to temperature increases may suggest a potential success of the species in a climate change situation (*e.g.* Sand-Jensen 2000 – P, Josefsson 2011 – B), however it should be taken into account that the Nuttall's waterweed is a temperate zone species, and the predicted climatic changes, despite the fact they may stimulate invasive success, will not affect the species' behaviour dramatically.

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 **X**	high	level of confidence

acomm37. Comments:

The present climatic conditions of Poland are close to those in the region of the species' origin (North America) and optimal for its development. At present, there are no geographical barriers connected with climatic conditions. Research findings indicating a significant tolerance of Nuttall's waterweed to temperature increases may suggest the potential success of the species in a climate change situation (*e.g.* Sand-Jensen 2000 – P, Josefsson 2011 -B), including an increase of its impact on wild plant and animals, as well as aquatic habitats and ecosystems.

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 impact on plant crops – an aquatic species not interacting with cultivated plants.

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
X	increase moderately
	increase significantly

aconf35.	Answer provided with a	low	medium **X**	high	level of confidence

acomm39. Comments:

In the case of a mass growth of the Nuttall's waterweed in waterbodies, the plant may affect fish farms and cause an increase in the maintenance costs of fishponds.

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
X	increase moderately
	increase significantly

aconf36.	Answer provided with a	low	medium	high **X**	level of confidence

acomm40. Comments:

The potential invasive success of the species accompanying temperature increase may cause additional nuisances for humans when utilising waters (*e.g.* Josefsson 2011). Mass growth hinders recreation and adversely affects the maintenance and use of aquatic equipment, *etc.* There is no direct influence on human health, however.

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	high **X**	level of confidence

acomm41. Comments:

The potential invasive success of the species accompanying temperature increase may cause additional nuisances for humans when utilising waters. Mass growth hinders recreation and adversely affects the maintenance and use of aquatic equipment, *etc.* (*e.g.* Josefsson 2011 – B, Sand-Jensen 2000 P).

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.83	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.75	1.00
Environmental impact (questions: a13-a18)	0.60	0.90
Cultivated plants impact (questions: a19-a23)	0.06	0.88
Domesticated animals impact (questions: a24-a26)	0.00	1.00
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.50	1.00
Invasion (questions: a06-a12)	0.86	1.00
Impact (questions: a13-a30)	0.60	0.96
Overall risk score	0.52	
Category of invasiveness	moderately invasive alien speciesp	

A6 | Comments

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

acomm42. Comments:

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