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. Anna Maria Łabęcka – external expert
2. Aneta Spyra
3. Małgorzata Strzelec

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr	Institute of Environmental Sciences, Faculty of Biology, Jagiellonian University in Cracow	12-01-2018
(2)	dr	Department of Hydrobiology, Faculty of Biology and Environmental Protection, University of Silesia	28-01-2018
(3)	prof. dr hab.	Department of Hydrobiology, Faculty of Biology and Environmental Protection, University of Silesia	28-01-2018

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

Polish name: Szczeżuja chińska

Latin name: ***Sinanodonta woodiana*** (Lea, 1834)

English name: Chinese pond mussel

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:

Polish name (synonym I) –	Polish name (synonym II) –
Latin name (synonym I) *Anodonta woodiana*	Latin name (synonym II) –
English name (synonym I) Chinese pond mussel	English name (synonym II) Chinese huge mussel

a03. **Area** under assessment:

Poland

acomm03. Comments:
–

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

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

aconf01. Answer provided with a

low	medium	high	level of confidence
		X	

acomm04. Comments:

The Chinese pond mussel occurs in the majority of Poland. It is also recorded in heated cooling water of the power plant and in water with a natural thermal regime. It occupies various environments, such as rivers, ditches, lakes, canals, oxbow-lakes and fish ponds. It has been recorded in the Narew River, the Oder River, the Warta-Gopło Canal, the Postomia River (a tributary of the Warta River), and the Vistula River (Böhme 1998, Domagała et al. 2003, 2007, 2013, Kraszewski 2007, Marzec 2016 - P, Kobak 2017 – A, Szlauer-Łukaszewska et al. 2017, Bonk et al. 2018 - P). It also occurs in fish ponds in the Barycz Valley, the Bug River, the Narew River, the Noteć River, the San River, the Słupia River, the Warta River, the Wisłok River and the Vistula River (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P). So far, the highest number of the sites of its occurrence has been recorded in fish ponds, due to the accidental introduction of the larvae (glochidia) of the Chinese pond mussel along with fry. The range of the occurrence of this species includes aquatic environments located mainly in the north-western and south-western Poland (inter alia Kraszewski and Zdanowski 2001, Ożgo et al. 2010, Urbańska et al. 2011, Najberek et al. 2013, Zając et al. 2013, Waldon-Rudzionek and Rudzionek 2016 - P). This species reaches its sexual maturity in the second year of its life (Chen et al. 2015 - P). In cooling water it reproduces continuously, with higher intensity during spring and summer (Łabęcka and Domagała 2016 - P). In aquatic environments with undisturbed water temperatures this species does reproduce, however, the full phenology of its reproduction is still unknown (Domagała et al. 2007 - P).

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: So far, in Poland there has been no data directly documenting any negative impact of this species on natural environment, human health and other domains generated by humans. In fish ponds which are located in the area of Poland no negative impact on ichthyofauna has been recorded. There is no data on the displacement of native species from their habitats in Poland. In occupied habitats, the Chinese pond mussel co-exists with native benthic fauna (Ciemiński and Zdanowski 2009, Spyra et al. 2012 - P). This species does not show the full features of a typical invasive species (Kraszewski and Zdanowski 2011 - P). Impact on natural environment: In studies conducted outside Poland, the presence of the Chinese pond mussel can be a threat to native bivalve species (Cappelletti et al. 2009, Benkő-Kiss et al. 2013 - P). The Chinese pond mussel may affect native bivalve species as a result of the increased number of individuals. The Chinese mussel is a component of trophic chains and a host for parasites (Łabęcka 2009, Yuryshynets and Krasutska 2009, Andrzejewski et al. 2012, Cichy et al. 2016 - P). Impact on husbandry: The invasive potential of this species is attributed to its parasitic larvae (Douda et al. 2012 - P), which can deteriorate the condition of fish or cause their death – mainly in ponds with fry (Benkő-Kiss 2012 - P). Impact on other domains: In the periods of mass mortality of bivalves (e.g., during droughts or floods), the number of decomposing bivalve bodies and empty bivalve shells is likely to reduce the attractiveness of areas famous from water tourism and recreation (Bódis et. al. 2014a - P).

A1 | Introduction

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

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

	low
	medium
X	high

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

acomm06.	Comments: The Chinese pond mussel is established in Poland. This species has the ability to migrate naturally. Adult mussels migrate along water courses (Andrzejewski et al. 2012 - P), and their parasitic larvae (glochidia) are transported on the body (skin, fins, gills) of fish (Łabęcka 2009 – N). Chinese pond larvae require obligatory fish hosts for their metamorphosis. Basically, in an aquatic environment the access of mussel larvae to fish is virtually unlimited, which is why the colonization of new habitats in Europe is still possible by this route. The spreading of the Chinese pond mussel will increase (Douda et al. 2012 - P) due to the migration of fish transporting glochidia along greater distances in open waters.

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 Chinese pond mussel is established in Poland. This species has been spread by humans in the majority of Europe, including Poland's neighboring countries: Germany, the Czech Republic, Slovakia and Ukraine (Košel 1995, Beran 1997, Reichling 1999, Yuryshynets I Korniushin 2001 - P). The Chinese pond mussel also occurs in Poland where it has been introduced by unintentional human actions (Kraszewski and Zdanowski 2001, 2007 – P). This species has reached Poland in its larval form (glochidium) along with freshwater fish species brought from Hungary (the grass carp, the black carp, the silver carp and the bighead carp) (Kraszewski and Zdanowski 2011 - P). The probability of an accidental transport along with fry is very high. The Chinese pond mussel has been recorded in the following countries: Romania, Hungary, France, Slovakia, the Czech Republic, Germany, Austria, the Netherlands, Ukraine, Serbia, Greece, Moldavia, Sweden, Italy, Spain and Montenegro (Petró 1984, Sárkány-Kiss 1986, Giradi and Ledoux 1989, Košel 1995, Beran 1997, Reichling 1999, Reischütz 2000, van Peursen 2001, Yuryshynets and Korniushin 2001, Bank 2006, Paunovic et al. 2006, Munjiu and Shubernetski 2008, von Proschwitz 2008, Cappelletti et al. 2009, Pou-Rovira et al. 2009, Lajtner and Crnčan 2011, Tomović et al. 2013 - P).

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

	low
	medium
X	high

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

acomm08. Comments:

This species is already present in Poland. It is recorded primarily in fish ponds where it was introduced along with fry (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P) (cf question a07 and acomm07). It is supposed to be an efficient way for the expansion of this species. The Chinese pond mussel is described as a species that can be introduced intentionally (Ciafanelli et al. 2007 - P) and only one such case is known (in Italy), where these mussels have been introduced intentionally for the production of freshwater pearls (Berni et al. 2003 – P, Povoledo 2004 - I). It is the biggest species among European freshwater bivalves (Benkő-Kiss 2012 - P), which can affect its attractiveness and its transfer to small water holes and ponds. Bivalves are filter feeders, which is why the filtrating activity of the Chinese pond mussel has an effect on the quality of water (Kiss 1995, Andrzejewski et al. 2012 - P).

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 first sites of the occurrence of the Chinese pond mussel were limited to cooling waters near power plants (Zdanowski 1996, Kraszewski and Zdanowski 2001, Domagała et al. 2003 - P) and to fish ponds rich in nutrients and fish, which are the host for glochidia (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P). The Chinese mussel prefers warmer water (Kraszewski and Zdanowski 2001, 2007 – P); however, the history of its invasion into Poland shows that heated waters are the main source of the subsequent invasions of this species into Poland. This species shows adaptation to water with thermal conditions typical of the temperate climatic zone (Domagała et al. 2007, 2013, Marzec 2016, Szlauer-Łukaszewska 2017 - P) where it reproduces. The presence of glochidia incubated in the gills of adult female mussels in natural water has been confirmed by Domagała et al. (2007 - P). Studies indicate the occurrence of specimens from different age classes in Polish fauna, both adult (e.g., 8 year old) and young individuals (Soroka 2000, Afanasjev et al. 2001, Kraszewski 2006, Spyra et al. 2012, 2016, Urbańska et al. 2012 - P), but, e.g., the presence of young specimens in ponds may be associated with the constant introduction of the glochidia of the Chinese pond mussel along with fry. In Poland, sites with the occurrence of this species overlap areas with the highest average annual air temperatures (Spyra et al. 2016 - P). The Chinese pond mussel has a wide tolerance for environmental conditions; it is also resistant to changes in water temperature and oxygen deficiency (Woźnicki et al. 2004, Sîrbu et al. 2005, Corsi et al. 2007, Bieler et al. 2016 - P)

a10. Poland provides **habitat** that is

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

aconf06.	Answer provided with a	low	medium	high **X**	level of confidence

acomm10. Comments:

Sinanodonta woodiana has found convenient habitat conditions in Poland. It occurs in flowing waters, but with low flow rates (Domagała et al. 2007, Kraszewski i Zdanowski 2007, Łabęcka i Domagała 2016 - P) and in stagnant waters (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P). It occupies rivers, lakes (preferably the littoral zone), ponds and it is a benthic existence. Habitat conditions optimal for the development of this species include a specific type of substrate (muddy, muddy and loamy, sandy and loamy, sandy, with no stagnant areas, no excessive water turbulence and coarse-grained substrate (Kraszewski and Zdanowski 2007, Skuza et al. 2009, Andrzejewski et al. 2013 - P). The occurrence of the mussel is limited only by stony bottoms and compact stretches of macrophytes (Kraszewski and Zdanowski 2007 - P). This species reproduces in Poland (Domagała et al. 2007, Łabęcka and Domagała 2016 - P), surviving winter seasons and forming stable and abundant populations; therefore, it can be assumed that habitat conditions in Poland are optimal for it (Gąbka et al. 2007, Spyra et al. 2012 - P). An analysis of habitats in which the Chinese pond mussel occurs in Poland indicates that the possibilities of its appearance in the subsequent years in new habitats will not depend on numerous existing or newly established fish ponds, but rather on their location (in areas with the highest mean annual temperature their number will increase) (Spyra et al. 2016 - P).

A3 | Spread

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

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

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

	very low
	low
X	medium
	high
	very high

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

acomm11. Comments:

Dispersion from a single source (Data type: A).

The Chinese pond mussel introduced along with fry to fish ponds without outflow will have little chance of independent spreading; however, in flowing waters this is possible due to glochidia (Douda et al. 2012 - P). During its life cycle, the Chinese pond mussel produces glochidia (Domagała et al. 2007, Łabęcka and Domagała 2016 - P). These are larvae that parasitize on the bodies of fish (Łabęcka 2009 - N). Due to the higher mobility of fish, as opposed to adult mussel specimens, it is the parasitizing larval stage that facilitates the migration of these bivalves for longer distances and their spreading (Domagała et al. 2007 - P). After the parasitic period, the glochidia descent to reservoir bottoms and live as a benthic species. The level of dispersion for a single specimen of this species is medium and ranges from ca. 500 meters to ca. 5 kilometers per year.

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

	low
	medium
X	high

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

acomm12. Comments:

Bivalves are transported by humans to new water bodies in the form of fish parasites which cannot be seen with “the naked” eye (Kraszewski and Zdanowski 2011 - P). Currently, the Chinese pond mussel occurs in fish ponds in the valleys of the Barycz River, the Bug River, the Narew River, the Noteć River, the San River, the Słupia River, the Warta River, the Wisłok River and the Vistula River (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P). The trade and transport of adult mussels to ponds and small reservoirs intended to increase water clarity (bivalves are filter feeders) affects this species' level of spreading (Andrzejewski et al. 2012 - P). In the majority of sites where the Chinese pond mussel has been introduced, this species survives winter seasons, although it occurs in various densities, from single specimens to populations estimated at several hundred specimens (Gąbka et al. 2007 - P). Factors limiting its occurrence include a rocky bottom (Kraszewski and Zdanowski 2007 - P) and abundant vegetation (Kraszewski and Zdanowski 2001, Spyra et al. 2012, Andrzejewski et al. 2013 - P). The frequency of such spreading should be estimated as high (more than 10 cases per decade are expected).

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**:

	inapplicable
X	low
	medium
	high

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

acomm13. Comments:

The species is neither predatory nor herbivorous. Parasitism is related to its larval stage. Larvae of the Chinese pond mussel (glochidia) parasitize on fish gills, fins and skin. The mass occurrence of this species could deteriorate the condition of fish, lead to the dysfunction of internal organs, and as a consequence, cause higher mortality of fish (Benkő-Kiss 2012, Slavík et al. 2017 - P); however, no mass fish mortality caused by glochidiosis has been recorded yet. The parasitizing of larvae was observed not only in fish species excluded from special protection, but also in the bitterling (*Rhodeus amarus*) which is subject to partial protection (Journal of Laws 28 Dec 2016 - P).

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

	low
X	medium
	high

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

acomm14. Comments:

So far, in Poland there has been no observed negative impact of this species on native bivalves, e.g., from the family Unionidae; therefore, the impact of the Chinese pond mussel caused by competition should be considered as small. However, the Chinese pond mussel could constitute a threat to native bivalve species, because experimental studies have shown that this species competes with them for the host fish necessary for the metamorphosis of glochidia (Donrovich et al. 2017 - P). The number of glochidia incubated by one female *S. woodiana* amounts to 167-200 million (for comparison, the native duck mussel (*Anodonta anatina*) usually produces between 20 and 60 thousand) (Wächtler et al. 2001, Müller et al. 2015 - P). These characteristics confirm the high reproductive potential of the Chinese pond mussel. It presents the risk of increasing this species' population in relation to native species. Additionally, if one takes into account the fact that native *A. anatina* releases its glochidia in early spring (Piechocki 1969 - P) and the glochidia of *S. woodiana* are released throughout the whole year (Łabęcka 2009 - N), they can potentially infest fish (hosts) more frequently and earlier in terms of seasons (Donrovich et al. 2017 - P). It can contribute to a decrease in the population of the native bivalve species. The presence of *S. woodiana*

larvae on fish bodies also reduces the ability of the duck mussel's glochidia to undergo metamorphosis (Doronovich et al. 2017 - P). Consequently, this reduces the population of the native duck mussel or may even lead to its complete extinction, which is exemplified by changes observed in the Balaton Lake (Hungary) and in some water bodies of Italy (Benkő-Kiss et al. 2013, Cappelletti et al. 2009 - P). *Sinanodonta woodiana* is also responsible for diminishing the reproductive success of a partially protected fish species – the European bitterling *R. amarus* (Journal of Laws 28. 12.2016 - P). The European bitterling lays its eggs in the mantle cavities of mussels, but the Chinese pond mussel effectively removes the roe laid inside it (Reichard et al. 2007 - P). Assuming that the species will spread all over Poland, it can be expected that it can lead, at most, to a small reduction in the populations of special care native species (e.g., endangered or protected bivalve species) or serious decreases in the populations of the remaining species of native bivalves.

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

X	no / very low
	low
	medium
	high
	very high

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

acomm15. Comments:

There are no known cases of interbreeding between the Chinese pond mussel and native bivalve species.

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

	very low
	low
	medium
X	high
	very high

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

acomm16. Comments:

In Poland, this mussel has become a host for parasites (*Aspidogaster conchicola* and *Rhipidocotyle campanula*) which do not occur in the native Asian area of *S. woodiana* (Łabęcka 2009 - N, Yuryshynets and Krasutska 2009, Cichy et al. 2016 - P). The hosts of *A. conchicola* also include freshwater bivalves (the duck mussel, the partially protected swan mussel (*Anodonta cygnea*) and the strictly protected thick shelled river mussel (*Unio crassus*)), prosobranch snails as well as freshwater turtles and fish (Journal of Laws 28 Dec 2016 - P). The parasite lives and lays eggs in various tissues and organs (Adamczyk 1972, Rhode 2005, Yuryshynets and Krasutska 2009, Marszewska and Cichy 2015 - P). The duck mussel is a typical intermediary host for *R. campanula*, and freshwater fish are the final hosts (Müller et al. 2015 - P). Therefore, the Chinese pond mussel has become a species extending the pool of available hosts enabling the development of parasites. This species is a host or vector for at least one parasite that infests native special care species, causing small reductions in their populations, or it infests other native species causing serious drops in their populations.

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

X	low
	medium
	high

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

acomm17. Comments:

So far, this species has been described in Poland as not posing a threat to the integrity of Polish aquatic environments by disturbing their abiotic factors (Kraszewski and Zdanowski 2007 - P). Similar to other bivalves, the Chinese pond mussel produces faeces and pseudofaeces. Covering reservoir bottoms with a large number of empty shells can affect decomposing processes occurring in water (Sousa et al. 2014 - P). In the worst case, this species can cause easily reversible changes in processes occurring in habitats not belonging to special care habitats (e.g., oligotrophic waters or rivers with muddy banks).

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

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

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

acomm18. Comments:

So far, this species has not posed a threat to native Polish mussels of the family Unionidae, with which it could potentially compete for habitats (Kraszewski and Zdanowski 2007 - P). A possible negative impact of this species on the abiotic factors of an ecosystem is reflected, e.g., by hindering the development of the partially protected European bitterling *(Rhodeus amarus)* (Journal of Laws 28.12.2016 - P). The European bitterling lays its eggs in the mantle cavities of the Unionidae mussels, while the Chinese pond mussel effectively removes the roe laid inside them (Reichard et al. 2007 - P). The Chinese pond mussel is a component of trophic chains (Andrzejewski et al. 2012 - P). These bivalves are consumed, e.g., by birds such as the Eurasian oystercatcher (*Haematopus ostralegus*), the white-tailed eagle (*Haliaeetus albicilla*), as well as by other animals, including the wild boar (*Sus scrofa*) and the red fox (*Vulpes vulpes*) (Andrzejewski et al. 2012, Urbańska et al. 2013 - P). Assuming that this species will spread all over the country, this impact should be assessed as medium. In the worst case, this species will cause hard to reverse changes in processes occurring in habitats not subject to special care (e.g., fish ponds, rivers) or it can cause easily reversible changes in special care habitats (e.g., in aquatic environments subject to protection).

A note on the positive impact of the Chinese pond mussel: Empty shells of this species serve a positive role for benthic animals, constituting a substrate for their occurrence and sheltering (Bódis et al. 2014b - P).

A4b | Impact on the cultivated plants domain

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

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

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

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

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

acomm19. Comments:

The species lives in water; it is a filter feeder species.

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

X	inapplicable
	very low
	low
	medium
	high
	very high

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

acomm20. Comments:

The species is not a plant.

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

X	inapplicable
	no / very low
	low
	medium
	high
	very high

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

acomm21. Comments:

The species is an animal. It does not interbreed with plants.

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	high **X**	level of confidence

acomm22. Comments:

The species is an aquatic animal. In Poland there are no cultivations in water bodies or wetlands, which is why there are no reasons to suppose that the Chinese pond mussel could affect the integrity of cultivations, even if such cultivations were introduced in Poland in the future. Furthermore, compact stretches of macrophytes limit the occurrence of bivalves (Kraszewski and Zdanowski 2007 - P).

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

X	very low
	low
	medium

	high
	very high

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

acomm23. Comments:

The species is an aquatic animal. In Poland there are no plant cultivations in water bodies or wetlands. There are no indicators whether the Chinese pond mussel could be a host or a vector for pathogens and parasites which are harmful to plants, even if such cultivations were introduced in Poland in the future.

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:

	inapplicable
	very low
X	low
	medium
	high
	very high

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

acomm24. Comments:

In the case of this species, only the larval form exhibits parasitic habits. The large production of glochidia by the specimens of this species could cause higher mortality of fish in fish farming and deteriorating their condition (Ondračkova 2009, Benkő-Kiss 2012 - P), but there have been no such data in Poland so far.

The Chinese pond mussel is a generalist in selecting its fish host. Its larvae undergo a successful metamorphosis on the bodies of both native and alien fish species (Łabęcka 2009 - N, Douda et al. 2012 - P). Fish glochidiosis can contribute to impairing the breathing of fish, deteriorating blood parameters, kidney and liver dysfunctions (Douda et al. 2017, Slavík et al. 2017 - P), by doing so being capable of causing the mortality of farmed fish and a decrease in their productivity. It should be emphasized that the highest number of Polish registered sites of the Chinese pond mussel were found in fish ponds (Mizera and Urbańska 2003, Gąbka et al. 2007, Ożgo et al. 2010, Najberek et al. 2011, 2013, Andrzejewski et al. 2012, 2013, Spyra et al. 2012, 2016, Urbańska et al. 2012, Wojton et al. 2012 - P, Urbańska and Andrzejewski 2018 - A), but no mass fish mortality caused by glochidiosis has been recorded so far. The Chinese pond mussel has become an intermediary host for the *Rhipidocotyle campanula,* whose final hosts are freshwater fish (Cichy et al. 2016 - P). This parasite in not dangerous to fish farming. (cf. in questions a05 and acomm05).

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:

So far, no impact of the live specimens of this species has been recorded with respect to the health of a single animal or livestock production, caused by properties posing a hazard during a direct contact. The only exception is glochidiosis described in question a24 (a swimming fish must come close to or even rub the mussel to cause it to release its glochidia).

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

	inapplicable
	very low
X	low
	medium
	high
	very high

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

acomm26. Comments:

The impact of the Chinese pond mussel on animal health and livestock production can be defined as small, because this species is a carrier of the sporocysts and cercarias of the *Rhipidocotyle campanula* (Digenea: Bucephalidae) – a trematode whose final hosts are freshwater fish (Cichy et al. 2016 - P). The mussel has a parasite shared with fish, but for this parasite there is no obligation of reporting and it does not cause diseases. There is no data on possible economic losses caused by *R. campanula* in fish farming, which is why the impact is considered to be small.

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:

This species is not a human parasite.

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

X	very low
	low
	medium

	high
	very high

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

acomm28. Comments:

Due to the fact that the Chinese pond mussel is not an edible species in Poland, it does not affect human health, although this species accumulates heavy metals, contaminants, pesticides and biogenic elements in its body and shell (Kiss 1995, Sinicyna 1997, Królak and Zdanowski 2001, Uno et al. 2001, Liu et al. 2010 - P). Tissues of the mussel excrete mucus which can be allergising to some people as a result of direct contact (BHP UJ 2010 - I). The probability is low (less than one case of contact per year among 100,000 people), the effect is minor (medical consultations are rare, the disease does not cause absence from work, no permanent impairments, low stress level) and the impact is very small.

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

	inapplicable
X	very low
	low
	medium
	high
	very high

aconf25.	Answer provided with a	low	medium	high **X**	level of confidence

acomm29. Comments:

There is no evidence that the Chinese pond mussel is a vector of pathogens and parasites which are harmful to people.

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:

X	very low
	low
	medium
	high
	very high

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

acomm30. Comments:

In Poland, its harmful impact on infrastructure has not been recorded, and this mussel has been occupying Polish inland waters for about 40 years. A potential harmful impact could only occur in habitats where the population of the Chinese pond mussel would be high. Very numerous empty shells can be deposited in the shoreline zone as the so-called shell outwash, which in the case of water bodies used for recreation (angling, swimming) could have a negative impact on their use, however, only in a situation when the specimens of this species reach very high population density. In the periods of mass mortality of mussels (e.g., during droughts or floods), the amount of decomposing mussel bodies and the empty shells of molluscs may contribute to losing the attractiveness of water bodies in areas famous for water tourism and recreation (Bódis et al. 2014a - P). Even assuming its

	spreading all over the country, this would not mean that the populations would be abundant. The probability is low (no more than one event per year among 100,000 objects), the effect is minor (totally reversible) and the impact is very low.

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: The field studies on this species did not record this type of impact. Experimental studies have shown that fish glochidiosis can contribute to the impaired breathing of fish, deteriorating blood parameters, kidney and liver dysfunctions (Douda et al. 2017, Slavík et al. 2017 - P), and by doing so it may lead to mortality of farmed fish and a decrease in their productivity. The Chinese pond mussel has become an intermediary host for the *Rhipidocotyle campanula* – *a* trematode whose final hosts are freshwater fish (Cichy et al. 2016 - P). Nonetheless, there is no data on possible economic losses caused by *R. campanula* in fish farming.

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: Similar to other bivalves, the Chinese pond mussels produce faeces and pseudofaeces (Sousa et al. 2014 - P), but they also contribute positively to water purification processes (Kiss 1995 - P). The *Sinanodonta woodiana* can constitute a threat to native bivalve species, because it competes with them for host fish which are necessary for the metamorphosis of its glochidia (Donrovich et al. 2017 - P). The presence of the larvae of *S. woodiana* on fish bodies reduces the ability of the glochidia of the duck mussel *Anodonta anatina* to undergo metamorphosis (Doronovich et al. 2017 - P). The *Sinanodonta woodiana* is also responsible for reducing the reproductive success of a partially protected fish species which is the European bitterling *Rhodeus amarus* (Journal of Laws 28 Dec 2016, Reichard et al. 2007 - P).

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

	significantly negative
	moderately negative

X	neutral
	moderately positive
	significantly positive

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

acomm33. Comments:

So far, no impact of the Chinese pond mussel on cultural services has been recorded.

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

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

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

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm34. Comments:

The Chinese pond mussel features quite a wide range of ecological tolerance (Bielen et al. 2016 - P). It produces a large amount of cholinesterase – an enzyme which enables it to withstand unfavourable environmental conditions and which enables the glochidia to develop in a wider range of conditions (Corsii et al. 2007 - P). Unlike the native duck mussel, the Chinese pond mussel is also more resistant to stress caused by changes in temperature (Bielen et al. 2016 - P). In warm water, the reproductive cycle of the Chinese pond mussel is also continuous (Łabęcka and Domagała 20016 - P) and the parasitic period of life is shortened (Kiss 1995 - P).

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm35. Comments:

The Chinese pond mussel reproduces in Poland both in waters with a natural thermal regime and in cooling waters (Domagała et al. 2007, Łabęcka and Domagała 2016 - P). These

mussels generally prefer warmer waters (Kraszewski 2006, Kraszewski and Zdanowski 2007, Bódis et al. 2014a - P) in which they are able to reproduce throughout the whole year, with the highest intensity during spring and summer. In natural waters, the full phenology of their reproduction is unknown (maybe the reproduction is seasonal).

If the climate were to become warmer, one could expect the presence of populations which could reproduce more frequently or longer throughout the year.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf32. Answer provided with a

low	medium	high	level of confidence
		X	

acomm36. Comments:

The species spreads mainly with the participation of humans and farmed fish, but also by natural routes (adult bivalve specimens migrate along watercourses (Andrzejewski et al. 2012 - P); their parasitic larvae (glochidia) are transported on the bodies of fish living in the wild (Łabęcka 2009 – N). It should be presumed that regardless of climatic changes, the Chinese pond mussel will still spread by these routes (also cf. question a07, a08 and acomm 07, acomm08).

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	level of confidence
	X		

acomm37. Comments:

Climate changes will most likely not affect the type of the behaviour of the Chinese pond mussel in relation to native animals and natural habitats. However, it could have some influence on the intensity of impact connected, e.g., to an increase in the number of adult specimens or the number of produced parasitic larvae. Due to a changing climate, other non-native species can also occur in Polish waters, which is why it is hard to predict which life strategy will be presented by the Chinese pond mussel when they appear in water bodies.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf34. Answer provided with a

low	medium	high	level of confidence
		X	

acomm38.	Comments: The species is an aquatic animal and it does not affect cultivated plants or plant production in Poland. It is very unlikely that this situation could change due to climatic changes.

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: Climatic changes will probably not affect the type of the behaviour of the Chinese pond mussel in relation to farmed fish. However, the intense reproduction of mussels in warm waters could lead to an increase in the prevalence of the recorded infestations of fish with glochidia. It is also difficult to predict which life strategy will be exhibited by the Chinese pond mussel in a situation when new alien species appear in water bodies, e.g., parasites which could negatively affect fish farming.

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: Climatic changes will probably not change the behaviour of the Chinese pond mussel in relation to humans, excluding the possible occurrence of human parasites and pathogens previously absent in Poland.

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: In the periods of mass mortality of bivalves (e.g., during droughts and low water levels), the amount of decomposing bodies and shell thanatocoenoses may contribute to the loss of the attractiveness of water bodies in areas famous for water tourism and recreation (Bódis et al. 2014a - P).

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.75	1.00
Environmental impact (questions: a13-a18)	0.29	1.00
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.17	0.83
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.00	1.00
Invasion (questions: a06-a12)	0.92	1.00
Impact (questions: a13-a30)	0.29	0.97
Overall risk score	0.27	
Category of invasiveness	non invasive alien species	

A6 | Comments

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

acomm42. Comments:

The Chinese pond mussel has been classified as a non-invasive alien species (total score of the questionnaire – 0.27). It is established (score 1.0; questions: a09-a10) and it has spread over Poland (score 0.75; questions: a11-a12), which is reflected by its numerous reported sites. However, the largest share of this species' sites is limited mainly to fish ponds (which could largely reflect the result obtained for the invasion process: 0.92; questions a06-a12). The continued spreading process of the Chinese pond mussel in Polish waters is caused mainly by introducing it into fish farming in its larval form, although independent spreading may not be excluded. The mussel reproduces many times throughout the year (Douda et al. 2012, Łabęcka and Domagała 2016 - P), and the number of glochidia incubated by one female exceeds by many times the number of larvae produced by the native duck mussel *Anodonta anatina* (Wächtler et al. 2001, Müller et al. 2015 - P). These features indicate a large reproduction potential of the Chinese pond mussel. By combining it with the transport of glochidia via fish living in the wild, this mussel can easily expand its range in open water, but perhaps a drop in the temperature during winter and an ice cover are the key factors inhibiting an increase in the population of *S. woodiana* outside cooling waters and water bodies affected by them. Habitat conditions in Poland are rather favourable, due to, e.g., the type of substrate and water chemistry, especially because the Chinese pond mussel is characterised by a quite wide range of tolerance in relation to environmental factors. Low temperatures are a parameter limiting the reproductive potential of this species and the size of its population. The impact of the Chinese pond mussel on the natural environment (score 0.29; questions: a13-a18) is small. A similar assessment was made for impact on animal farming (score 0.17; questions: a24-a26) and total negative impact (score 0.29; questions: a13-a30). So far, the features of “invasiveness” have been shown by this species only in laboratory studies. In the natural environment, much richer in interactions with organisms,

as contrasted with a simple experimental setup, it is difficult to observe the significant impact of this species on the native fauna after more than 40 years of the presence of *S. woodiana* in Poland. There is also no feedback of fish farmers, e.g., regarding decreased productivity in their ponds. It should be noted that, if such a situation were to occur in Poland, most Poles would discover this fact during Christmas (the glochidia of the Chinese pond mussel also parasitize the common carp). Due to considerable climatic warming, the invasiveness of this species will probably increase, and its total negative impact will be higher than what is calculated today (0.29; questions a13-a30). Similar to every alien species, it is recommended to monitor the sites of its occurrence, along with estimating the size of its population. Studies indicating new inhabited aquatic environments in Poland are also significant.

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