UNIWERSYTET ŚLĄSKI
W KATOWICACH

INSTYTUT OCHRONY PRZYRODY PAN

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. Joanna Hegele-Drywa
2. Monika Normant-Saremba – external expert
3. Wojciech Solarz

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr	Department of Experimental Ecology of Marine Organisms, Institute of Oceanography, University of Gdansk	09-03-2018
(2)	dr hab.	Department of Experimental Ecology of Marine Organisms, Institute of Oceanography, University of Gdansk	22-04-2018
(3)	dr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	03-05-2018

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

Polish name: Krabik amerykański

Latin name: ***Rhithropanopeus harrisii*** Gould, 1841

English name: Dwarf Crab

Fundusze Europejskie Infrastruktura i Środowisko

GENERALNA DYREKCJA OCHRONY ŚRODOWISKA

Unia Europejska Fundusz Spójności

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acomm02.	Comments:

According to WoRMS (World Register of Marine Species), there is only one Latin synonym, i.e. *Rhithropanopeus harrisii tridentatus* Maitland, 1874.

Polish name (synonym I)	Polish name (synonym II)
Krab amerykański	Krab zalewowy
Latin name (synonym I)	Latin name (synonym II)
Heteropanope tridentata	*Pilumnus tridentatus*
English name (synonym I)	English name (synonym II)
Estuarine mud crab	Harris mud crab

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:

Rhithropanopeus harrisii was first reported in Poland in 1951 (Demel 1953 – P). Since its introduction into the natural environment of Poland, this species has established populations, including in the Vistula Lagoon (Rychter 1999 – I, Jabłońska-Barna et al. 2013 – P), Martwa Wisła (Turoboyski 1973, Normant et al. 2004 – P), the Gulf of Gdańsk (Hegele-Drywa and Normant 2014a – P), and the Odra estuary (Czerniejewski and Rybczyk 2008 – 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
	the domesticated animals domain
	the human domain
	the other domains

acomm05. Comments:

R. harrisii is an omnivorous species that feeds on plants (e.g. green algae), and animals (e.g., crustaceans, mussels, snails, polychaetes, coelenterates, sand fleas) (Turoboyski 1973, Milke and Kennedy 2001, Czerniejewski and Rybczyk 2008, Hegele-Drywa and Normant 2009, Forsström et al. 2015 – P). Another important component of its diet is detritus (dead organic matter), which indicates the role of this species in cleaning the bottom of water bodies, as well as transferring matter and energy to higher trophic levels, because *R. harrisii* is consumed by predatory fish such the European eel *Anquilla anquilla*, the flounder *Platichthys flesus*, the perch *Perca fluviatilis*, the fourhorn sculpin *Myoxocephalus quadricornis*, the roach *Rutilus rutilus*, the round goby *Neogobius melanostomus,* and birds (Filuk and Żmudziński 1964, Bacevičius and Gasiunaite 2008 – P, Puntila 2016 – I). The carapace of *R. harrisii* provides a hard substrate to which settled organisms can attach, such as the barnacles *Amphibalanus improvisus* or freshwater hydroid *Cordylophora caspia* (Normant-Saremba 2014 – A). Baculovirus was detected in *R. harrisii* (Payen and Bonami 1979 – P),

	but there is no information on the consequences of this infection or the potential transmission of this pathogen to other crustaceans. *R. harrisii* is also the host of the parasitic barnacles *Loxothylacus panopaei*, whose larvae are intolerant to salinity below 10 psu (Reissler and Forward 1991 – P). In habitats where there are no predators regulating the population of *R. harrisii* its numbers may become large and cause changes in the ecosystem (Kotta et al. 2018 – 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 species is established in Poland, which according to the methodology of risk assessment Harmonia[+PL] Procedure of negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland (further Harmonia[+PL]) indicates the choice of answers: high probability and high level of confidence. During its life cycle, *R. harrisii* passes through larval stages, and larvae can spread spontaneously, e.g. with sea currents (Costlow et al. 1966 – P). However, the mechanism of retention of larvae close to the parental habitat has been observed in this species, in addition to the formation of genetically diverse clustered populations, which suggests that larvae spread is unlikely (Cronin 1982, Projecto-Garcia et al. 2010, Hegele-Drywa et al. 2015 – P). Another argument supporting the larval retention in this species may be the fact that despite its presence in Martwa Wisła and the Vistula Lagoon from the early 1950s, the population of *R. harrisii* in the Gulf of Gdańsk (and in other regions of the Baltic Sea to which larvae could potentially move) was established not earlier than after 2000 (Demel 1953, Michalski 1957, Hegele-Drywa and Normant 2014a – P).

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 is established in Poland, which according to the methodology of risk assessment Harmonia[+PL] indicates the choice of answers: high probability and high level of confidence. Larvae and adults of *R. harrisii* can be transported to Polish ports in ships, i.e. in ballast tanks and on hulls (Projecto-Garcia et al. 2010 – P, CABI 2018 – B). It has been estimated that the number of releases of larvae of this species to the natural environment could be higher than 10 cases per decade.

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:

The species is established in Poland, which according to the methodology of risk assessment Harmonia+PL indicates the choice of answers: high probability and high level of confidence. However, it is unlikely that *R. harrisii* is imported to Poland intentionally, e.g., by aquarists, because this species has unattractive colouration compared to tropical crabs, and it is rather uninteresting to aquarists. On the other hand, it is relatively easy to catch in the environment, i.e. in the Polish coastal zone. The above arguments suggest that there is a probability of the release of individuals of this species to the natural environment of Poland by intentional human actions.

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 is established in Poland, which according to the methodology of risk assessment adopted in Harmonia+PL indicates the choice of answers: optimal climate and high level of confidence. The native regions of *R. harrisii* are the eastern coasts of North America, from New Brunswick (Canada) to Veracruz by the Gulf of Mexico, located in the zones of temperate, subtropical and tropical climate (Roche and Torchin 2007 – P). According to the global map showing areas of climate similarity, prepared by modelling with an emphasis on Mahalanobis distances, climate conditions in Poland are different from those in most areas of the natural occurrence of *R. harrisii*. It is also known that higher temperatures are more favourable for this species (Hegele-Drywa and Normant 2014b – P), and low temperatures in winter, despite the ability of this species to overwinter, can increase its mortality, especially in shallow water bodies (Turoboyski 1973 – 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:
	The species is established in Poland, which according to the methodology of risk assessment adopted in Harmonia[+PL] indicates the choice of answers: optimal habitat and high level of confidence. It seems that in the natural environment of Poland, depending on the habitat, *R. harrisii* has access to a diversity of foods (Turoboyski 1973, Czerniejewski and Rybczyk 2008, Hegele-Drywa and Normant 2009 – P). There are also different types of substrate preferred by the species, i.e. soft – in which it buries itself, or hard (natural and anthropogenic), overgrown by sedentary organisms, like barnacles, mussels or coelenterates – among which it finds shelter from predators (Milke and Kennedy 2001, Grabowski et al. 2005, Roche and Torchin 2007, Hegele-Drywa and Normant, 2014a – P). On the other hand, studies have demonstrated that the lower salinity limit tolerated by *R. harrisii* is 2.5 psu, and the optimum is 15-25 psu, which suggests that the values of this abiotic factor in Polish Marine Areas are not optimal (Costlow et al. 1966 – P). Salinity is a key factor determining the reproduction and development of *R. harrisii*. Even adults of this species survive in fresh water for just a few days, which may be associated with higher metabolic expenditure (Kujawa 1957, Normant and Gibowicz 2008 – P). Also, the presence of predatory fish such as the European eel *Anquilla anquilla*, the flounder *Platichthys flesus*, the perch *Perca fluviatilis* or the round goby *Neogobius melanostomus* does not seem to be beneficial for this species, because predators can significantly limit the growth of its population (Filuk and Żmudziński 1964, Bacevičius and Gasiunaite 2008 – P, Puntila 2016 – I).

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:

X	very low
	low
	medium
	high
	very high

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

acomm11.	Comments:
	Dispersal from a single source (Data type: A) / Expansion of population (Data type: B) Although *R. harrisii* is established in Poland, it seems that the capacity of the species to disperse without human assistance is limited due to the larval retention close to the parental stocks observed in this species. Therefore, the scale of dispersal from a single source was assessed as very low, under 50 m per year. It is difficult to determine the distance travelled during the year by an individual of this species or its propagule, because there is no relevant information in the literature. Considering, however, the fact that the population of *R. harrisii* in the Gulf of Gdańsk was formed about 50 years after the introduction of the species into the Vistula Lagoon and the Martwa Wisła, where it established a population, the risk of further expansion, i.e. the distance at which the range of *R. harrisii* is shifted per year, was defined as very small, i.e. less than 10 m (Demel 1953, Michalski 1957, Hegele-Drywa and Normant 2014a – 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:

While the transport of *R. harrisii* larvae in ship's tanks is unlikely (maritime transport within Poland that would entail the filling of ballast tanks in one port and emptying in another is not developed), it can not be ruled out that this species will be transported on the hulls of vessels, if they are overgrown with other organisms, among which the crab may hide (Projecto-Garcia et al. 2010 – P). However, information about the dispersal of this species by human actions is unavailable, and humans do not exploit this species in any way, e.g., *R. harrisii* is not of interest to aquarists, as implied by information obtained from companies operating in the aquarium market (Normant-Saremba 2014 – A). The above suggests that the probability of the species' dispersal within Poland by human actions is medium, and more than one case but fewer 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:

R. harrisii is an omnivorous species, and its diet may differ depending on the habitat (Turoboyski, 1973, Milke and Kennedy 2001, Czerniejewski and Rybczyk 2008, Hegele-Drywa and Normant 2009, Forsström et al. 2015 – P). Studies have demonstrated that in Poland this species feeds mainly on detritus (dead organic matter) (Czerniejewski and Rybczyk 2008, Hegele-Drywa and Normant 2009 – P). Much less frequently it feeds on animals, such as the edible mussel *Mytilus edulis,* and the zebra mussel *Dreissena polymorpha* (Kujawa 1957, Turoboyski 1973, Czerniejewski and Rybczyk 2008 – P), crushing their shells with its massive chelipeds, a polychaete worm *Hediste diversicolor* (Turoboyski 1973 – P), a hydroid *Cordylophora caspia* (Turoboyski 1973 – P) and amphipods, snails and Ostracoda mussel shrimps (Hegele-Drywa and Normant 2009 – P). In addition, larvae of *R. harrisii* sometimes feed on the larvae of barnacles *Amphibalanus improvisus* (Turoboyski 1973 – P).

	Plant food detected in the stomach of *R. harrisii* found in Poland included fragments of green algae *Cladophora* sp. and *Enteromorpha* sp. Unfortunately, there is no information in the literature about the impact of *R. harrisii* on changes in the population of species it feeds on. However, considering the fact that there are no species of special concern among them, it can be assumed that this impact will be small, i.e. *R. harrisii* will cause a slight, if any, decline in the population of native species that are not of special concern.

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

X	low
	medium
	high

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

acomm14. Comments:

In Polish Marine Areas there are no native crabs with which *R. harrisii* could compete for food or habitat. It is also unlikely that this species in occupied habitats competes for food or other resources with other representatives of the order Decapoda, e.g., the brown shrimp *Crangon crangon* or the Baltic prawn *Palaemon adspersus*, because they are also opportunistic species and are capable of adapting to the existing environmental conditions.

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 crab species native to Poland; apart from that, no cases of *R. harrisii* hybridisation with other crab species have been reported (CABI 2018 – B). Therefore, *R. harrisii* has no or very small effect on native species through hybridisation.

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	high X	level of confidence

acomm16. Comments:

R. harrisii is a carrier of baculovirus, which has been detected in its testicular cells (Payen and Bonami 1979 – P). It is not known, however, whether it causes a disease or leads to the death of infected organisms. There is also no information on the transmission of this pathogen to other crustaceans. *R. harrisii* is also the host of the parasitic barnacles *Loxothylacus panopaei*, native to the Gulf of Mexico and the Caribbean Sea (Walker et al. 1992 – P). However, this parasitic barnacle does not live in low-salinity water found in Polish Marine Areas (Reisser and Forward 1991, Walker et al. 1992, Grosholz and Ruiz 1995, Petersen 2006 – P). Because in Poland (and elsewhere in the world) there are no other representatives of the genus *Rhithropanopeus*, as well as no known pathogens/parasites

	shared by *R. harrisii* and native species from the order Decapoda, the effect of *R. harrisii* on native species by hosting pathogens or parasites that are harmful to them has been assessed as very small.

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

	low
X	medium
	high

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

acomm17.	Comments: *R. harrisii* in high densities may indirectly contribute to the increase in nutrient concentration and, as a consequence, to the eutrophication of water bodies (Kotta et al. 2018 – P). However, no such changes have been reported for over 60 years of the presence of this species in the Vistula Lagoon and over 10 years in the waters of the Gulf of Gdańsk. This implies that if *R. harrisii* has any effect on ecosystem integrity by disturbing its abiotic properties, potential changes in the ecosystem are reversible. Therefore, it can be assumed that the effect of *R. harrisii* on ecosystem integrity by disturbing its abiotic properties is medium, because changes concern processes taking place in habitats of special concern (e.g. 1130 – estuaries, 1160 – large shallow inlets and bays).

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: *R. harrisii* in high densities in areas where there is no pressure from predators can have a cascade effect on the food web (Kotta et al. 2018 – P). Through excessive predation on filter-feeding molluscs it can contribute to the excessive growth of phytoplankton. However, no such changes have been reported for over 60 years of the presence of this species in the Vistula Lagoon and over 10 years in the waters of the Gulf of Gdańsk. This implies that if *R. harrisii* has any effect on ecosystem integrity by disturbing its biotic properties, potential changes in the ecosystem are reversible. Therefore, it can be assumed that the effect of *R. harrisii* on ecosystem integrity by disturbing its biotic properties is medium, because changes concern processes taking place in habitats of special concern (e.g. 1130 – estuaries, 1160 – large shallow inlets and bays).

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: *R. harrisii* is an omnivorous animal and aquatic plants are a small part of its diet. *R. harrisii* does not feed on cultivated plants, nor is it a plant parasite, so the effect of this species on cultivated plant targets through herbivory or parasitism has not been reported.

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: *R. harrisii* is an animal species.

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: *R. harrisii* is an animal species.

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: *R. harrisii* has no effect on the health and yield of cultivated plants by affecting the cultivation system's integrity.

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

X	very low
	low
	medium
	high
	very high

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

acomm23.	Comments: *R. harrisii* is not a host or vector of pathogens or parasites that are harmful to plants.

A4c | Impact on the domesticated animals domain

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

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

	inapplicable
X	very low
	low
	medium
	high
	very high

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

acomm24.	Comments: *R. harrisii* is not a parasite of farmed animals and does not feed on them. On the other hand, there are cases of damage (cutting with chelipeds) to fish caught in nets (CABI 2018 – B), but the frequency of these events seems marginal.

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: *R. harrisii* does not have biological and/or chemical properties that are harmful upon contact with farmed animals, companion animals or animal production. However, it clamps its chelipeds onto an opponent when disturbed. Nevertheless, *R. harrisii* is a small animal (carapace width about 22 mm; Hegele-Drywa and Normant 2014a – P), and even in contact with the largest specimens the impact of this species on production animals and companion animals will be very low and produce mild symptoms. If *R. harrisii* spreads on a wide scale, the probability of direct contact with farmed animals and companion animals also seems to be low – fewer than one case per 100 000 animals per year.

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
X	very low
	low
	medium
	high
	very high

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

acomm26.	Comments: Baculovirus was detected in *R. harrisii* (Payen and Bonami 1979 – P), but there is no information on the consequences of this infection and potential transmission of this pathogen to other crustaceans, e.g., those commercially grown (Bateman and Stentiford 2017 – P). Because there are no known pathogens/parasites shared by *R. harrisii* and farmed animals or companion animals (including commercial fish species), and shellfish is not commercially farmed in Poland, the impact has been defined as very 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: *R. harrisii* does not have the ability to parasitize on humans.

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: *R. harrisii* clamps its chelipeds onto an opponent at the moment of danger. Nevertheless, *R. harrisii* is a small animal (carapace width about 22 mm; Hegele-Drywa and Normant 2014a – P), and even in contact with the largest specimens the impact of this species on human health will be very low and produce no permanent injury. If *R. harrisii* spreads on

	a wide scale, the probability of direct contact with humans also seems to be low – fewer than one case per 100 000 people per year.

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 are no known pathogens or parasites shared by humans and *R. harrisii* (CABI 2018, NOBANIS 2018 – B).

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: *R. harrisii* in high densities was reported to cause fouling problems in water intake pipes for industrial cooling systems (CABI 2018, NOBANIS 2018 – B). This problem was observed in the native region of the species. In Poland, there are no such systems, and coastal waters are not used for this purpose, so the probability of causing this type of damage to infrastructure by *R. harrisii* was assessed as low, i.e. fewer than 1 case per year per 100 000 facilities. In addition, because the consequences of such activity are completely reversible, the effect of *R. harrisii* on infrastructure has been defined as very small.

A5a | Impact on ecosystem services

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

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

	significantly negative
	moderately negative
X	neutral

	moderately positive
	significantly positive

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

acomm31.	Comments:
	There are reports on the damage caused by *R. harrisii* to fish in nets (CABI 2018 – B), but during the decades of presence of this species in Poland, this type of negative activity has not been observed (Normant-Saremba – A). On the other hand, *R. harrisii* provides food for commercial fish species, including eel, flounder and perch (Filuk and Żmudziński 1964, Bacevičius and Gasiunaite 2008 – P, Puntila 2016 – I).

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm32.	Comments:
	R. harrisii, as a detritophage feeding on dead plant and animal matter, acts as a cleaner in its aquatic habitats (Czerniejewski and Rybczyk 2008, Hegele-Drywa and Normant, 2009 – P). *R. harrisii* occurring in high densities may indirectly contribute (by predation on molluscs feeding on phytoplankton) to an increase in nutrient concentration and, as a consequence, to the eutrophication of water bodies (Kotta et al. 2018 – P). However, no such changes have been reported for over 60 years of the presence of this species in the Vistula Lagoon and over 10 years in the waters of the Gulf of Gdańsk.

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

	significantly negative
	moderately negative
	neutral
X	moderately positive
	significantly positive

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

acomm33.	Comments:
	Because there are no crab species indigenous to Poland (and the Baltic Sea), *R. harrisii* attracts the interest of scientists and members of the public. In its native range this species has been used repeatedly as an experimental animal in studies testing the effects of pesticides on aquatic invertebrate fauna (CABI 2018 – B).

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:

R. harrisii established a stable population in Poland more than several decades ago, which implies that it has already overcome geographical barriers, and climate warming will not change anything in this respect.

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:

R. harrisii has already been established in Poland for several decades, which means that it has overcome the barriers that prevented its survival and reproduction. The climate of Poland is suboptimal for this species. However, it is unlikely that the expected climate warming will change the existing conditions to more favourable. The expected warming can, at most, offset the negative impact of reduced salinity, which is forecasted for the Baltic Sea along with climate change (IMGW 2014 – I, Holopainen et al. 2016 – P).

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm36. Comments:

Populations of *R. harrisii* show a patchy distribution pattern (Projecto-Gracia et al. 2009, Hegele-Drywa et al. 2015 – P) and the species has a limited capability of dispersal by natural means. Climate change does not seem to significantly increase its potential in this respect.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm37. Comments:

R. harrisii has formed stable viable populations of a patchy distribution pattern in Poland for several decades. So far, the species has had no significant impact on wild plants, animals, habitats or ecosystems in Poland, and the forecasted climate changes are not expected to change this in any way.

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 **X**	level of confidence

acomm38. Comments:

R. harrisii has no impact on cultivated plants and plant domains, and there is no reason to believe that this situation will change as a result of climate change.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm39. Comments:

R. harrisii has no impact on domesticated animals and animal production in Poland. There is no reason to believe that this impact will change as a result of the expected climate change.

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	high X	level of confidence

acomm40. Comments:

The effect of *R. harrisii* on human health has been assessed as very small. There is no reason to believe that this situation will change as a result of the expected climate change.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm41. Comments:

The impact of *R. harrisii* on infrastructure has been assessed as very small, and there is no reason to believe that this situation will change as a result of climate change.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.25	1.00
Environmental impact (questions: a13-a18)	0.17	1.00
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.00	1.00
Human impact (questions: a27-a29)	0.00	1.00
Other impact (questions: a30)	0.00	1.00
Invasion (questions: a06-a12)	0.75	1.00
Impact (questions: a13-a30)	0.17	1.00
Overall risk score	0.12	
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 regularly repeated.

acomm42.	Comments:
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