Appendix A

Harmonia^{+PL} – procedure of 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

Przemysław Śmietana
first name and family name

Maciej Bonk – external expert
first name and family name

Wojciech Solarz

acomm01. Comments:

degree	affiliation	assessment date
Dr.	Instytut Badań nad Bioróżnorodnością, Wydział Biologii Uniwersytet Szczeciński	21.12.2017
degree	affiliation	assessment date
M.Sc.	Instytut Ochrony Przyrody Polskiej Akademii Nauk w Krakowie	21.12.2017
degree	affiliation	assessment date
Dr.	Instytut Ochrony Przyrody Polskiej Akademii Nauk w Krakowie	22.12.2017

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

Polish name

rak sygnałowy
Latin name

Pacifastacus leniusculus Dana, 1852
English name

Signal crayfish

acomm02.	Comments:	
	Polish name (synonym I)	Polish name (synonym II)
	rak szwedzki	…….
	Latin name (synonym I)	Latin name (synonym II)
	…….	…….
	English name (synonym I)	English name (synonym II)
	…….	…….

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	
alien, present in Poland in the environment, established	**x**

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

acomm04.	Comments: in „Comments" (questions acomm04-41) experts should provide **explanations for their answers and list sources of information**. In particular, Comments should explain the decision in cases when data is lacking, incomplete or uncertain, or if the available information is contradictory. Source of the information should also be provided here, with author and year of publication; data sources should be divided into P – published results of scientific research; B - databases; N – unpublished data; I - other; A – author's own data. Detailed information (including full bibliographic record) should be provided at the end of the questionnaire "Data sources". Guidance on data sources citation is available at the end of the *Harmonia*$^{+PL}$ – procedure of negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland. The Signal crayfish has been present in Polish waters since 1971 (Kossakowski et al. 1978 - P). The earliest introduction to open waters was in 1972 near Ełk. Between 1972 and 2010 there were 18 known localities of the species in Poland, including 11 sites confirmed in the field (Śmietana 2011 - P). Currently, there are at least 20 stable populations of the species. This number number may be higher, as populations in different sections of the same river (e.g. in the Drawa, Piława, Wieprza, Pokrzywna and Słupia in the Pomerania) are considered as one (Śmietana – A, Dobrzycka-Kahel et al. 2017 - P). For instance, the population in the Wieprza occupies practically the entire course of the river, including its mouth into the Baltic (Hesse et al. 2016 – I, Śmietana - A). Over the past few years, there rate of expansion has been increasing dynamically, mainly due to unauthorised introductions (Suwalski - N, Laskowski - N, Śmietana - A). Generally, in Poland the species occurs in waters of the lakelands in the northern part of the country. Since 2016 it has also been recorded in southern Poland, in the Raczok stream near Kuźnia Raciborska (Śmietana - A).

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

environmental domain	**x**
cultivated plants domain	
domesticated animals domain	**x**
human domain	**x**
other domains	**x**

acomm05.	Comments: The Signal crayfish negatively affects the environment, aquaculture, infrastructure and, to a lesser degree, humans. Impact on the environment is mainly due to displacement of native crayfish species and transformation of environmental conditions through changes in vegetation structure; negative effects on fish and aquatic invertebrates and macrophytes were also recorded (Nyström and Strand 1996, Guan and Wiles 1997, Vorburger and Ribi 1999, Usio et al. 2001, Stenroth and Nyström 2003, Crawford et al. 2006, Johnson 2014 – P). The domesticated animals domain is affected mainly in terms of impact on native crayfish farming, resulting from transmission of crayfish plague, detrimental for the native species (Oidtman et al. 2006, Souty-Grosset et al. 2006 - P). Direct impact on the human domain is limited – attempts to catch crayfish may result in cuts, usually minor. Impact on other domains is the effect of burrowing by the Signal crayfish, which may weaken causeways, ditches or embankments (Holdich 2000, Śmietana 2011 – 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 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	
high	**x**

aconf02. Answer provided with a

low	medium	high
		x

level of confidence

acomm06. Comments:

The Signal crayfish is already established in Poland. Generally, it is not capable of long-distance crossing of land barriers between waters. However, it can disperse between water reservoirs at distances not exceeding 500 m (Śmietana – N). In nearly all cases, the occurrence of the species in Poland resulted from human-mediated introductions (Śmietana – I).

In rivers, e.g. in the Wieprza, the Signal crayfish is remarkably mobile, easily crossing hydro infrastructure constructions, both down and up the stream (Śmietana – I).

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

low	
medium	
high	**x**

aconf03. Answer provided with a

low	medium	high
		x

level of confidence

acomm07. Comments:

A case of moving the species out of water reservoir with diving equipment is known (Laskowski – N). It is also confirmed that the species can be transferred between water reservoirs with fishing gear, and young individuals may be moved with macrophytes (Śmietana – I).

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

low	
medium	
high	**x**

aconf04. Answer provided with a

low	medium	high
		x

level of confidence

acomm08.	Comments: The species has was intentionally introduced to Poland – a few introduction attempts were undertaken between 1972-1979 (Kossakowski et al. 1978, Krzywosz et al. 1995, Grabowski et al. 2005 – P). Śmietana (2011 – P) reports on intentional releases of the Signal crayfish to waters connected with the Drawieński National Park in the early 1990s. Probably it was illegal introduction of adult individuals brought from Sweden. There were also a few cases of intentional introductions into lakes of the Pojezierze Bytowskie lakeland (Śmietana – I).

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	
optimal for establishment of the *Species*	**x**

aconf05.	Answer provided with a	low	medium	high x

level of confidence

acomm09.	Comments: In its native range the species occurs in areas with climate similar to the one in central Europe, although with more boreal character. Comparing growth rates of the Signal crayfish and the native Noble crayfish, climatic conditions in Poland seem optimal for the American species (Śmietana, Krzywosz, 2006 – P).

a10. Poland provides **habitat** that is:

non-optimal	
sub-optimal	
optimal for establishment of the *Species*	**x**

aconf06.	Answer provided with a	low	medium	high x

level of confidence

acomm10.	Comments: The species is very flexible and adapts to diverse habitats in Polish waters, including different reservoirs (from small ponds to large lakes) and watercourses (from small streams to big rivers). It clearly prefers oligo- and mesotrophic habitats (Śmietana 2011 – P).

A3 | Spread

Questions from this module assess the risk of the *Species* to overcome dispersal barriers and (new) environmental barriers within Poland. This leads 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 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	**x**
high	
very high	

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

acomm11. Comments:

Single source dispersal (Type A)

Despite a few decades of presence of the Signal crayfish in Poland, its distribution remains fairly restricted. It can be attributed to the fact that few people are aware of its presence, thus the risk of intentional transfer to new areas is reduced. In almost all water reservoirs, the species occurrence results from human-mediated introductions. However, there are cases of short-distance self-propelled (up to 500 m) dispersal across the land between water reservoirs (Śmietana – N).

Population expansion (Type B)

When the species enters a watercourse, its self-propelled expansion is very dynamic both up and down the stream. This process has currently been continuing in rivers of the Pomerania, where the species expands despite potential barriers – hydro infrastructure; compare a8 (Śmietana – I).

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

low	
medium	
high	**x**

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

acomm12. Comments:

Practically all introductions to water reservoirs in Poland should be considered as a result of intentional introductions. Within the last few years, the incidence of introductions significantly increased. Once the species is introduced, invasion along watercourses or within water systems results from its remarkable ability to expand without any further human help (Śmietana – I).

A4a | Impact on 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. 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 on the local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as a (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	
low	
medium	**x**
high	

aconf09. Answer provided with a

low	medium	high
		x

level of confidence

acomm13. Comments:

As the Signal crayfish is omnivorous, it can affect different groups of animals and plants (Guan and Wiles 1998 – P). In England, it contributes to decrease in salmonid populations (Peay et al. 2009 – P). Negative impact upon other native fish was demonstrated also elsewhere. In areas in which the species was introduced, it had a significant negative influence on water plants, reducing diversity and abundance of invertebrates, young fish and native crayfish due to predation and competitive displacement (Nyström and Strand 1996, Guan and Wiles 1997, Vorburger and Ribi 1999, Usio et al. 2001, Stenroth and Nyström 2003, Crawford et al. 2006, Johnson 2014 – P). Further expansion of the Signal crayfish will threaten the native and red-listed Noble crayfish *Astacus astacus*. Introduction into south or south-eastern part of the country may have very serious consequences for the last remaining large populations of the native crayfish in Poland (Śmietana and Strużyński 1996 – P). Twardochleb et al. (2013 – P) demonstrated negative impact of crayfish on different organisms, including aquatic macrophytes. However, the scale of negative impact is directly related to the crayfish population numbers, particularly if the species is locally overpopulated. The Signal crayfish is clearly capable of building up such large and dense populations (Holdich 2002 - P).

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

low	
medium	
high	**x**

aconf10. Answer provided with a

low	medium	high
		x

level of confidence

acomm14. Comments:

Competition with native European crayfish was recorded, including *Austropotamobius pallipes* (Söderbäck 1990, Śmietana 2013 – P). Cases of sexual interference (not hybridisation) may be considered as completion for mating (Śmietana – I). Competitive abilities of the Signal crayfish are partly responsible for decrease in native crayfish species (Henttonen i Huner 1999, Holdich et al. 1999, Bubb et al. 2004 – P).

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

no / very low	**x**
low	

medium	
high	
very high	

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

acomm15. Comments:
Hybridisation between *Astacus* and *Pacifastacus* genera is not known. There are records of sexual interference (Śmietana – I), considered as competition for a mate.

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

very low	
low	
medium	
high	
very high	**x**

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

acomm16. Comments:
The species is a vector for crayfish plague, contributing to complete disappearance of the Noble crayfish, recorded e.g. in Finland (Oidtman et al. 2006 – P). Combination of the impact from the crayfish plaque with its high competitive abilities is partly responsible for the decrease also in other European crayfish species (Bubb et al. 2004 – P).

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:
Due to burrowing, the Signal crayfish may have some impact on ecosystem elements. However, as the native Noble crayfish displays the same behaviour, the effect of the American species should not be considered as more negative (Śmietana 2011 – P).

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

low	
medium	**x**
high	

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

acomm18. Comments:
Complex interactions with native species (a13) lead to changes in ecosystem functioning (Souty-Grosset et al. 2006 - P). Twardochleb et al. (2013 – P) demonstrated negative impact of crayfish species on different aquatic organisms, fish, invertebrates and macrophytes, that is, key elements for the ecosystem functioning.

A4b | Impact on cultivated plants domain

Questions from this module qualify the consequences of the *Species* on 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 plants targets through **herbivory or parasitism** is:

inapplicable	
very low	**x**
low	
medium	
high	
very high	

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

acomm19. Comments:
No plants are used in aquaculture in Poland. However, if this practice becomes common in Poland, the Signal crayfish may have some negative impact on such plants.

a20. The effect of the *Species* on cultivated plants targets through **competition** is:

inapplicable	**x**
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 plants 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

level of confidence

acomm21. Comments:
The species is not a plant.

a22. The effect of the *Species* on cultivated plants 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:
No plants are used in aquaculture in Poland.

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

very low	**x**
low	
medium	
high	
very high	

aconf19. Answer provided with a

low	medium	high
		x

level of confidence

acomm23. Comments:
The species is not a host or a vector of pathogens or parasites affecting plants.

A4c | Impact on 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	
low	**x**
medium	
high	
very high	

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

acomm24. Comments:
The Signal crayfish may be a conflicting species in fish aquaculture, both as a predator of small fish and due to competition for food.

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

very low	
low	
medium	
high	**x**
very high	

aconf21.	Answer provided with a	low	medium	high x	level of confidence

acomm25. Comments:
The species may have direct impact on fish and nativ crayfish in aquaculture. For successful crayfish farming, invasion of the Signal crayfish may be the critical factor. However, so far such serious impact has only been detected in a single farm that specialises in breeding the Noble crayfish for reintroduction programmes in Poland (Śmietana – I).

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	
low	
medium	
high	

very high	**x**

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

acomm26. Comments:
Due to transmission of a micro-fungus, *Aphanomyces astaci*, the agent of the deadly fungal disease – crayfish plague, the Signal crayfish may threaten farms in which native crayfish species are bred. However, crayfish farming is not very popular in Poland, with only single farms in operation (Oidtman et al. 2006, Souty-Grosset et al. 2006 - P).

A4d | Impact on human domain

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

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

inapplicable	**x**
very low	
low	
medium	
high	
very high	

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

acomm27. Comments:
The species is not a parasite.

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

very low	
low	**x**
medium	
high	
very high	

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

acomm28. Comments:
The Signal crayfish poses only a minor threat for humans in direct contact. In comparison with native species, mobility of claws in the Signal crayfish is higher, which may increase the probability of hurting humans trying to catch large individuals. The claws of this species are also largest and strongest among all crayfish species in European waters (Śmietana – I).

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

inapplicable	
very low	**x**
low	
medium	
high	
very high	

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

acomm29. Comments:
The species is not known to carry any parasites or pathogens that could be dangerous to humans.

A4e | Impact on other domains

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

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

very low	
low	
medium	
high	**x**
very high	

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

acomm30. Comments:
The species influences stability of hydro infrastructure due to burrowing in ditches, causeways and embankments (Holdich 2000, Śmietana 2011 – P). Assuming that the species expands throughout Poland, the likelihood of such impact should be estimated as high (more than 100 cases per 100 000 infrastructure items per year), while the consequence – as medium (partly reversible); the overall impact should therefore be rated as high.

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 x	medium	high	level of confidence

acomm31. Comments:
The Signal crayfish may have a negative impact on abundance of aquatic organisms, including those of commercial value. In Sweden, the species may build up overcrowded populations that significantly affect fish habitats (Edsman et al. 2010 – P). This negative influence is not balanced by the fact that the Signal crayfish has become the source of food, replacing the native Noble crayfish, depleted due to crayfish plague.

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

significantly negative	
moderately negative	**x**
neutral	
moderately positive	
significantly positive	

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

acomm32. Comments:
The Signal crayfish may have some impact on abiotic conditions of water courses and aquatic vegetation, thus reducing regulation services. When occurring massively, the species may modify mass and energy flow in ecosystems, particularly as an efficient herbivore transforming aquatic (Twardochleb et al. 2013 - P).

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 x	medium	high	level of confidence

acomm33. Comments:
The Signal crayfish is not expected to have any negative impact on cultural services. Thanks to close relation to the native Noble crayfish, the Signal crayfish effectively replaced the native species, extinct due to crayfish plague, in providing cultural services in Scandinavia.

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

Below, each of the Harmonia+ modules is revisited under the premise of the future climate. The proposed time horizon is the mid-21st century. We suggest to take into account the reports of the Intergovernmental Panel on Climate Change. Specifically, the expected changes of atmospherical 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	high
		x

level of confidence

acomm34. Comments:
The species is already established in Poland.

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

decrease significantly	
decrease moderately	
not change	**x**
increase moderately	
increase significantly	

aconf31. Answer provided with a

low	medium	high
		x

level of confidence

acomm35. Comments:
The species has already established breeding populations in Poland, thus the climatic barriers are irrelevant in this respect.

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

decrease significantly	
decrease moderately	**x**
not change	
increase moderately	

increase significantly	

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

acomm36. Comments:
Increase in temperature may limit spread of the Signal crayfish. However, it may be difficult to disentangle the direct effect of temperature from its interactions with other environmental factors (Capinha et al. 2012) – P.

a37. IMPACT ON 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 x	high	level of confidence

acomm37. Comments:
Assuming that climate warming will lead to increase also in average temperature of waters, it can be assumed that the level of adaptation of the Signal crayfish to the environmental conditions will also decrease. Simulations for the Iberian peninsula demonstrated that climate warming will negatively affect the species. Climatic optimum will generally decrease for four alien crayfish species, including *Pacifastacus leniusculus* (Capinha et al. 2012 – P). A similar result was obtained for whole Europe, with the decrease in the species range estimated to be about 30% (Gallardo i Aldridge 2013 – P).

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

decrease significantly	
decrease moderately	
not change	**x**
increase moderately	
increase significantly	

aconf34.	Answer provided with a	low	medium	high x	level of confidence

acomm38. Comments:
There are no crops in Poland that could be affected by the species.

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

decrease significantly	

decrease moderately	**x**
not change	
increase moderately	
increase significantly	

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

acomm39. Comments:
Climate warming, as argued in a37, will contribute depleting environmental conditions for the Signal crayfish. Available data indicate that this may lead to limiting the species distribution because of its preferences to boreal climate (Gallardo and Aldridge 2013 – P). Unsuccessful introductions of the Signal crayfish in the Iberian peninsula seem to confirm this supposition (Capinha et al. 2012 – P). Taking into account high adaptive capabilities of the species, it is difficult, however, to assume that this would lead to a significant decrease in the species and significant lowering of its impacts.

a40. IMPACT ON 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 Signal crayfish has limited direct consequences on humans 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	**x**
not change	
increase moderately	
increase significantly	

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

acomm41. Comments:
Assuming potential influence on other domains, particularly on hydro infrastructure, as argued in a30, climate warming may lead to decrease in the level of impact because of lower adaptation of the Signal crayfish to altered environmental conditions (Capinha et al. 2012 – P, Gallardo and Aldridge 2013 – 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)	0,50	1,00
Cultivated plants impact (questions: a19-a23)	0,00	1,00
Domesticated animals impact (questions: a24-a26)	0,67	0,67
Human impact (questions: a27-a29)	0,13	0,25
Other impact (questions: a30)	0,75	0,50
Invasion (questions: a06-a12)	0,92	1,00
Impact (questions: a13-a30)	0,75	0,68
Overall risk score	0,69	
Category of invasiveness	moderately invasive alien species	

A6 | Comments

This assessment is based on information available at the time of its completing. It has to be taken into account, however, that biological invasions are, by definition, very dynamic and unpredictable. This includes introductions of new alien species and detection of 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.

Below you can include your own comments on the assessment.

acomm42.	Comments: This risk assessment classified the Signal crayfish as moderately invasive alien species in Poland. The maximum values of negative impact (0.75) were scored for the impact on other domains (a30). In environmental impact module, questions on competition (a14) and on transmission of pathogens and parasites (a16) scored the maximum value (1.0) with high levels of confidence (1.0). However, the overall result was lowered by lower levels of negative impact in other points in this module. Categories of invasiveness in this assessment were defined *a priori*, without knowing the distribution of actual values of this parameter. The maximum value scored by the Signal crayfish (0.75) falls 0.01 down the limit of classifying species as highly invasive (0.76). Despite the overall outcome of this risk assessment, suggesting that the Signal crayfish is only moderately invasive, it should be remembered that the invasion of this species may have detrimental effect of the native Noble crayfish. There is a risk that any introduction of the signal crayfish into diminishing populations of the Noble crayfish may lead to their total extinction. The Signal crayfish may also rich very high densities and severely affect aquatic habitats. In this context, it is a very invasive alien species. These considerations should be taken into account when decisions are made about the management approach for the assessed species, including their prioritisation.

Data sources

1. Published results of scientific research (P)

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2. Databases (B)

3. Unpublished data (N)

4. Other (I)

Laskowski P. – przeniesienie raka sygnałowego na sprzęcie do nurkowania.

Suwalski T. – informacja o występowaniu raka sygnałowego w Darłowie.

5. Author's own data (A)

Śmietana P. – Information from a 20-year research into distribution and ecology of freshwater crayfish in Europe.