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. Przemysław Śmietana
2. Maciej Bonk
3. Wojciech Solarz

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	Department of Plant Ecology and Environmental Protection, Faculty of Biology, University of Szczecin	25-01-2018
(2)	mgr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	10-01-2018
(3)	dr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	05-02-2018

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

Polish name: Rak pręgowaty

Latin name: ***Orconectes limosus*** (Rafinesque, 1817)

English name: Striped crayfish

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:

A more correct name would be striped crayfish – this species has no stripes as such, the spots on the abdomen resemble stripes. Another common name for it is American crayfish.

Polish name (synonym I) Rak amerykański	Polish name (synonym II) -
Latin name (synonym I) *Astacus limosus*	Latin name (synonym II) *Faxonius limosus*
English name (synonym I) American crayfish	English name (synonym II) Spinycheek crayfish

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 **X**	level of confidence

acomm04.	Comments:

The most common and the most numerous crayfish in Poland. In Pomerania (Western Pomerania, Central and Gdańsk Pomerania) at least 865 habitats were found (Śmietana 2011, 2013 – P) and over 1383 in the whole country(Pockl et al. 2006 – P). Large ecological plasticity translates into the species adaptation to the conditions offered by very diverse water habitats. It occurs in waters flowing from small watercourses (however, it avoids the upper course i.e. the land of trout, which includes the upper course of the stream together with the spring zone, with cold (temperature does not exceed 10 °C), transparent and rapidly flowing water, stony and gravel bottom, to large rivers like Vistula and Oder. It is found in all types of reservoirs from lobelia lakes to hypertrophic fire reservoirs, as well as from ponds, through all types of lakes (except acidified and mountain), to coastal waters of the Baltic Sea (Szczecin Lagoon, Vistula Lagoon, Pomeranian Bay, Gulf of Gdańsk) (Leather 2007 – I, Śmietana 2013 – P, Karolak 2017 – I, Szaniawska et al. 2017 – P). A series of new habitats not presented in the foregoing works were found recently slightly south of the known species border in Poland (Bonk et al. unpublished). However, this species probably does not occur in the south-eastern part of the country and most of the Polish Carpathians (Kouba et al. 2014 – P, Bonk et al. 2017 – A).

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

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

acomm05.	Comments:

The species mainly affects native crayfish as a disease vector (e.g. Kozubíková et al. 2011, Śmietana 2011 – P) a competitor and stress factor, among others to fish – for example by

occupying the same hiding places (Hirsch and Fischer 2008 – P). It also affects mass and energy flow in water ecosystems (Hartel-Borer et al. 2005 – P). The impact on other constituents of aquatic habitats and biocenoses is relatively poorly researched, yet no strong impacts have been found so far, translating into a decline in the level of biodiversity. The species digs burrows (e.g. Holdich and Black 2007 – P, Bonk – A), may potentially have an impact on other objects, e.g. on ponds, etc. The species found in breeding ponds (Nowak 2017 – A) – may compete with fish for food. The impact on people is minimal. Fishermen, anglers and other people using open water can be hurt when catching the striped crayfish (Bonk – A).

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 found in the vast majority of Poland (e.g. Śmietana 2011, Kouba et al. 2014 – P). The first introduction carried out by the German breeder into European waters took place in 1890 in present-day Poland in Barnówek in Western Pomerania (100 individuals entered into a small pond) and hence the species spread to the vast majority of contemporary habitats (Śmietana 2013 – P). In Poland, as a result of independent expansion running from dispersion centers from North to South, the number and thus the concentration of species occurrence increases (Śmietana 2013 – 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:

Striped crayfish can be transferred between waters on fishing, recreational, transport equipment or as a bottom substrate, also with aquatic vegetation. Transfer in fishing nets is confirmed (Holdich et al. 2006, Śmietana 2013 – P), as well as in aquatic vegetation, e.g. Canadian waterweed (Śmietana 1998-2017, 2014-2016 – N). A common occurrence in the country (Śmietana 2011 – P) increases the risk of accidental movement of individuals.

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 was introduced to Poland intentionally (Filipová et al. 2011, Śmietana 2011 – P). Striped crayfish is often deliberately introduced into "new" waters by humans. Most often as an excess of unused bait in fishing, in order to confirm the quality of owned waters (based on the knowledge: "where the crayfish live, there the water is clean "), to willfully recreate the historical occurrence of other crayfish species. All these cases are determined by the lack of knowledge about the occurrence of crayfish species other than the striped crayfish in the Polish waters, and as a consequence, the identification of the striped crayfish with the noble crayfish (Śmietana 2013 – P) found in the sale offers of organisms used for the settlement of garden ponds and in the living state at fish stands at marketplaces and at local suppliers (Śmietana 1998-2017, 2014-2016 – N).

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 comes from a climatic zone close to the Central European conditions (e.g. Hamr 2002 – P). In addition, the history of changes in displacement, as well as the current state in Europe, indicate the existence of extremely favorable climatic conditions, also in Poland. The current climatic conditions are clearly more favorable to the striped crayfish, rather than the native noble crayfish (Śmietana 2013 – P). The noble crayfish may be considered largely a post-glacial relic. Śmietana (2013 – P) showed that the last natural habitats of noble crayfish in Pomerania have been preserved in areas with a harsher climate and clearly lower human pressure exerted, e.g. the level of eutrophication. The universality of the effects of anthropopression (such as, for example, pollution, eutrophication, regulation of watercourses, eel fry-stocking, over-exploitation, etc.) do not adversely affect populations of the striped crayfish (Śmietana 2013 – P). In response to this question, the map of the similarity of climates included in the Harmonia^{+PL} manual was also used. According to it, climatic conditions largely coincide with those in the original occurrence of the species.

a10. Poland provides **habitat** that is

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

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

acomm10. Comments:

The species is characteristic of lowland waters (e.g. Talbot 1985 as cited in Śmietana 2011 – P). High adaptive ability, however, predestines this species to occupy a wide spectrum of aquatic habitats in Poland. It is common in many habitats like medium and large rivers,

canals, small rivers and streams, lakes, ponds, clay pits, dammed reservoirs (Śmietana 2011 – P, Bonk – A), its presence is also found in the brackish waters of the Baltic Sea, where it may reproduce (Szaniawska et al. 2017 – P). It is not found in the upper cuts of watercourses (trout land) and tanks with low pH (less than 5.5). In particularly favorable conditions, it periodically creates very large populations. Anthropogenic changes in habitats, including the growth of trophies and pollution, do not constitute a habitat barrier for this species (Śmietana 2013 – P). It does not have the bioindication value of high-quality habitats, as it is in the case of noble cancer.

A3 | Spread

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

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

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

	very low
	low
	medium
	high
X	very high

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

acomm11. Comments:

Expansion of population (data type B)

The spreading of this species without human involvement is strongly determined by the continuity of the habitat, i.e. it is possible if there are water connections between watercourses and reservoirs. Under such conditions, this species can spread very quickly. It is worth noting, however, that a significant part of lakes and other reservoirs is connected with each other by rivers or canals, which enables effective dispersion. The species has also penetrated to most of the main river basins in Poland, so the network of watercourses enables it to have virtually unlimited possibilities for dispersion by water. It is worth noting that transverse restrictions, such as weirs and dams do not constitute a barrier to this species. This is evidenced by the current distribution of the striped crayfish in Poland's river systems, which is particularly visible on the basis of results collected for Pomerania (Śmietana 2013 – P).

Population expansion: the established pace of mastering new areas in Europe is 2.5 to 24 km a year (Hudina 2009 – P). Therefore, it is a very large expansion capacity which should also be adopted in Poland. The species is able to move between tanks that are not too far apart as well (Puky 2014 – P), which additionally, but slightly, increases its potential in terms of spreading. Spontaneous movement between isolated basins should be considered as very limited and rather accidental (Śmietana 1998-2017, 2014-2016 – N)

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: Lack of detailed data, yet frequent occurrence and potential use of the species as a fishing bait, are circumstances conducive to its rapid spread. Lack of awareness of the occurrence of different species of crayfish and the ability to recognize them, is a highly harmful synergy in the spread of the species with the participation of humans. Striped crayfish is introduced as an excess of unused bait, with fishing gear during fry-stocking and willfull introduction of crayfish (Holdich and Black 2007, Śmietana 2013 – P). Over 10 years, at least 10 habitats of the striped crayfish were destroyed this way in Pomerania (Śmietana 1998-2017, 2014-2016 – N). The scale of crayfish dislocations is probably large and the transfer to distances over 50 km may occur more often than 10 times per decade.

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
	low
	medium
X	high

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

acomm13.	Comments: The problem of significant impact of the species through these interspecies interactions (Śmietana 2011 – P) has not been studied so far. However, due to the number of individuals in some populations, this can definitely not be ruled out, and even considered highly probable and dangerous for special care species in terms of coexistence (e.g. fish, newt). There are confirmed cases of eating the vendace spawn, which can also be treated as an accidental interaction related to eating the substrate on which the spawn was laid (Sakowicz and Kompowski 1961 – P). The species eats molluscs (Klocker 2004 – P), although its impact on native molluscs species is not known, it can be assumed that it may potentially threaten, for example the thick shelled river mussel *Unio crassus* and swan mussel *Anodonta cygnea* (EN category – endangered – which is ascribed to species with high risk of extinction in the near future (Zając 2004a, Zając 2004b – P)). Šidagyte et al. (2017 – P) based on laboratory tests suggest that it may affect invertebrate clusters in waters. The species prefers vegetable food (Orzechowski 1984 – P) and in the case of strong populations, it can potentially significantly affect tank biocenosis.

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

	low
	medium
X	high

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

acomm14. Comments:

A highly competitive species for the native species of noble crayfish *Astacus astacus* (an endangered species (VU) according to IUCN and The Polish Red Data Book of Animals, Krzywosz and Śmietana 2004 – P) and narrow-clawed crayfish *Astacus leptodactylus* (Śmietana 2013 – P). VU vulnerable category – it is given to species that may quite soon become extinct, though not as fast as endangered species, which are given the EN status (endangered). Coexistence with indigenous species always ends with the displacement of the native one. Among the decisive mechanisms there are: transmission of the plague and the competitive advantage resulting from a different life strategy (r). This strategy is typical for species living in conditions of strong competition and is characterized, among others, by short life expectancy, rapid start of reproduction and achievement of maximum fertility, fast pace of individual growth. Native crayfish use a completely different life strategy type "K". In the case of striped crayfish, strategy type "r" determined by higher fertility, faster growth rate especially in the first year of life (Śmietana 2008, 2013 – P), lower susceptibility to predation, including fishing exploitation, interference (disruption) of the noble crayfish mating process (Śmietana 2016 – P) consisting in the attempts of mating *O. limosus* males with *A. asatcus* females, which often results in the loss of laying and mutilation of noble crayfish females. The results suggest that interspecies interactions between these two species may contribute to the displacement of noble crayfish (Musil et al. 2010 – P). Prognosis concerning the prevalence of noble crayfish in Pomerania indicate that if the rate of expansion of striped crayfish is not stopped, the rate of disappearance of the native crayfish population will increase at least four times (Śmietana 2013 – P). A drastic reduction in the number of noble crayfish in the Cracow Dąbski Pond may be associated with the emergence of striped crayfish (Stanek et al. 2015 – I). Furthermore, he species competes for habitats with native species of fish in Europe (e.g. with burbot (*Lota lota*), Hirsch and Fischer 2008 – P). It may compete with such fish species as: Amur bitterling (*Rhodeus sericeus*) and spined loach (*Cobitis taenia*), yet there is no data on this subject (Śmietana 1998-2017, 2014-2016 – N).

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:

This species does not interbreed in the strict sense of the term, with any of the crayfish found in our waters. However, it was found that mating of male striped crayfish with female striped crayfish resulting in the loss of laying (consisting of the detachment of almost all eggs that the female has attached to the abdomen during almost six months of incubation) and loss of limbs in the latter (Śmietana 2016 – P).

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
X	very high

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

acomm16. Comments:

A species recognized in Europe as one of the main vectors of water mold (*Aphanomyces astaci*) causing in native crayfish a lethal disease called crayfish plague, e.g. the noble crayfish, a special care species (Oidtmann et al. 2006, Schulz et al. 2006, Kozubíková 2011, Śmietana 2011 and works cited therein – P). In the Danube basin, it was shown that 32% of invasive crayfish (including striped crayfish) were carriers of *A. astacii* (Pârvulescu 2012 – P). Nevertheless, in Poland, for the first time in the world, there were several dozen individuals of striped crayfish free from *A. astaci* (Schrimpf et al. 2006 – P), which may indicate that its effect as a disease vector can be different in different locations. *Aphanomyces astacii* is on the OIE list.

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 **X**	high	level of confidence

acomm17. Comments:

The only known phenomenon that can disturb the abiotic factors caused by the striped crayfish is digging burrows in the bottom. Considering the much lower tendency to dig burrows compared to the native noble crayfish, the impact of striped crayfish on the integrity of the ecosystem should be considered rather insignificant for this reason. This impact should not be of greater importance for special care habitats.

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

	low
	medium
X	high

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

acomm18. Comments:

As an omnivore the species may influence the aquatic vegetation, changing the habitat conditions for other organisms. The impact on plants can affect the following natural habitats: e.g. 3260 – water courses of plain to montane levels with the *Ranunculion fluitantis* vegetation, 3150 – natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation. It can affect the composition of macrophytes in the water directly as a herbivore, and indirectly as a predator – by eliminating other herbivores (e.g. snails) that affect vegetation in the water (Śmietana 1998-2017, 2014-2016 – N). By far the strongest disrupting phenomenon in the ecosystem related to the occurrence of the striped crayfish is the displacement of native crayfish species, thus reducing their role in the ecosystem, including in special care habitats.

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:

In Poland, no aquatic plants are grown. However, if such crops are introduced, the species may have a limited negative impact.

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:

This 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:

This species is not a plant.

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: In Poland, no aquatic plants are grown. If such crops are introduced, the species may have potential effects through its herbivorousness. Less important is the indirect influence of the species on water structures.

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 not a vector of pathogens and plant parasites.

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
	low
	medium
X	high
	very high

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

acomm24.	Comments: The species may be conflicting in fish farms, both as a predator eating roe and small individuals (Sakowicz and Kompowski 1961 – P). It is difficult to estimate the frequency with which it can come into contact with breeding organisms. The species is sometimes found in breeding ponds, which means that the frequency of impacts can be high (in the high category). On the other hand, the effect on particular individuals does not always have to end in death or injury. Due to attempts to interbreed with native crayfish, mutilated female crayfish may occur.

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
X	high
	very high

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

acomm25.	Comments: Possible aggression and body mutilation in small animals in aquaculture in case of accidental entry of individuals of this species.

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
X	very high

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

acomm26.	Comments: This species is a vector of crayfish plague preset on the OIE list. In the case of transmission and triggering an epidemic of this disease in breeding individuals of noble or narrow-clawed crayfish, it completely destroys the breeding effect (Oidtmann et al. 2006, Kozubíková 2011, Śmietana 2011 and the works cited there, Śmietana 2016 – P, Śmietana 1998-2017, 2014-2016 – N). Although there are very few mixed populations of noble and striped crayfish, and populations where no striped crayfish infected with "crayfish plague" (Schrimpf et al. 2006 – P) were found. However, this does not change the level of threat created by this species in any way.

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 parasite.

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

	very low
X	low
	medium
	high
	very high

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

acomm28. Comments:

Claws ended with sharp spikes may break the continuity of the skin layers in the body of a pinched man. Apart from the danger of bacterial infection, they do not pose serious threats to human health. Such a threat can be relatively frequent (though difficult to estimate). It is also difficult to explicitly name minor injuries, the effects of mutilations are usually minimal.

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 and parasites that could be transmitted by the species and that could endanger a human being. Possible infection may occur in the case of human injury caused by crayfish. Pathogens causing possible infections are not specific to striped crayfish and there are no indications that they are common, i.e. capable of causing infection in both humans and crayfish.

A4e | Impact on other domains

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

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

	very low
	low
X	medium
	high
	very high

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

acomm30. Comments:

Burrow digging species (Gherardi et al. 2002 – P) may constitute a potential locally high threat to the sustainability of flood control infrastructure, e.g. earthworks, dams or embankments. The frequency of impacts of varying strength on buildings and fortifications can be relatively large, whereas the effect should generally be reversible.

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	high **X**	level of confidence

acomm31. Comments:

Due to the fact that it is possible to transmit plague to native crayfish farms, this impact may be large, but due to a small number of such types of farms currently existing, the final assessment is moderately negative. This species can also have a negative impact on the economically acquired fish.

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

X	significantly negative
	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm32. Comments:

The species is important for the mass and energy flow in ecosystems through food effects on macrophytes (Hartel and Borer 2005 – P). Thus, as a herbivore, it can affect the aquatic vegetation. Due to the fact that as a result of human impact, there are a number of adverse changes in habitats, it is difficult to assess the absolute level of impact resulting only from the activity of the species at the level of regulatory services. The assessment was based on the precautionary principle.

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 **X**	high	level of confidence

acomm33. Comments:

Due to a strong establishement in the Polish culture (e.g. culture of speech) of the noble crayfish, the striped crayfish through its commonness, enables a certain conceptual continuity in the sense of catchphrases or proverbs containing the word “crayfish”. Due to lack of protection and the availability of striped crayfish, it is used as a culinary object in the local cuisine (e.g. Kashubian) and festivities promoting the protection of native species (Śmietana 2016 – P).

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

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

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

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm34. Comments:

The current distribution of the species (e.g. Kouba et al. 2014 – P) suggests that it does not colonize mountain areas. Increasing the temperature can facilitate colonization of colder mountain watercourses (in lower locations of trout land).

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
	not change
X	increase moderately
	increase significantly

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

acomm35. Comments:

The species occurs and reproduces in Poland – there are no barriers mentioned above in most areas of the country. However, there may be colonization of previously inaccessible cool submontane and montane streams, and in the lower rivers of the trout land.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm36.	Comments: The current distribution of the species (e.g. Kouba et al 2014 – P) suggests that it does not colonize mountain areas. Increasing the temperature may facilitate the colonization of colder mountain watercourses and those of such character (e.g. Pomeranian rivers). The increase in average temperatures of inland waters will contribute to the increase of ecological resilience (higher fertility, faster growth rate) of this relatively thermophilic species.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm37.	Comments: The increase in average temperatures of inland waters will contribute to the increase of ecological resilience (higher fertility, faster growth rate) of this relatively thermophilic species. The impact may also increase in the case of colder water courses, where suboptimal conditions prevail.

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: The species does not affect the plants grown in Poland.

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	high **X**	level of confidence

acomm39.	Comments: Climate change may cause undesirably high dynamics of the species resulting from the higher rate of metabolism of this cold-blooded organism in some pond fish farms, which may increase its negative impact on these farms by accelerating the foregoing negative traits of the species.

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:

This impact is currently very small and results from aggressiveness of this species when captured. There is no reason to conclude that climate change will significantly affect the behavior of crayfish, as well as the frequency of events involving them. On the other hand, higher ambient temperature significantly increases the motor efficiency of this cold-blooded organism (Holdich et al. 2002 – P), potentially increasing the probability of pinching and its strength.

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:

Higher ambient temperature significantly increases the motor efficiency of this cold-blooded organism and ecological resilience. One can expect an increase in the probability of damage to hydraulic equipment (dams, embankments), caused by a greater number of more active crayfish digging their burrows.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	1.00	1.00
Environmental impact (questions: a13-a18)	0.67	0.83
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.83	0.67
Human impact (questions: a27-a29)	0.13	1.00
Other impact (questions: a30)	0.50	1.00
Invasion (questions: a06-a12)	1.00	1.00
Impact (questions: a13-a30)	0.83	0.90

Overall risk score	0.83	
Category of invasiveness	very 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: Striped crayfish is currently a species widespread in Poland. The only place it does not occurr is the Carpathians, which may be the result of an inconvenient habitat and climatic conditions, or a considerable distance from the dispersion centers (colonization of the area of Poland for this species runs from North to South). Research to answer these questions will be undertaken in the near future (Bonk et al. 2017 – A). This species always displaces the native noble crayfish in case of their coexistence and is one of the most important factors determining the extinction of the native species on the Polish Lowlands (Śmietana 2013 – P). The presence of plague is particularly dangerous, but not all populations are carriers of the most virulent strains of this oomycete, as there are a few mixed populations of noble and striped crayfish, and populations with no infected striped crayfish (Śmietana 2013 – P). Nevertheless, noble crayfish, despite the lack of mass mortality, are in regress in such situations. One such situation is well documented (Krakow, Stanek et al. 2015 – I). The species has great potential for spreading, hence one should expect further pressure put on noble crayfish.

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