



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. Tomasz Kakareko
2. Joanna Grabowska
3. Karolina Mazurska

acomment01.	Comments:	degree	affiliation	assessment date
	(1)	dr hab.	Department of Hydrobiology, Faculty of Biology and Environmental Protection, The Nicolaus Copernicus University, Toruń	24-01-2018
	(2)	dr hab.	Department of Ecology and Vertebrate Zoology, Institute of Ecology and Environmental Protection, Faculty of Biology and Environmental Protection, University of Lodz	20-01-2018
	(3)	mgr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	31-01-2018

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

Polish name: Babka łyśa (babka gołogłowa)

Latin name: ***Neogobius gymnotrachelus*** (Kessler, 1857)

English name: Racer goby

acomm02.	Comments:	According to FishBase (2018 – B) the racer goby belongs to Babka genus, not Neogobius. In the database, this species is designated: Babka gymnotrachelus (Kessler, 1857).	
	Polish name (synonym I)	Babka gołogłowa	Polish name (synonym II) –
	Latin name (synonym I)	<i>Gobius burmaisteri</i>	Latin name (synonym II) <i>Gobius gymnotrachelus</i>
	English name (synonym I)	Goad goby	English name (synonym II) –

a03. Area under assessment:

Poland

acomm03.	Comments:	–
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a04. Status of the species in Poland. The species is:

<input type="checkbox"/>	native to Poland
<input type="checkbox"/>	alien, absent from Poland
<input type="checkbox"/>	alien, present in Poland only in cultivation or captivity
<input type="checkbox"/>	alien, present in Poland in the environment, not established
<input checked="" type="checkbox"/>	alien, present in Poland in the environment, established

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

acomm04.	Comments:	The racer goby derives from the Pontocaspian region. For the first time, it was found in Poland in the Bug River in 1995 (Danilkiewicz 1996 – P). In 2000, it was caught in the Wrocławski Reservoir (Kostrzewa and Grabowski 2001 – P). Within 3-4 years, it colonized a considerable portion of the Lower Vistula River, moving downstream in the current of the river. There are no data on its dispersion upstream in the Vistula River. This species forms stable, reproducing populations in Polish waters (Kakareko et al. 2009 – P, Płachocki 2017 – I, Non-native species in Poland 2018 – B).

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

<input checked="" type="checkbox"/>	the environmental domain
<input type="checkbox"/>	the cultivated plants domain
<input checked="" type="checkbox"/>	the domesticated animals domain
<input checked="" type="checkbox"/>	the human domain
<input type="checkbox"/>	the other domains

acomm05.	Comments:	The racer goby is an important link in the food web, both as a bentophage (Grabowska 2005, Kakareko et al. 2005 – P), and an important prey for many native fish species (Płachocki et al. 2012 – P). This species preys on the benthic fauna, thus reducing the food resources and increasing competitive tension between fish. It can drive from microhabitats (shelters) of other fish species having the similar biology, e.g. the European bullhead (<i>Cottus gobio</i>), which is a protected species in Poland (the ordinance of the Minister of Environment of the 16 th December 2016 on the species protection of fauna, Council Directive 92/43/EEC – I). This species can transfer parasites, posing a threat to other fish, as well as to humans (nematode <i>Eustrongylides excisus</i>).

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:

<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

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

acomm06. Comments:
The racer goby penetrates independently the territory of Poland, via the so-called the central migration corridor for the Ponto-Caspian fauna. The corridor runs from the Black Sea, the Dnieper and Prypeć Rivers, the Dnieper-Bug Canal, and the Muchawiec (a tributary of the Bug River) to Poland, and then with possible further expansion through the Bydgoszcz Canal, the Noteć, the Oder, to Germany and Western Europe (Alien species in Poland 2018 – B).

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

<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

aconf03.	Answer provided with a	low	medium	high	level of confidence
				X	

acomm07. Comments:
The river transport plays a significant role in spreading of Ponto-Caspian fish gobies in large European rivers (Wiesner 2005, Roche et al. 2013 – P); therefore, the racer goby can be moved passively (e.g. in the form of eggs and / or individuals in tanks filled with outboard water) for long distances. The spread of the racer goby is also attributed to inland channels connecting large river mouths and transformations of the river bed, which lead to increasing the portion of the stony bottom, which is abundant in microhabitats (shelter) for this species (e.g., stony embankments). All of the above mentioned factors increase the probability of the introduction of the racer goby in areas yet non-colonized, also in Poland.

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

<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

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

acomm08. Comments:
No cases of the introduction of this species to the natural environment for animal production in Poland have been known. Anglers can contribute to the spread of the racer goby, because it is used as a live bait (Kakareko 2018a, author’s observations – A). There is no data on the extent of this phenomenon. If the high number of the racer goby is considered, the probability has been assessed as high.

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:

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | non-optimal |
| <input type="checkbox"/> | sub-optimal |
| <input checked="" type="checkbox"/> | optimal for establishment of <i>the species</i> |

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

acomm09.	Comments: Climatic conditions for the racer goby in Poland are favourable for development and reproduction, and it creates numerous breeding populations locally (Płachocki 2017 – I). The conditions for the development in the temperate climate are convenient, with its optimum in the temperature range between 4°C and 20°C (FishBase 2018 – B).
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a10. Poland provides **habitat** that is

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | non-optimal |
| <input type="checkbox"/> | sub-optimal |
| <input checked="" type="checkbox"/> | optimal for establishment of <i>the species</i> |

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

acomm10.	Comments: The racer goby has optimum habitat conditions in Poland, and it is an established species here. It is highly flexible in terms of the habitat. Laboratory research shows that it prefers slow water flow (10 cm/s) and muddy bottom (Kakareko 2011 – P). However, it can occupy various types of running water (big and smaller rivers, faster watercourses), as well as stagnant water (lakes, bays) (FishBase 2018). It occurs mainly in the muddy or muddy-sandy bottom, but it is also found in sandy or gravel bottoms (Pinchuk et al. 2003 – P). It is usually found in places with a considerable complexity, e.g., overgrown by macrophytes (FishBase 2018 – B). In the Włocławek Reservoir, it extends across the whole width of the reservoir, in flooded areas (4-5 m deep) as well as in the former bed of the Vistula River (10-12 m) (Kakareko 2011 – P).
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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:

- | | |
|-------------------------------------|-----------|
| <input type="checkbox"/> | very low |
| <input type="checkbox"/> | low |
| <input type="checkbox"/> | medium |
| <input type="checkbox"/> | high |
| <input checked="" type="checkbox"/> | very high |

aconf07.	Answer provided with a	low	medium	high X	level of confidence
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acommm11.

Comments:
Population expansion (data type B)
The racer goby has colonized a considerable section of the lower Vistula within 3-4 years – at least approx. 100 km section between Włocławek and Bydgoszcz (Kakareko et al. 2009 – P), which meets the highest criterion of Harmonia+PL (the species range extends at the speed higher than 10 kilometres per year), and the evaluation of the ability to independent spread is assessed as very high. The racer goby was found for the first time in Poland in the Bug River in 1995 (Danilkiewicz 1996 – P). In 1997-1999, it was not recorded in the Vistula (Wiśniewolski et al. 2000 – P). In 2000, a racer goby was found in the Włocławek Reservoir (Kostrzewa and Grabowski 2001 – P). In 2003-2004, the number of specimens was quite high during research fishing in the Vistula River in Toruń and Bydgoszcz (Gawroński 2004 – I, Kakareko et al. 2009 – P).

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
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acommm12.

Comments:
The river transport plays an important role in spreading Ponto-Caspian gobies in large European rivers (Roche et. al. 2013 – P); thus, the racer goby can be transferred by man unintentionally, passively (e.g., in the form of eggs and / or individuals in outboard water tanks) for long distances, including inland channels connecting large river basins. Anthropogenic transformations of rivers (stony river embankment, port infrastructure, dam reservoirs) create favourable habitats for this species and support its expansion. The racer goby can be also spread in Poland by anglers, because it is used as a live bait (Kakareko 2018a, author's observations – A). There is no data on the scale of this phenomenon. The racer goby is probably used as bait in places where it usually occurs. However, transferring the specimens for a distance longer than 50 km cannot be excluded. Due to the fact that the racer goby can occur locally in large numbers, the frequency with which the species spreads in Poland with human participation may be estimated as high.

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

<input checked="" type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf09.	Answer provided with a	low	medium X	high	level of confidence
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a13. Comments:
The species affects native species – but only invertebrates – by predation. In environments occupied by this species in Poland (rivers, dam reservoirs), the racer goby feeds mainly on amphipods (*Amphipoda*), midges larvae (*Chironomidae*), and bivalves (*Mollusca*), while other invertebrates are a smaller part of this diet, fish is only minimal (Kostrzewa and Grabowski 2003, Kakareko et al. 2005, Grabowska 2005 – P, Alien species in Poland 2018 – B). The predation impact of this species on the preyed populations has not been studied so far. It has been determined in this questionnaire as medium, because the racer goby can occur locally in big numbers and it affects the population size of native invertebrate populations preyed upon. Its impact is significant to non-special care species, while the effect to the population size of special care species is smaller, which include solid orb mussel: (*Sphaerium solidum*) protected in Poland and the river orb mussel (*Sphaerium rivicola*) (ordinance of the Minister of Environment of the 16th of December, 2016, on the protection of animal species – I).

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

<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

aconf10.	Answer provided with a	low	medium X	high	level of confidence
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a14. Comments:
There are clear premises indicating that the racer goby is a threat, and it competes with the European bullhead – a species protected in Poland and listed in Annex II of the Council Directive 92/43/EEC – I. The racer goby occurs in microhabitats in the form of shelters among submerged elements (stones, roots, empty shells of bivalve *Anodonta* sp., litter) (Alien species in Poland 2018 – B). Especially, in the reproductive period, the male aggressively protects the place selected by it for the establishment of the nest. Experimental laboratory research has shown that, in spring, the racer goby drives the European bullhead from such microhabitats (Grabowska et al. 2016 – P). As the more aggressive fish, the racer goby is more effective in competition with this species, chasing it away from feeding grounds and reducing the time of feeding for this species (Kakareko et al. 2013 – P). In natural conditions, the adverse impact of the racer goby on the European bullhead is minimized as a result of habitat selection (Kakareko et al. 2016 – P). Conclusions from field studies are not unambiguous. Van Kessel et al. (2016 – P) report the decrease in the population number after Ponto-Caspian gobies had occurred. Janáč et al. (2018 – P) have not confirmed this finding. The racer goby can compete for food and space with other native fish species, but no negative impact on these species has been documented.

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

<input checked="" type="checkbox"/>	no / very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf11.	Answer provided with a	low	medium	high X	level of confidence
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acom15.

Comments:

In Polish freshwaters where the racer goby occurs, there are no native species closely related to this species (from *Gobiidae* family). No cases of hybridization between the racer goby and native fish species have been recorded.

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

aconf12.

Answer provided with a

low	medium X	high
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level of confidence

acom16.

Comments:

The parasitic fauna of the racer goby in newly occupied waters consists mostly of taxa typical for these waters, which occur in native fish species (Mierzejewska et al. 2014 – P). There are no studies implicitly indicating the contribution of the racer goby in transferring parasites within fish groups in occupied habitats. It is noted that, in the case of studies in the Włocławek Reservoir (Mierzejewska et al. 2014 – P), the presence of Ponto-Caspian gobies affects the proportions of parasites in a specific area (rare parasites in local fish were numerous in non-native species). In this case the non-native fish species, including the racer goby, they have become a factor supporting the development of populations of some parasites in the reservoir: *Apatemon gracilis*, *Bucephalus polymorphus*, and *Holostephanus spp.* (Kvach i Mierzejewska 2011, Mierzejewska et al. 2014 – P). Because of the transfer of cosmopolitan parasites by the racer goby in Poland to special care species (e.g., European bullhead, stone loach (*Cobitis taenia*), bitterling (*Rhodeus sericeus*)), the impact of this species has been determined as big in accordance with the instruction of Harmonia^{+PL}. Racer gobies are a host for fluke *Gyrodactylus proterorhini* (Mierzejewska et al. 2011, Mierzejewska i in. 2014 – P), a species new to Poland. Although *G. proterorhini* is considered a species specific to the goby family (*Gobiidae*), monitoring has been conducted of native fish from the *Perciformes* order in terms of the presence of the fluke due to the relationship of these fish with *Gobiidae* (Mierzejewska et al. 2014 – P). So far, *G. proterorhini* has been not found in native fish species.

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

- low
- medium
- high

aconf13.

Answer provided with a

low	medium X	high
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level of confidence

acom17.

Comments:

There are no premises indicating that the racer goby can disturb abiotic factors of the ecosystem. Specimens of this species can dig shelters in the bottom, collecting sand and silt in their muzzle and transporting it to another place (Kakareko 2013 – A). This is likely to bring about, at most, easily reversible changes in the bottom structure in habitats not classified as special care ones.

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

- low
- medium
- high

aconf14. Answer provided with a

low	medium X	high
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 level of confidence

acomm18. Comments:
The racer goby is a link of the food web, because it feeds mainly on invertebrates, and it is the prey for piscivorous fish. Potentially, it can compete with other fish for food and habitats. However, the knowledge of the impact of this species on other organisms is small. Because this species does not occur in very large numbers, it is unlikely to disturb biotic factors of the ecosystem.

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
- very low
- low
- medium
- high
- very high

aconf15. Answer provided with a

low	medium	high
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 level of confidence

acomm19. Comments:
This species is entirely carnivorous.

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

- inapplicable
- very low
- low
- medium
- high
- very high

aconf16. Answer provided with a

low	medium	high
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 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:

- 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:

<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf18.	Answer provided with a	low	medium	high	level of confidence
acomm22.	Comments:	There are no premises indicating that the racer goby can disturb the integrity of plant cultivations. It is a freshwater fish, and it does not affect plant cultivations.			

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

<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf19.	Answer provided with a	low	medium	high	level of confidence
acomm23.	Comments:	There are no premises indicating that the racer goby is a host or vector for pathogens and parasites 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:

<input type="checkbox"/>	inapplicable
<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

aconf20.	Answer provided with a	low	medium	high	level of confidence
acomm24.	Comments:	The racer goby is not a typical predator or parasite of farm animals. There is no evidence that the impact of this species, including eating fish eggs and/or larvae, is significant.			

A very small fraction of these components was recorded in the diet of the racer goby in the Włocławski Reservoir and downstream the Vistula River (Grabowska – 2005, Kakareko et al. – 2005). In the Dnieper Reservoir, fish are a considerable portion of the diet in large specimens of the monkey goby, but these have been nearly exclusively gobies (Didenko et al. 2017 – P).

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
- very high

aconf21. Answer provided with a

low	medium	high X
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 level of confidence

acomm25. Comments:
Experimental studies have shown that the racer goby is an aggressive species, and it has a negative impact on the European bullhead (Kakareko et al. 2013, Grabowska et al. 2016 – P). The racer goby shows aggressive behaviour (attack, biting, and threatening) regarding the European bullhead and specimens of this species itself (in relation to specimens of the same body size or smaller). There is no information on similar behaviours in relation to bred species or those commercially caught in the wild. Young specimens (fry) of species occurring together with the racer goby in the environment are European perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*), which are potentially exposed to preying.

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

aconf22. Answer provided with a

low	medium X	high
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 level of confidence

acomm26. Comments:
Because the racer goby occurs in water where fish are restocked and caught commercially, e.g., in the Vistula River, Vistula Lagoon, Zegrze Reservoir, and in the Włocławek Reservoir, it has an impact on commercially caught fish (various species), as a vector for parasites in native fish species and as a factor supporting the development of a parasite population, such as *Apatemon gracilis*, *Bucephalus polymorphus*, and *Holostephanus spp.* (Kvach and Mierzejewska 2011, Mierzejewska et al. 2014 – P). Because the assessed impact regards a very numerous group of animals occurring in the wild (fish caught commercially in open waters), it was delineated, but with the medium degree of certainty.

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:

- inapplicable
- very low
- low
- medium
- high
- vert high

aconf23. Answer provided with a

low	medium	high
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 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
- low
- medium
- high
- very high

aconf24. Answer provided with a

low	medium	high X
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 level of confidence

acomm28. Comments:
There are no premises to judge that the racer goby can affect human health due to its properties which pose a hazard during direct contact. It reaches the length of 16 cm (FishBase 2018 – B), has no quills or venom glands, and it is totally harmless in contact with humans.

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

- inapplicable
- very low
- low
- medium
- high
- very high

aconf25. Answer provided with a

low	medium X	high
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 level of confidence

acomm29. Comments:
Nematode *Eustrongylides excisus* has been found in the racer goby, which can infest humans when they consume raw or undercooked (thermal treatment) fish (Bjelic-Cabrilo et al. 2013, Ljubojevic et al. 2015, Branciaro et al. 2016 – P). *E. excisus* has been found in racer goby specimens in the Włocławski Reservoir (Mierzejewska et al. 2014). Infestation with the nematode is treatable. Nematode of *Eustrongylides excisus* genus occurs in humans in the form of larvae, and it elicits gastritis and intestinal perforation; larvae can be removed only by surgery (Bjelic-Cabrilo et al. 2013 – P).

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:

<input checked="" type="checkbox"/>	very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

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

acomment30. Comments:
There are no premises that the racer goby can affect infrastructure.

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:

<input type="checkbox"/>	significantly negative
<input type="checkbox"/>	moderately negative
<input checked="" type="checkbox"/>	neutral
<input type="checkbox"/>	moderately positive
<input type="checkbox"/>	significantly positive

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

acomment31. Comments:
On one side, the species may positively affect fish breeding in the wild and caught commercially (fished commercially by fishermen), because it is food for predatory fish (Płachocki et al. 2012 – P), but at the same time, it can have adverse effects as a result of depleting food resources (invertebrates) and as the vector for parasites or a factor contributing to the development of a parasite population. As it is difficult to assess the weight of the positive and negative impacts of this species on supply services, the cumulated effect has been considered neutral.

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

<input type="checkbox"/>	significantly negative
<input type="checkbox"/>	moderately negative
<input checked="" type="checkbox"/>	neutral
<input type="checkbox"/>	moderately positive
<input type="checkbox"/>	significantly positive

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

acomm32.

Comments:

This species is an important link of the food web (it is bentophag and at the same time it is prey for piscivorous fish). There is no evidence that it can disturb abiotic or biotic factors of the ecosystem. It transfers parasites, which can control zoonotic diseases, but assessment of the scale of this impact is difficult.

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

- significantly negative
- moderately negative
- neutral
- moderately positive
- significantly positive

aconf29.

Answer provided with a

low	medium X	high	level of confidence
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acomm33.

Comments:

This species can have an effect on recreational angling in two ways: positively, because it is food for predatory fish (Płachocki et al. 2012 – P); and, simultaneously, negatively, because it depletes food resources (invertebrates), and as parasite vector or a factor supporting the development of a parasite population. As it is difficult to assess the weight of the positive and negative impacts of this species on cultural services, the cumulated effect has been considered neutral.

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
- increase moderately
- increase significantly

aconf30.

Answer provided with a

low	medium	high X	level of confidence
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acomm34.

Comments:

There are no premises to judge that climate changes will affect overcoming geographical barriers by the racer goby. It is a species already introduced and established in Poland (Danilkiewicz 1996, Kostrzewa and Grabowski 2001 – P, Płachocki 2017 – I).

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
- increase moderately
- increase significantly

aconf31. Answer provided with a

low	medium	high X
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 level of confidence

acomm35. Comments:
The racer goby is a species established in Poland. This situation is unlikely to change due to climate changes.

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
- increase moderately
- increase significantly

aconf32. Answer provided with a

low	medium	high X
-----	--------	------------------

 level of confidence

acomm36. Comments:
It should be supposed that the racer goby will spread even more in Poland, due to climate changes. This species derives from the Ponto-Caspian region where the climate is a bit warmer. Thus, climate changes should increase moderately fertility, survival rate, and the total population size. It should also favor the establishment of new waters by this species, in running water and in lakes. Some authors think that the rapid invasion of this species in various areas in Europe, similarly to other gobies from the same Eurasian region, is connected with the currently observed increase in mean annual temperatures (Harka and Bíró 2007 – P).

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
- increase moderately
- increase significantly

aconf33. Answer provided with a

low	medium	high X
-----	--------	------------------

 level of confidence

acomm37. Comments:
It should be supposed that, due to climate changes, the racer goby will spread even more in Poland (see pp. a36), and, at the same time, the share of this species in fish populations and the scale of environmental impact on the natural environment will increase.

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
- not change
- increase moderately
- increase significantly

aconf34. Answer provided with a

low	medium	high X
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 level of confidence

acommm38. Comments:
This species is a freshwater species, exclusively carnivorous. It does not affect plant cultivations.

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
- increase moderately
- increase significantly

aconf35. Answer provided with a

low	medium X	high
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 level of confidence

acommm39. Comments:
It should be supposed that, due to climate changes, the racer goby will spread even more in Poland (see pp. a36), and, at the same time, it should be expected that the impact of this species on fish farming will also increase, while this regards mainly running waters and fish in the wild caught commercially by fishermen. The racer goby is found rarely in standing waters (in lakes) (Kakareko 2018b, author’s observations – A).

a40. IMPACT ON THE HUMAN DOMAIN – Due to climate change, the consequences of *the species* on human in Poland will:

- decrease significantly
- decrease moderately
- not change
- increase moderately
- increase significantly

aconf36. Answer provided with a

low	medium X	high
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 level of confidence

acommm40. Comments:
It should be supposed that due to climate changes the racer goby will spread even more in Poland (see pp. a36) (see p. a36), and it is expected that the risk of transferring parasites harmful to humans (*Eustrongylides excisus*) will increase.

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
- increase moderately
- increase significantly

aconf37. Answer provided with a

low	medium	high X
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 level of confidence

acommm41. Comments:
There are no premises indicating that the racer goby can affect other domains and this situation will change due to climate changes.

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)	0.38	0.58
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.25	0.83
Human impact (questions: a27-a29)	0.25	0.75
Other impact (questions: a30)	0.00	1.00
Invasion (questions: a06-a12)	1.00	1.00
Impact (questions: a13-a30)	0.38	0.83
Overall risk score	0.38	
Category of invasiveness	potentially 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.

acommm42.

Comments:

In the risk assessment for Poland, the racer goby has reached a high score (1.00) for modules related to the invasion process (questions: a06-a12). In Poland, this species is still in the expansion phase, and its main spreading routes are the Bug and Vistula Rivers, where it forms numerous populations in favourable habitat conditions. There is a real threat of the further spreading of this species in Poland, especially in running waters. The species has been classified as a minimally invasive species. The highest score for the adverse impact of this species (0.38) has been shown for module: Impact on the natural environment (questions: a13-a18). Lower values (0.25) was shown for the following modules: The effect of the Species on individual animal health and production (questions: a24-a26), Impact on human domain (questions: a27-a29). The lowest value (0.00) was shown for modules: Cultivated plants impact (questions: a19-a23), The effect of the Species on causing damage to infrastructure (question: a30). These are values considerably lower than the boundary for the classification of non-native species as medium invasive (0.51). However, it should be noted that the assessment of the negative impact of the racer goby was carried out with the lower degree of certainty (0.58-1.00) in comparison to the assessment of the invasion process (1.00). It results from the fact that the knowledge of the impact of this species on biota and inanimate elements of the ecosystem is low. Thus, in the future this assessment can be changed as the knowledge in this field grows.

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