



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. 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	22-01-2018
	(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 szczupła (babka rzeczna)

Latin name: ***Neogobius fluviatilis*** (Pallas, 1814)

English name: Monkey goby

acomm02.	Comments:	
	Polish name (synonym I) Babka rzeczna	Polish name (synonym II) –
	Latin name (synonym I) <i>Neogobius cephalarges</i>	Latin name (synonym II) <i>Gobius affinis</i>
	English name (synonym I) Sand goby	English name (synonym II) River goby

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 X	level of confidence
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acomm04.	Comments: A monkey goby is a species from the Ponto-Caspian region. In Poland it was first found in 1997 in the Bug (Danilkiewicz 1998 - P). In 2002, it was observed in the Włocławek Reservoir (Kostrzewa and Grabowski 2002 - P). Within 3-4 years, it colonized a significant part of the lower Vistula, moving with the current down the river. There is no data on its dispersion up the Vistula. It creates stable, reproducing populations in our waters. It is a common species in the lower Vistula, generally much more numerous than the other two species of Ponto-Caspian gobies: racer goby (<i>Babka gymnotrachelus</i>) and tubenose goby (<i>Proterorhinus semilunaris</i>) (Kakareko et al. 2009 - P, Płachoński 2017 - I, Alien species in Poland 2018 - B).
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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: Monkey goby is an important link in the food web, both as a bentophage (Kakareko and Żbikowski 2005, Grabowska et al. 2009 - P), and an important prey for many native fish species (Płachoński et al. 2012 - P). By feeding on the benthic fauna (Grabowska et al. 2009 - P) this species may deplete the food base and increase competitive tensions between fish. During the breeding period, it can displace other fish species of similar biology from the hiding places (spawning grounds), e.g. other species of Gobiidae (Kakareko 2011 - P) or the European bullhead (<i>Cottus gobio</i>) – a protected species under the ordinance of the Minister of Environment of 16 December 2016 on the protection of species of animals (Ordinance 2016 – I) and Annex II of the Council Directive 92/43/EEC (Council Directive 92/43/EEC 1992– I). This species can transmit parasites that pose a threat to other fish, including farmed fish (e.g. <i>Anguillicoloides crassus</i> nematode), and also to humans (e.g. <i>Eustrongylides excisus</i> nematode).
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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	

acomment06. Comments:
 Monkey goby penetrates the area of Poland alone, through the so-called the central migration corridor for the Ponto-Caspian fauna. This corridor leads from the Black Sea through the Dnieper, Pripjat, Dnieper-Bug Canal, and Muchawiec (tributary of the Bug) to Poland, from where further expansion through the Bydgoszcz Canal, Noteć, Oder, Germany and Western Europe (Alien species in Poland 2018 - B) is possible.

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	

acomment07. Comments:
 River transport plays an important role in the spreading of Ponto-Caspian gobies in large rivers in Europe (Wiesner 2005, Roche et al. 2013 - P) and this way the monkey goby can be moved passively (e.g. in the form of eggs and / or individuals in tanks filled with outboard water) to larger distances. The spread of the monkey goby is also connected with channels that connect large river basins and transformations of the riverbed (e.g. in the region of ports), which increase the share of sandy bottom, i.e. the substrate preferred by this species (Kakareko 2011 - P) and submerged objects constituting the spawning substrate and the place where the male is to be nested (for example, stones from bank fortifications). All these factors increase the likelihood of introducing the monkey goby to areas not yet 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	

acomment08. Comments:
 There are no known cases of species introduction into the natural environment of Poland for breeding purposes. Anglers can contribute to the spreading of the monkey goby, because this species is sometimes used as a live bait (Kakareko 2018 - A). There is no data on the scale of

this phenomenon. Considering the fact that the monkey goby can be very numerous, the probability is 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:

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

aconf05. Answer provided with a

low	medium	high
		X

 level of confidence

acomment09. Comments:
The monkey goby has favourable climatic conditions for development and reproduction in Poland, and creates numerous breeding populations (Płachocki 2017 - I). This species finds favourable conditions for development in a temperate climate, in the temperature range from 4 to 20 ° C (FishBase 2018 - B).

a10. Poland provides **habitat** that is

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

aconf06. Answer provided with a

low	medium	high
		X

 level of confidence

acomment10. Comments:
The monkey goby finds optimal habitat conditions in Poland and is an established species. This species prefers water bodies with moderate water flow (20 cm / s) (Kakareko 2011 - P) and sandy soil (Čáková et al. 2008, Kakareko 2011 - P, Płachocki 2017 - I, Alien species in Poland 2018 - B). The monkey goby finds favourable habitat conditions in sandy bottom, therefore it is a common species in lower Vistula (Płachocki 2017 - I), which is abundant in such habitats.

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
- very high

aconf07.	Answer provided with a	low	medium	high X	level of confidence
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acommm11. Comments:
Expansion of population (Type of data: B)
The monkey goby colonized a significant part of the lower Vistula within 3-4 years - at least approx. 100 km section from Włocławek to Bydgoszcz (Kakareko et al. 2009 - P), which meets the highest Harmonia^{+PL} criterion (the distance of moving the range barrier is higher than 10 km per year) and allows assessing the ability of the species to self-propagate to be very high. The monkey goby was first found in Poland in Bug in 1997 (Danilkiewicz 1998 - P). At that time (1997-1999) it was not yet in found in Vistula (Wiśniewolski et al. 2000 - P). In 2002 the monkey goby was found in the Włocławek Reservoir (Kostrzewa and Grabowski 2002 - P). In the years 2003-2004 it was one of the most-fished species in research fisheries in Vistula in Toruń and Bydgoszcz (own observations, Kakareko and others 2009 - P, Kakareko 2018 - A).

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

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

aconf08.	Answer provided with a	low	medium	high X	level of confidence
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acommm12. Comments:
River transport plays an important role in the spreading of Ponto-Caspian gobies in large rivers in Europe (Roche et al 2013 - P) and this way, the monkey goby can be moved unintentionally and passively by humans (e.g. in the form of eggs and / or individuals, in tanks filled with outboard water) for considerable distances, including inland channels connecting large river basins. The monkey goby can also be spread in Poland by anglers because it is sometimes used as live bait (own observations, Kakareko 2018 - A). There is no data on the scale of this phenomenon. Probably the monkey goby is used as bait mainly in places of its occurrence. It is not possible, however, to exclude cases of moving individuals of this species to a distance greater than 50 km. Considering the fact that the monkey goby can be very numerous, the frequency with which the species spreads in Poland with human participation may be quite 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:

<input type="checkbox"/>	inapplicable
<input type="checkbox"/>	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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acomment13. Comments:
 Through predation the species affects native species but mostly invertebrates. In the communities it is established in (rivers, dam reservoirs), the monkey goby feeds mainly on *Chironomidae* and small crustacea larvae (mainly amphipods (*Amphipoda*)), and to a lesser extent on oligochaetes, molluscs, other invertebrates, and to a negligible extent on fish (Kakareko and Żbikowski 2005, Grabowska et al. 2009 - P, Alien species in Poland 2018 - B). The fish found in its diet are usually gobies (Didenko et al. 2017 - P). The impact of this species through predation on the populations of its prey has not been examined so far. In this survey it is described as average because the monkey goby can occur in large numbers and affect the population size of native invertebrates, which it feeds on, mainly those not belonging to special care species, and to a lesser extent to the population size of species of special care: e.g. small bivalves protected in Poland: solid orb mussel (*Sphaerium solidum*), river orb mussel (*Sphaerium rivicola*) (ordinance of the Minister of Environment of 16 December 2016 on the protection of animal species).

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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acomment14. Comments:
 The monkey goby reproduces on the underside of immersed objects (stones, roots, rubbish) (Alien species in Poland 2018 - B) and during the breeding period (April-June) it may make it difficult to occupy such microhabitats (hiding places) by the European bullhead – protected species in Poland and listed in Annex II of the Council Directive 92/43 / EEC. At the time of breeding the goby male aggressively defends the place, in which it chose to establish a nest. Outside the breeding period, the monkey goby is less connected with microhabitats in the form of hiding places and its impact on the European bullhead is smaller (Błońska et al. 2016 - P). The monkey goby can compete for food and space with other native species of fish (e.g. gudgeon (*Gogio gobio*)), occupying similar habitats, but there are no documented cases of its negative impact on these species.

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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acomment15. Comments:
 In fresh waters in Poland, where the monkey goby may be found, there are no native species closely related to it (from the *Gobiidae* family). Therefore, no cases of hybridization between monkey goby and native species of fish were found. On the other hand, a case of interbreeding the monkey goby with other species of goby coming from the Ponto-Caspian region – the round goby (*Neogobius melanostomus*) (Lindner et al. 2013 - P) was described.

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

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

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

acom16. Comments:
 A list of parasites found on the monkey goby is rich (CABI 2018 - B), while in newly established waters it consists mostly of taxa typical of these waters, occurring in domestic fish species (Mierzejewska et al. 2014, Ondračková et al. 2015 - P). There are no conclusive studies on the role of the monkey goby in the transmission of parasites within fish communities in established environments. Research in the Włocławek Reservoir (Mierzejewska et al. 2014 - P) draw our attention to the fact that the presence of Ponto-Caspian gobies affects the quantitative relations of parasites in a given area (rare parasites in local fish were numerous in alien species). In this case, alien species of fish, including monkey goby, have become a factor supporting the development of the population of some parasites in the reservoir: *Apatemon gracilis*, *Bucephalus polymorphus*, *Holostephanus* spp. (Kvach and Mierzejewska 2011, Mierzejewska et al. 2014 - P). Since it cannot be ruled out that in Polish waters the monkey goby will transport the cosmopolitan parasites, including special care species (e.g. the European bullhead, spined loach (*Cobitis taenia*)), according to the Harmionia^{PL} instructions, the impact of the species is defined here as large. Gobies are hosts of a new species of *Gyrodactylus proterorhini* trematoda in Poland (Mierzejewska et al. 2011, Mierzejewska et al. 2014 - P). Although *G. proterorhini* is considered to be a family-specific parasite (*Gobiidae*), it is recommended to monitor native *Perciformes* fish for the presence of this parasite due to the relationship of these fish to *Gobiidae* (Mierzejewska et al 2014 - P). So far, *G. proterorhini* has not been found in native species of fish. In addition, the monkey goby is a paratenic host of the *Anguillicoloides crassus* nematode (Ondračková et al. 2015 - P). The *A. crassus* parasite weakens the condition of European eel (*Anguilla anguilla*), thus indirectly contributing to the reduction of its population (Rolbiecki 2011 – P).

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

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

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

acom17. Comments:
 There are no indications that the monkey goby may disturb abiotic factors of the ecosystem. Specimens of this species are closely related to the sandy bottom of flowing waters and are able to bury themselves by exposing only the end of their mouth and eyes (Alien species in Poland 2018 - B). It should be assumed that this interaction causes at most easily reversible changes in the structure of the bottom in habitats that are not part of special care habitats.

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

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

aconf14. Answer provided with a

low	medium X	high
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 level of confidence

acomment18. Comments:
The monkey goby is a link in the food web (feeds mainly on invertebrates, it is the prey of piscivorous fish). Potentially it can compete with other fish for food and habitat. However, the impact of this species on other organisms has not been investigated so far. It is estimated that this species is likely to cause easily reversible changes in processes occurring in habitats that are not part of 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
- very low
- low
- medium
- high
- very high

aconf15. Answer provided with a

low	medium	high
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 level of confidence

acomment19. Comments:
The species is a carnivorous animal only.

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

acomment20. Comments:
The species is not a plant.

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

- inapplicable
- no / very low
- low
- medium
- high
- very high

aconf17.	Answer provided with a	low	medium	high	level of confidence
acomm21.	Comments:				
	The species is 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 indications that the monkey goby may disturb the integrity of plant crops.				

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 indications that the monkey goby is a host or a vector of 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 monkey goby is not a typical predator or parasite of farm animals. There is no evidence to suggest that the impact of this species on other fish by eating fish eggs and / or larvae is significant. In the diet of the monkey goby in the Włocławek Reservoir and the Vistula				

below this reservoir these components are either missing (Grabowska et al. 2009 - P), or their participation is very small (Kakareko and Żbikowski 2005 - P). In the Dnieper Reservoir a significant share of fish in the diet of mature monkey goby individuals was noted, but they were almost exclusively gobies (Didenko et al. 2017 - P). Similarly, in the lower Rhine, fish found in the diet of Ponto-Caspian *Gobiidae* were mostly young gobies (Borcherding et al., 2013).

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

acom25. Comments:
There are no indications that a monkey goby may affect the health of a single animal or animal production as a direct result of contact. Unlike other species of gobies, no aggressive behaviour towards native fish species was observed (Błońska et al 2016 - P).

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

acom26. Comments:
The monkey goby is the paratenic host of the *Anguillicoloides crassus* nematode (Ondračková et al. 2015 - P). The *A. crassus* parasite weakens the condition of eel individuals, thus contributing indirectly to reducing the size of its population (Rolbiecki 2011 - P). Because the monkey goby is present in the waters where fry-stocking and commercial harvesting is carried out, e.g. in the Vistula, Vistula Lagoon, Zagrze Reservoir, Włocławek Reservoir, it can affect the production of economically acquired fish (various species) as a vector of parasites for native fish species and a factor supporting the development of parasite populations, such as, for example, *Apatemon gracilis*, *Bucephalus polymorphus*, *Holostephanus spp.* (Kvach and Mierzejewska 2011, Mierzejewska et al 2014 - P). Because the impact assessed concerns a very large group of animals occurring in the wild state, i.e. fish exploited economically in open waters, including eels, it is possible to develop more than 1 but not more than 100 individuals per 100,000 livestock per year, and the disease caused by this parasite is not fully curable, this effect is defined as high but with an average 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

acom28. Comments:
There are no reasons to believe that a monkey goby can affect human health because of the properties that are dangerous during direct contact. It is a fish growing up to about 20 cm long (FishBase 2018 - B), lacking spikes or venom glands, completely 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:
In the case of the monkey goby, parasites have been found that can infect humans in the event of eating raw or poorly prepared (thermal processing) fish, such as the *Eustrongylides excisus* nematode (Bjelic-Cabrilo et al. 2013, Branciaro et al. 2016 - P), or *Metagonimus yokogawai* tapeworm (Ljubojevic et al. 2015 - P). The *E. excisus* was found in the monkey goby from the Dniester estuary and from the Black Sea (Kvach 2004 and 2005 - P). In monkey goby individuals in Poland (in the Włocławek Reservoir), *Eustrongylides spp.* larvae (Mierzejewska et al. 2014 - P) were found. The *M. yokogawai* was found in monkey goby individuals in the Danube (Molnár et al. 2006). This parasite has not been found in individuals of monkey goby in Poland (Mierzejewska et al. 2014 - P). Infections caused by the above parasites are curable. *Eustrongylides* nematodes are found in humans in larvae forms and cause gastritis and intestinal perforation; the only way to get rid of the larvae is surgical intervention (Bjelic-Cabrilo et al. 2013 - P). *M. yokogawai* is an intestinal trematoda that causes a disease called metagonimiasis, treated pharmacologically (Diseases of FDI 2018 - I).

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
- very high

aconf26. Answer provided with a

low	medium	high
		X

 level of confidence

acomm30. Comments:
There are no reasons to believe that the monkey goby can influence the 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:

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

aconf27. Answer provided with a

low	medium	high
	X	

 level of confidence

acomm31. Comments:
The species can affect the production of fish in the wild and economically exploited state (commercially obtained by fishermen) - positively: because it is prey for predatory fish (Płachocki et al. 2012 - P), and also - negatively: as a result of depleting fish food base (invertebrates) and transferring pathogens and parasites, e.g. *Anguillicoloides crassus* (Ondračková et al. 2015 - P), weakening individuals of the European eel (*Anguilla anguilla*) (Rolbiecki 2011 - P). The cumulative impact of the monkey goby on the supply services was therefore defined as neutral.

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

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

aconf28. Answer provided with a

low	medium	high
	X	

 level of confidence

acomm32.

Comments:

This species is an important link in the food web (it is a bentophagus and, at the same time, prey for piscivorous fish). However, there is no evidence that it disturbs the abiotic or biotic factors of the ecosystem. The species carries parasites, which may affect the regulation of zoonotic diseases, but it is difficult to assess the scale of this interaction.

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
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level of confidence

acomm33.

Comments:

The species can affect fishing recreation - positively: because it feeds predatory fish (Płachocki et al. 2012 - P), and at the same time - negatively: as a result of depleting fish food base (invertebrates) and transferring pathogens and parasites, e.g. *Anguillicoloides crassus* (Ondračková et al. - 2015 - P), weakening individuals of the European eel (*anguilla*) (Rolbiecki 2011 - P). The cumulative impact of the monkey goby on cultural services is therefore defined as 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

acomm34.

Comments:

There are no reasons to believe that climate change will affect goby's narrow geographic barriers. It is a species already introduced and established in Poland (Danilkiewicz 1998, Kostrzewa and Grabowski 2002 - 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
-----	--------	------------------

 level of confidence

acomm35. Comments:
The monkey goby is an established species in Poland. It is unlikely that this situation will be different as a result of climate change.

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 assumed that due to climate changes, the monkey goby will spread even more in Poland. This species comes from the Ponto-Caspian region, where the climate is slightly warmer. Therefore, climate changes should moderately positively affect the fertility, growth rate, survival rate and overall abundance of monkey gobies, and favor the establishment of this species in new types of waters - mostly watercourses with moderate flow and sandy bottom, where it occurs most often. Some authors believe that the rapid invasion of this species in different regions of Europe, like other gobies from the same region of Eurasia, is associated with the currently observed increase in average 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 assumed that due to climate changes, the monkey goby will spread even more in Poland (see p. A36), thus the participation of this species in fish assemblages will increase and the scale of the impact of this species 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
-----	--------	------------------

 level of confidence

acomm38. Comments:
The species is a freshwater fish, exclusively carnivorous. It does not affect plant cultivation.

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

acomm39. Comments:
It should be assumed that due to climate changes, the monkey goby will spread even more in Poland (see p. 36), thus it is expected that the impact of this species on livestock will also increase, but this applies mainly to flowing waters and fish in wild, commercially harvested by fishermen.

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

acomm40. Comments:
It should be assumed that due to climate changes, the monkey goby will spread even more in Poland (see p. 36), thus it is expected that the risk of transmitting parasites harmful to humans (*Eustrongylides excisus*, *Metagonimus yokogawai*) 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

acomm41. Comments:
There are no indications that the monkey goby can influence other objects, and that this situation will change under the influence of global warming.

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.

acomm42.

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 monkey 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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3. Unpublished data (N)

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4. Other (I)

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