Appendix A

Harmonia^{+PL} – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland

QUESTIONNAIRE

A0 | Context

Questions from this module identify the assessor and the biological, geographical & social context of the assessment.

a01. Name(s) of the assessor(s):

first name and family name

1. Joanna Grabowska
2. Tomasz Kakareko
3. Karolina Mazurska

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	Department of Ecology and Vertebrate Zoology, Faculty of Biology and Environmental Protection, University of Lodz	19-01-2018
(2)	dr hab.	Department of Hydrobiology, Faculty of Biology and Environmental Protection, The Nicolaus Copernicus University, Toruń	26-01-2018
(3)	mgr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	27-01-2018

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

Polish name: Sumik karłowaty

Latin name: ***Ameiurus nebulosus*** (Le Sueur, 1819)

English name: Brown bullhead

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:

Synonym: *Ictalurus nebulosus* (Le Sueur, 1819) was often used in earlier studies, but the currently valid name is *Ameiurus nebulosus* (Le Sueur, 1819). In Polish, the species is also known as

sumik amerykański or amerykański sumik karłowaty. Anglers sometimes use the usual name of koluch.

Polish name (synonym I) sumik amerykański	Polish name (synonym II) amerykański sumik karłowaty
Latin name (synonym I) *Amiurus vulgaris*	Latin name (synonym II) *Ictalarus nebulosus*
English name (synonym I) Bullhead	English name (synonym II) Catfish

a03. **Area** under assessment:

Poland

acomm03.	Comments:

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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:

On Polish Lowlands the species is considered quite common (Pomerania, Masuria, the middle course of the Oder and Vistula and their tributaries) (Kolejko 1998, Brylińska 2000 - P). Locally, it is very numerous, e.g. in some lakes of the Łęczyńsko-Włodawskie Lakeland its share in catches exceeds 50% of the weight of harvested fish (Kolejko 1998, Kornijów 2001, Kotusz 2012 - P). Until the 1990s the species was found in 22% of Polish rivers (Witkowski 1996 - P), but in recent decades in many of the rivers its regress was recorded (Grabowska et al. 2010 - P). This is due to the fact that the restocking various Polish waters with this species was abandoned, which was the common practice of local fishing organizations in the 1990s. As a result, although the rivers are not the preferred habitat of the brown bullhead, it infiltrated frequently into flowing waters, where it was found during inventory works of ichthyofauna of a given river.

Currently, apart from lakes, it is also often found in fish ponds and commercial fishing grounds (Grabowska, own observations 2017 - A). The species is naturalized, i.e. it reproduces in our waters without human participation, its numbers remain stable (Grabowska et al. 2010, Witkowski and Grabowska 2012 - P).

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

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

acomm05.	Comments:

The introduction of brown bullhead causes a clear change in the ichthyofauna of some lakes and other small water reservoirs, where the species in a short time can become a species dominanting in abunadance of fish assemblages in, by feeding on their eggs and juvenile fish (Adamczyk 1975,Kornijów 2001 - P). The species often occurs in large numbers in fish ponds and commercial fishing grounds, where it is treated as "weed". Many anglers are not interested in fishing for this species, and even complain that on some fisheries the brown bullhead very often catches the bait and makes catching other desirable species more difficult (Grabowska, own observation 2017 _ A). The brown bullhead has hard-tipped and serrated hard radii on the pectoral fin and dorsal fin, with venom glands at the base – there are cases of wounded anglers, which complain of severe pain, swelling, numbness, dizziness caused by hematolytic and dermatotoxic effects of venom (Satora 2006 - P).

A1 | Introduction

Questions from this module assess the risk for *the species* to overcome geographical barriers and – if applicable – subsequent barriers of captivity or cultivation. This leads to *introduction*, defined as the entry of *the organism* to within the limits of *the area* and subsequently into the wild.

a06. The probability for ***the species*** to expand into Poland's natural environments, **as a result of self-propelled expansion** after its earlier introduction outside of the Polish territory is:

	low
	medium
X	high

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

acomm06.	Comments:

A species established in Poland since the 19th century, when it was deliberately introduced in 1885. Since then, it has spread in most of the lowland waters in our country (Grabowska et al. 2010, Kotusz 2012, Witkowski and Grabowska 2012 - P), using river systems and channels for self-expansion. For example, it was brought into the Łęczyńsko-Włodawskie Lakeland before World War II, from where it penetrated to the central section of Bug and Wieprz river through the system of canals. Further migration was facilitated by the Wieprz - Krzna Canal system. Self-expansion of the brown bullhead is supported by the features of its biology: an effective reproductive strategy, a very high tolerance to oxygen deficits, pH fluctuations and water pollution (Kotusz 2012 - P). Its current range is the result of both passive dispersion (deliberate restocking, introduction with restocking material) and active, independent migration.

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:

Accidental transfer of the species together with the stocking material of economic species (mainly cyprinids) contributed to the species expansion, as the species is often found in fish ponds (Kotusz 2012 - P).

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 original reason for the introduction of the brown bullhead to many countries in Europe was its use in fishing and angling. In Poland, in 1885, 50 individuals were brought to the ponds of Barnówka near Dębno (currently West Pomeranian Voivodeship). Already after five years this species has reached the number of over 2.5 thousand individuals (Horoszewicz 1971 - P). The next introductions should be considered as a conscious act, fitting in the contemporary fashion of importing exotic fish (Kotusz 2012 - P). The species was brought into the Łęczyńsko-Włodawskie Lakeland in 1935-1937, and then it was moved to Shatsky Lakes. The brown bullhead expansion after World War II was also associated with mass introductions by angler associations, cyprinidae fish farmers and private individuals. Even in the 1990s, some fishing grounds were deliberately modified so that their ichthyofauna would be dominated by the bullhead (Kotusz 2012 - P). One of the factors favoring the expansion of the species was its use as a live bait in fishing for predatory fish. Anglers stocked more basins with bullhead species releasing unused fish at the place of fishing (Kotusz 2012 - P).

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:

In Poland, optimal climatic conditions prevail for reproduction and establishment of the species. The species reproduces without problems in our waters, where the spawning season falls into the period: late spring - the beginning of summer, when the water reaches a temperature of 18-20 ° C (Kotusz 2012 - P). For example, in 1885, for the first time in Poland, 50 individuals were brought to the ponds. Already after five years this species has reached the number of over 2.5 thousand individuals (Horoszewicz 1971 - P).

a10. Poland provides **habitat** that is

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

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

acomm10.	Comments:

In many waters of Poland, habitat conditions are optimal for reproduction and permanent establishment of species, as evidenced by its current widespread occcurence. On Polish Lowlands the species is considered quite common, locally creates very numerous populations, mainly in eutrophic lakes, fish ponds and fishing grounds (Kotusz 2012 - P), where the conditions preferred by the brown bullhead prevail: muddy bottom, densely overgrown with weed vegetation. It is much less common in flowing waters, where it avoids a strong current, but rather chooses places with slow flow or stagnant water, e.g. meanders and oxbow lakes. It is not found in mountain and submountain waters. The species tolerates oxygen deficits, summer overheating of water. Currently, its range includes the basin of the Bug, Wieprz, lower and middle San River, the Warta basin (Wielkopolska, Kujawy), the central Odra basin (Silesia) and Vistula (Mazovia), Łęczyńsko-Włodawskie Lakeland, P. Pomeranian and Masurian Lake District, (Kolejko 1998 , Brylińska 2000 - P).

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
X	high
	very high

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

acomm11.	Comments:

Estimation (Data type: C)
There are various premises allowing to assess with a high degree of certainty the ability of this species to spread in Poland without significant human assistance. First, the brown bullhead was initially bred in several pond farms, from where it escaped to many rivers and lakes of western Poland without human assistance (Brylińska 2000 - P). Similarly, it was brought into the Łęczyńsko-Włodawskie Lakeland before World War II, from where it penetrated to the central section of Bug and Wieprz rivers through a system of canals. Further migration was facilitated by the Wieprz - Krzna Canal system (Kotusz 2012 - P). Second, it has the features of biology that facilitates its expansion: it is very resistant to organic water pollution and large fluctuations in pH (3.4-9.1). It tolerates temporary oxygen deficits, including long-lasting winter droughtsanoxia (Kornijów 2001 - P). It is a food opportunist. It prefers standing water, overgrown with vegetation, but it uses canals, drainage ditches and rivers to spread (P - Kotusz, 2012, Brylińska 2000 - P). As a result, this species is widely distributed in Polish waters (Brylińska 2000, Kotusz 2012 - P). Since the species expansion in Polish waters has been going on since the end of the 19th century, it is impossible to clearly indicate what part of its current invasive range is a result of spontaneous spread without human assistance, and what is related to many intentional introductions and as a contaminant of stocking material.

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:

Intentional introductions, carried out on a massive scale by fish farmers and fishing organizations after the Second World War, practiced as early as in the 1990s, contributed to the expansion of the species. In addition, the brown bullhead was often accidentally transferred along with stocking material of commercial species (mainly cyprinids). An additional, "human" factor facilitating the expansion of the species was its use as live bait in predatory fish catching (Kotusz 2012 - P). At present, the Polish Anglers Association abandoned the stocking of water with the brown bullhead and it can also be presumed with a high degree of certainty that the owners of ponds and special fisheries also stopped doing that because the species is definitely undesirable, due to the clear reluctance of anglers to this fish and the problems it poses. Judging by the entries on angling forums, the awareness about the harmfulness of this species has definitely increased, so probably it is no longer used as "live bait". However, accidental transfer of the species with stocking material or "escapes" from ponds to open waters, e.g. during cleaning of ponds, cannot be ruled out. Currently, we can observe an increase in the number of small, private ponds created at individual farms, which leads to uncontrolled, let's call this "inter-neighbor" exchange of stocking material. In regions of Poland where the species is locally very abunadant, it can be an important source of the species spread to waters where it was previously not found (Grabowska, own observations, 2017 - A).

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	high **X**	level of confidence

acomm13. Comments:

The species is a food opportunists, although it prefers animal food. Its diet changes during ontogenetic development. Initially, the brown bullhead feeds mainly on zooplankton, older individuals are bentophagous, eat insect larvae: chironomids (Chironomidae), dragonflies

(Odonata) and caddisflies (Trichoptera), molluscs (Mollusca) and crustaceans (Malacostraca). It is also eager to feed on eggs and juvenile fish (Kotusz 2012 - P). In the brown bullhead diet from the Tisa - Danube channel, the following preys were found: common bleak (*Alburnus alburnus*), tench (*Tinca tinca*), crucian carp (*Carassius carassius*), ruffe (*Gymnocephalus cernuus*), but also species protected in Poland and included in Annex II of the Habitats Directive, i.e. bitterling (*Rhodeus sericeus*) and spined loach (*Cobitis taenia*) (Pupin and Sotirov 1966). Although there is no such data, it can be expected that the brown bullhead feeds on the same fish species also in Polish waters. In some water bodies, apart from animal feed, there were also insignificant amounts of filamentous algae and parts of macrophytes found (Kotusz 2012 - P).

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:

Due to the broad spectrum of its diet, the brown bullhead competes for food with many native species of fish (Kotusz 2012 - P) and in many waters, where the brown bullhead dominates in abunadance, this may be a significant problem. These are both cyprinids such as roach (*Rutilus rutilus*), common bream (*Abramis brama*), tench, white bream (*Blicca bjoerkna*), as well as predators such as perch (*Perca fluviatilis*), Eurasian ruffe, norhtern pike (*Esox lucius*) and zander (*Sander lucioperca*). Juvenile fish of the brown bullhead may potentially compete with co-occurring special care species, such as bitterling, mud loach (*Misgurnus fossilis*) and lake minnow (*Eupallasella percnurus*). However, no data is available on how it affects the number of these species. In addition, by feeding on eggs and juvenile fish it directly causes the reduction of the number or even the total disappearance of weaker competitors. This is confirmed by observations from the reservoirs in which it appears (e.g. the Łęczyńsko-Włodawskie Lakeland), where after some time it becomes the dominant and sometimes the only fish species (Adamczyk 1975, Witkowski 1989, Kotusz 2012 - P).

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:

The brown bullhead is a representative of the Ictaluridae, which has no representatives in the native ichthyofauna, hence there is no possibility of interbreeding with native species.

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

	very low
	low
	medium
X	high
	very high

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

acomm16. Comments:

Among the bullhead's parasites the following taxa species were found: Protozoa, Trematoda, Cestoda, Nematoda, Acanthocephala, leeches, glochidia (larvae of Mollusca). Among them are nonspecific species, which can infect different species of fish, i.e. both the bullhead and native species. Therefore, the bullhead infected with such a parasite may introduce it into the water bodies where they were not previously found, e.g. during translocation with stocking material. The increase in density observed in some reservoirs, where the bullhead is a dominant species, may increase the prevalence and the possibility of infection of other individuals of their own and other species. Since in the habitats favored by the bullhead, species of special care are encountered among the co-occurring species, for example, Amur bitterling, mud loach, lake minnow, the species may potentially be a vector of parasites, just like other native species of fish. It is difficult to assess the scale of this impact on populations of special care species. For example, *Diplostomum spathaceum* trematoda, *Raphidascaris acus* nematode and *Neoechinorhynchus rutili* Acanthocephala (Adamczyk 1975 - P) were found in the brown bullhead, which were also present in the lake minnow – priority species from Annex II of the Habitats Directive (Popiołek et al. 2011 - P). In addition, *Anguillicola crassus* nematode dangerous, also for commercial fish was found in the brown bullhead , (Thomas and Ollevier 1992 - P).

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

	low
X	medium
	high

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

acomm17. Comments:

The influence of the species on abiotic factors of the ecosystem has not been documented, although there are suggestions that at high density the bullhead individuals, due to intensive feeding on the bottom, stir up the sediment causing an increase in water turbidity. However, there are no measurements in this area (CABI 2018).

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:

The introduction of the brown bullhead has significantly changed the fish fauna structure of some lakes and ponds as a result of its effective reproductive strategy and antagonistic interactions (predation, competition, parasite vector) with native fish species. The species quickly became the dominant one in terms of abundance and biomass (Adamczyk 1975, Witkowski 1989, Kornijów 2001 - P). Research showed that the brown bullhead feeds also on species protected in Poland and those included in Annex II of the Habitats Directive, i.e. bitterling and spined loach (Pupin and Sotirov 1966). Furthermore, the results of monitoring in 2015-2016 have shown its presence in waters that are habitats of special care species in Annex II of the Habitats Directive – the lake minnow, though due to the low abunadance of the bullhead, its negative impact has not been observed (http://siedliska.gios.gov.pl/images/pliki_pdf/wyniki/2015-2018/2016/zwierzeta/wyniki_monitoringu_zwierzat_2015_2016_strzebla_blotna.pdf). It

	can be expected that in the case of an increase in the number of bullhead individuals in these habitats, the impact on the lake minnow could significantly increase.

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 some reservoirs in the bullhead's diet, apart from animal food, small amounts of filamentous algae and parts of macrophytes were also found, but their share was very small. The species is mainly carnivorous.

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: The species is an animal.

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

acomm20.	Comments: The species is an animal.

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:

The species is a predominantly carnivorous animal, although in the diet, sporadically and in a small amount, algae and macrophytes may appear; it certainly does not affect the cultivation of plants by disturbing the integrity of crops.

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 host or vector of pathogens and parasites harmful to plants. It is a predominantly carnivorous animal, plant food appears sporadically and in small amounts in the diet.

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	high **X**	level of confidence

acomm24. Comments:

The species is abundant in fish ponds and commercial fishing grounds, where feeding on macro-invertebrates depletes the food resources of breeding species. In addition, by feeding on eggs and juvenile fish, it directly contributes to the reduction of the number or even the total disappearance of weaker competitors. This can significantly reduce the production of farmed fish and fish used for catching in lakes. These are both native cyprinids, e.g. roach, common bream, tench, white bream, as well as predators such as

perch, Eurasian ruffe, norhtern pike and zander. This is confirmed by observations from reservoirs in which the brown bullhead appears (e.g. the Łęczyńsko-Włodawskie Lakeland), where after some time it becomes the dominant and sometimes the only species of fish (Kornijów 2001, Kornijów and in. 2003, Kotusz 2012 - 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
X	low
	medium
	high
	very high

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

acomm25. Comments:

Due to the sharp spikes in the pectoral and dorsal fins, the bullhead is practically never eaten by native predatory fish, because it would cause body perforation. Therefore, predators clearly avoid this type of "troublesome" victim, so the impact on the health of the animal or animal production was assessed as small, because such cases are probably very rare. There is no information about cases of injury to other co-existing species of farmed fish.

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
X	high
	very high

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

acomm26. Comments:

Among the bullhead's parasites the following taxa species were found: Protozoa, Trematoda, Cestoda, Nematoda, Acanthocephala, leeches, glochidia (larvae) Mollusca. Among them are nonspecific species, which can infect different species of fish, i.e. both the bullhead and native species. Therefore, the bullhead infected with such a parasite may introduce it into the water bodies where they were not previously found, e.g. during translocation with stocking material. The increase in density observed in some reservoirs, where the bullhead is a dominant species, may increase the prevalence and the possibility of infection of other individuals of their own and other species. This is important because the brown bullhead is often found in breeding ponds and on commercial fishing grounds. For example, nematode *Anguillicola crassus* dangerous to the European eel (*Anguilla anguilla*) and for other commercial fish species was found in the brown bullhead , (Thomas and Ollevier 1992 - P). This parasite weakens the condition of the European eel, thus indirectly contributing to the reduction of its population.

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:

The species is not a parasite.

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

	very low
	low
X	medium
	high
	very high

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

acomm28. Comments:

For defense purposes, the species has hard, spiky rays with a serrate edge in the dorsal fin and pectoral fins that have articular surfaces and are provided with a blocking mechanism when raised. In addition, at the base of these rays there are venom glands (found in most members of family Ictaluridae), the contents of which are released under pressure, that is at the time of pricking. Venom is a mixture of compounds with a haemolytic, dermatotoxic effect, causing edma and affecting the blood vessels. In Poland, toxicological centers recorded several cases of injuries of fishermen's hands through brown bullhead's spikes, accompanied by acute pain, numbness in place of the wound, dizziness and redness. Lower blood pressure and tingling were also observed. Remains of spikes left in the wound may also be a medical problem (Satora 2006 - P). There are problably much more of such case, which are not registered because the victim usually does not report to the medical point. Nevertheless, on the so-called fishing forums, there are numerous reports of such cases, especially in areas where there is a lot of brown bullhead species and it is often caught on a fishing rod.

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

	inapplicable
	very low
	low
X	medium
	high
	very high

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

acomm29. Comments:

The brown bullhead may be the second intermediate host of *Echinochasmus perfoliatus* trematoda, which may infect a human. However, the risk of infection is low, because the larvae of this trematoda reach the final host after eating raw fish, which is not the case for brown bullhead. In addition, the larvae of this trematoda are usually located in gills that are not eaten. However, in Japan, there were cases of infection, where the trematoda located

	itself in the intestine, causing various ailments of the gastrointestinal tract, such as diarrhea, vomiting, abdominal pain.

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
X	low
	medium
	high
	very high

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

acomm30.	Comments: With their presence, the brown bullheads lower the recreational values of fishing grounds. They are often caught by anglers in both open water and commercial fisheries, but are not desired by anglers. On the contrary, they pose a problem, because they catch the hook, eat the bait, and also the amateur fishing rules (Regulation of the Minister of Agriculture and Rural Development of 12 November 2001 on the catch of fish and the conditions of breeding, fish farming and harvesting of other organisms living in the water – P), prohibit releasing these fish back to the environment they were caught in.. Thus, it imposes the necessity of utilizing "unwanted" gains. For some, it means throwing them "into the bushes", which pollutes the banks, and thus the place of recreation, and is what other users complain about (Grabowska, own observations, 2017 - A).

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: The species has a negative impact on native fish species of economic importance obtained from the wild state by fishermen, anglers, bred in ponds and commercial angling fishing grounds. Through competition, predation on spawning eggs and juvenile fish and as a parasite vector, the species can reduce the production (abundance and biomass) of fish species used to supply people with food (Kotusz 2012 - P).

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm32. Comments:

Among the bullhead parasites, nonspecific species were found that could infect different species of fish, i.e. the bullhead itself and native species. Therefore, a bullhead infected with such a parasite may potentially introduce them into water bodies where they were not previously found, e.g. during translocation with stocking material. The increase in density observed in some reservoirs, where the bullhead is a dominant species, may increase the prevalence and the possibility of other individuals infection both their own and other species. It is worth noting, however, that the brown bullhead is one of the many species of fish (including native) that can carry these parasites, so it is difficult to separately assess the impact of this particular species as a vector of parasites.

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm33. Comments:

The species is often found in fish ponds (P - Kotusz 2012) and on commercial fishing grounds (Grabowska, own observations, 2017 - A), where it can feed on eggs and juvenile fish of breeding species and compete with them, mainly depleting their food resources (Kotusz 2012 - P). They are often caught by anglers in both open water and commercial fisheries, but are not desired by anglers. On the contrary, they cause a problem, because they catch the hook, eat the bait, and also the amateur fishing rules (Regulation of the Minister of Agriculture and Rural Development of 12 November 2001 on the catch of fish and the conditions of breeding, fish farming and harvesting of other organisms living in the water – P), prohibit releasing these fish back to the environment they were caught in.. Thus, it imposes the necessity of utilizing "unwanted" gains. For some, it means throwing them "into the bushes", which pollutes the banks, and thus the place of recreation, and is what other users complain about. In Poland, toxicological centers recorded several cases of injuries of fishermen's hands through brown bullhead's spikes, accompanied by acute pain, numbness in place of the wound, dizziness and redness. As a result it makes angling rather difficult (Grabowska, own observations 2017 – A).

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

Below, each of the Harmonia^{+PL} modules is revisited under the premise of the future climate. The proposed time horizon is the mid-21st century. We suggest taking into account the reports of the Intergovernmental Panel on Climate Change. Specifically, the expected changes in atmospheric variables listed in its 2013 report on the

physical science basis may be used for this purpose. The global temperature is expected to rise by 1 to 2°C by 2046-2065.

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

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm34. Comments:

The brown bullhead is a thermophilic species (Kotusz 2012 - P), but now it is already widespread in many watersin Poland and the warming of this climate will not change this.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm35. Comments:

The brown bullhead is a thermophilic species (Kotusz 2012 - P), but now it is already widespread in many waters in Poland, where it successfully reproduces, and climate warming will not change this.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm36. Comments:

The brown bullhead is a thermophilic species (Kotusz 2012 - P), but now it is already widespread in many waters in Poland and the warming of the climate will not change this.

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 consequence of climate warming will be an increase of species abundance and its share in fish assemblages, which will intensify competitive interaction, predatory pressure on macroinvertebrates, juvenile fish and native species of small fish, including those specified in Annex II of the Habitats Directive, which were found in the pygmy catfish diet, e.g. bitterling, spined loach. This is supported by the following premises. The brown bullhead is a thermophilic species (Kotusz 2012 - P). Fecundity of the fish increases with the temperature of the water. Warming will also have a positive effect on the survival of winter by juveniles. Warming will also cause changes in habitats, e.g. a more fertile growth of water vegetation or an increase in the fertility of the reservoir. As shown by the study, the contribution of the brown bullhead in fish assemblages decreased along with the increase in the trophy of the lake, but its condition and biomass increased (Kornijów and others 2003 - P).

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 crops in any way and the situation will not change as a result of global warming.

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:

The consequence of climate warming will be an increase of species abundance and its share in fish assemblages, including fish ponds and commercial fishing grounds, where it is currently abundant in some parts of the country. As a result, the impact of the species will increase due to its competitive interaction, predation on eggs and juvenile of economically used fish species, and as a parasite vector for them.

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
X	increase moderately
	increase significantly

aconf36.	Answer provided with a	low	medium X	high	level of confidence

acomm40. Comments:

Global warming will increase the occurrence, abundance of the species and its share in fish assemblages, which will most likely affect anglers, fishermen and owners of fish ponds and commercial fisheries. For many anglers this fish is not an attractive prey, on the contrary it is a problem (Grabowska, own observations, 2017 - A). Currently, it is considered to be a "weed" fish and pest (Kotusz 2012 - P, Grabowska, own observation, 2017 - A) also, due to sharp spines in the fins and venom glands, it can also cause severe injuries (Satora 2006 - P), e.g. when removing from a hook or from the net; it is also a vector of parasites.

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	high X	level of confidence

acomm41. Comments:

Global warming will increase the occurrence, abundance of the species and its share in fish communities, which will most likely affect anglers, fishermen and owners of fishing ponds and commercial fisheries. For many anglers this fish is not an attractive prey, on the contrary it is a problem (Grabowska, own observations, 2017 - A). Currently, it is considered to be a "weed" fish and pest (Kotusz 2012 - P, Grabowska, own observation, 2017 - A) also, due to sharp spines in the fins and venom glands, it can also cause severe injuries (Satora 2006 - P), e.g. when removing from a hook or from the net (Regulation of the Minister of Agriculture and Rural Development of 12 November 2001 on the catch of fish and the conditions of breeding, fish farming and harvesting of other organisms living in the water – P), prohibits releasing them into the environment in which they were caught. Thus, it imposes the necessity of utilizing "unwanted" gains. For some, it means throwing them "into the bushes", which pollutes the banks, and thus the place of recreation, and is what other users complain about.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.88	1.00
Environmental impact (questions: a13-a18)	0.71	0.92
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.58	0.67

Human impact (questions: a27-a29)	0.50	0.75
Other impact (questions: a30)	0.25	1.00
Invasion (questions: a06-a12)	0.96	1.00
Impact (questions: a13-a30)	0.71	0.87
Overall risk score	0.68	
Category of invasiveness	moderately invasive alien species	

A6 | Comments

This assessment is based on information available at the time of its completion. It has to be taken into account. However, that biological invasions are, by definition, very dynamic and unpredictable. This unpredictability includes assessing the consequences of introductions of new alien species and detecting their negative impact. As a result, the assessment of the species may change in time. For this reason it is recommended that it regularly repeated.

acomm42. **Comments:**

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2. Databases (B)

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3. Unpublished data (N)

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4. Other (I)

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