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. Krzysztof Kolenda
2. Mikołaj Kaczmarski – external expert
3. Karolina Mazurska

acomm01.	Comments:		
	degree	affiliation	assessment date
(1)	mgr	Department of Evolutionary Biology and Conservation of Vertebrates, Institute of Environmental Biology, University of Wrocław	25-01-2018
(2)	mgr inż.	Institute of Zoology, Poznań University of Life Sciences, Poznań, Poland	25-01-2018
(3)	mgr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	05-02-2018

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

Polish name: Żaba rycząca

Latin name: *Lithobates (Rana) catesbeianus* Shaw, 1802

English name: American bullfrog

acomm02.	Comments:

The correct Polish name for this species is "żaba rycząca" (American bullfrog). Occasionally erroneously two synonyms appear in the trade of exotic amphibians: "żaba byk", which, however, concerns the African bullfrog *Pyxicephalus adsperus* and "żaba wół", which also refers to the banded bullfrog *Kaloula pulchra*. Nevertheless, all three names of the species are present in the Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of alien species that could be a threat to native species or natural habitats in case of their release into the natural (Regulation… 2011 – P).

Polish name (synonym I)	Polish name (synonym II)
Żaba byk	Żaba rycząca

Latin name (synonym I)	Latin name (synonym II)
Aquarana catesbeiana	*Novirana catesbeiana*

English name (synonym I)	English name (synonym II)
Bullfrog	–

a03. **Area** under assessment:

Poland

acomm03.	Comments:
	–

a04. **Status** of *the species* in Poland. *The species* is:

	native to Poland
	alien, absent from Poland
X	alien, present in Poland only in cultivation or captivity
	alien, present in Poland in the environment, not established
	alien, present in Poland in the environment, established

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

acomm04.	Comments:

Individual sales offers appear on Internet forums, therefore it should be assumed that individuals of this species may be owned by private individuals (Kaczmarski and Kolenda 2013-2014 – A).

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

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

acomm05.	Comments:

American bullfrog adversely affects three domains: the natural environment, animal breeding, and humans. The effect on the natural environment is manifested by predation, competition with native species of amphibians, occupying niches of e.g. edible frogs *Pelophylax esculentus* and transmission of pathogens, i.e. *Batrachochytrium dendrobatidis* and ranaviruses causing infectious diseases, contributing to a global decline in amphibian population (Stumpel 1992, Kupfeberg 1997, Schloegel et al. 2009, Silva et al. 2011 – P). In case of animal breeding, American bullfrog's influence is by carrying the foregoing pathogens that are particularly dangerous in terrarium breeding (Schloegel et al. 2009 – P). The effect on humans is marginal, however, the tadpoles of this species can carry *Escherichia coli* bacteria (CABI 2018 – B).

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
X	medium
	high

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

acomm06.	Comments:
	At the moment, this species inhabits at least 9 European countries: Italy, France, Germany, Belgium, Greece, the Netherlands, Spain, the United Kingdom, and Slovenia (Lanza and Ferri 1997, Ficetola et al. 2007a, Ficetola et al. 2007b, Kirbiš et al. 2016 – P), and its presence remains unconfirmed in two countries (Denmark and Croatia; Adriaens et al. 2013 – B). The species has been found in Germany (near Bonn and Baden-Wuttemburg) which is the closest to Poland (Ficetola et al. 2007a – P, IUCN 2015 – I, CABI 2018 – B). Although it is believed that on the European Union scale this species has extremely high invasion potential, its rapid expansion towards Poland has not been observed (IUCN 2015 – I, Kopecky et al. 2016 – P). Distance of 600 km from well-known locations to the border with Poland allows to determine the probability of self-expansion as medium, assuming that new positions will not be created closer to the border. The natural dispersion of the species in the natural environment is about 1 km/year (Adriaens et al. 2013 – B). In addition, local flooding and flood waves may lead to distribution of tadpoles, young and adult forms (CABI 2018 – B).

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

X	low
	medium
	high

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

acomm07.	Comments:
	Few individuals are owned by private breeders, it is also a relatively valuable species and is rarely offered for sale on foreign markets, including e.g. Hamm, in Germany (Kaczmarski and Kolenda, own observations 2018 – A). American bullfrog is one of the largest amphibians (up to approx. 20 cm, Spitzen-van der Sluijs and Zollinger 2010 – P), therefore the probability that it will be transported accidentally is very small. Also, the risk of accidentally transporting tadpoles or spawn is very small. Nevertheless it may be difficult to distinguish natural dispersion from intentional introduction or escape from breeding (Kirbiš et al. 2016 – P).

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

	low
X	medium
	high

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

acomm08.	Comments:

Cases of American bullfrogs being released to the environment are recorded around the world (Stumpel 1992 – P). In Poland, trade involving this species is very limited – 1 sale offer for 474 recorded offers of exotic amphibians (Kaczmarski and Kolenda 2013-2014 – A), because it is in the ordinance of the Minister of the Environment regarding the list of alien plant and animal species, which in case of release to the natural environment may threaten native species or natural habitats (Regulation... 2011 – P), and in the Commission's Implementing Regulation (EU) 2016/1141 adopting a list of invasive alien species considered to pose a threat to the Union in accordance with Regulation of the European Parliament and Council (EU) No. 1143/2014 (Regulation 2014, Commission implementing regulation 2016 – P). The species is very prolific and resistant – therefore, the breeding surplus can enter the environment as part of a deliberate introduction ("enrichment of the environment"/getting rid of unnecessary individuals), same as excessively large individuals (in relation to the breeder's ability) can be released, similar as in case of exotic reptiles or fish. Nevertheless it may be difficult to distinguish natural dispersion from intentional introduction or escape from breeding (Kirbiš et al. 2016 – 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
X	sub-optimal
	optimal for establishment of *the species*

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

acomm09.	Comments:

Compared to the US area where American bullfrog is a native species (according to Figure 1 in the Harmonia[+PL] document – procedure for assessing the risk of negative effect of invasive and potentially invasive alien species in Poland), climatic conditions in Poland are similar only to a small extent. This species is quite plastic, though considered to be thermophilic. The species completes the full life cycle in the west and south of Europe (Ficetola et al. 2007a – P). The reproductive period is limited by overwintering period, i.e. it starts when the temperature exceeds 15°C during the day. The minimum temperature tolerated in winter is 0°C. The optimal temperature of water for species breeding is 25°C. Spring precipitation is not required to start the reproduction period, however, humid air promotes migration (Spitzen-van der Sluijs and Zollinger 2010 – P, CABI 2018 – B).

a10. Poland provides **habitat** that is

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

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

acomm10.	Comments:

There are moderately favorable habitat conditions in Poland. The key element is the presence of an appropriate range of wetland habitats and breeding reservoirs, including, among others, small watercourses with low current, drainage ditches, fish ponds, lakes and

temporary reservoirs (Adriaens et al. 2013 – B, CABI 2018 – B). Better conditions will be certainly found in a man-made environment, where the tanks are artificially heated and the water temperature can reach 25°C (preferred by the breeding species), and the water level is controlled (e.g. downtown ponds and bathing beaches, water heated by heat and power plants) (D'Amore et al. 2010, D'Amore 2012 – 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
X	medium
	high
	very high

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

acomm11.	Comments:
	Dispersion from a single source (Data type: A)
	The natural dispersion of the species in the natural environment is about 1000 m/year (maximum dispersion of 1500 m per year, Raney 1940, Willis et al. 1956 – P). For this dispersion, the species requires appropriate temperature (temperature >15°C during the species's activity, i.e. late spring) and habitat conditions (including ecological corridors: ponds, lakes, etc.). In Belgium, between 2000 and 2012, the average rate of occupying new atlas squares was estimated at 1.5 cells per year (cell surface area: 1x1 km = 1 km^2) (Adriaens et al. 2013 – B). In addition, local flooding and flood waves may lead to distribution of tadpoles, young and adult forms (CABI 2018 – B).

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

	low
X	medium
	high

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

acomm12.	Comments:
	Intentional resettlement and escapes from breeding are the two main possibilities of this species's dispersion with human involvement (CABI 2018 – B). Amphibians can be moved to waterholes, for example to make them more attractive (Dolata and Kolenda 2017 – P). It is worth emphasizing that even a few parent individuals can successfully occupy a new position (Adriaens et al. 2013 – B). At the same time, it may be difficult to distinguish natural dispersion from intentional introduction or escape from breeding (Kirbiš et al. 2016 – P).

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:
	American bullfrogs are predators that eat almost all types of organisms, from small invertebrates (e.g. ants) to amphibians, reptiles, small rodents, and even birds and bats (Beringer and Johnson 1995, Corse and Metter 1980, Kats and Ferrer 2003, Jancowski and Orchard 2013, Mikula 2015 – P). The negative effect of the American bullfrog through predation (limiting the number of animal groups that it feeds only, mainly invertebrates) has been repeatedly confirmed (e.g. Rosen and Schwalbe 1995 – I, CABI 2018 – B). The occurrence of this species in a water reservoir inhabited by other species of amphibians (being a part of special care species), may lead to drastic decline in their numbers or to their complete extermination.

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:
	The species has a broad spectrum of food (it is a generalist predator), i.e. eats all kinds of prey that it is able to catch and swallow, both in terrestrial and aquatic environments, therefore it can effectively compete for food with species inhabiting similar niches. Few large species of native amphibians, such as the common frog *Rana temporaria*, the common toad *Bufo bufo*, and water frogs *Pelophylax* spp., can co-exist with a American bullfrog, but only at very low densities. The niches of the last two species overlap the niche of the American bullfrog to the greatest extent (i.e. permanent, eutrophic water reservoirs (Adriaens et al. 2013 – B). It is estimated that the species can compete and adversely affect species such as great crested newt *Triturus cristatus*, common spadefoot *Pelobates fuscus*, European tree frog *Hyla arborea*, netterjack toad *Epidalea calamita* – however, further studies are necessary (Adriaens et al. 2013 – B). It is worth noting that excretions (unnecessary metabolism products) secreted by tadpoles of this species may delay the growth or even lead to mortality of other amphibian larvae (Laufer and Sandte 2004 – 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:

There is no risk of American bullfrog interbreeding with native species – there are no species closely related to the bullfrog species in Poland and Europe (IUCN 2015 – I, CABI 2018 – B).

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

	very low
	low
	medium
	high
X	very high

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

acomm16.	Comments:

The bullfrog is a vector of more than 40 pathogens (Najberek – work in progress – N), including e.g. parasitic fungus *Batrachochytrium dendrobatidis* attacking all native amphibians. In recent years, the presence of this fungus has also been found in Poland (Kolenda et al. 2017 – P). From other countries, there are known cases of total extinction of amphibian species due to the effect of this parasite (including decrease in electrolyte transport in the epidermis, decrease in serum concentration, problems with gas exchange, cardiac arrest, death). In addition, American bullfrog is a vector of ranaviruses which have also been confirmed in Poland, and which cause diseases most often resulting in amphibian death (Kolenda et al. – work in progress – N, Schloegel et al. 2009 – P). Both pathogens are on the list of the World Organization for Animal Health (OIE) and are subject to mandatory reporting (Schloegel et al. 2010 – P).

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

X	low
	medium
	high

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

acomm17.	Comments:

Even if the species settles throughout the country, its effect on the integrity of ecosystems by disturbing the abiotic factors seems to be low or zero, the more so because such an effect has not yet been found in other European countries.

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

	low
X	medium
	high

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

acomm18.	Comments:

Absolute predator and a food and habitat competitor of native amphibian species, this species can affect the food chains on a local scale. Competition for breeding sites can lead to a decrease in the population of other species not eaten by it, but the niches of which overlap with the American bullfrog – in domestic conditions it is the common toad and water frogs (Adriaens et al. 2013 – B). In addition, the presence of American bullfrog larvae in the aquatic environment causes changes in the colonization of individual tank zones by larvae of other species, which are thus more exposed to predation by fish (Blaustein and Kiesecker 2002 – P). This effect is mainly related to habitats that are not particular care ones. Furthermore, the development of the American bullfrog tadpole significantly reduces the rate of primary phytoplankton production in reproductive tanks (Adriaens et al. 2013 – B).

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:

Adults are exclusively carnivorous, while tadpoles are herbivorous, yet they do not affect the plant cultivation while remaining in water.

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 not a plant.

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

X	inapplicable
	no / very low
	low
	medium
	high
	very high

aconf17.	Answer provided with a	low	medium	high	level of confidence

acomm21.	Comments:
	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:
	So far, the effect of this species on crops by disturbing their integrity has not been noted.

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:
	So far, no American bullfrog has been reported to carry pathogens and parasites harmful to plants, and there is no reason to believe that they will be discovered.

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
X	low
	medium

	high
	very high

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

acomm24.	Comments:
	American bullfrog does not hunt farm animals nor pets in the classic sense. In Poland, there is no commercial breeding of American bullfrogs and other species of edible frogs for consumption, therefore there is no risk of predation by the American bullfrog. In breeding ponds, however, it can feed on bred fish (Corse and Metter 1980 – P). Adult frogs may also eat other animals found in terrarium breeding, but several species are usually not combined in a single tank, and in addition, the presence of this species in amateur breeding is minor (Kaczmarski and Kolenda 2013-2014 – A).

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

X	very low
	low
	medium
	high
	very high

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

acomm25.	Comments:
	Pets (e.g. dogs, cats) may experience an allergic reaction attempting to catch American bullfrog individuals due to contact with toxins produced by frogs, but this will not cause permanent damage to health.

a26. The effect of *the species* on individual animal health or animal production, by hosting **pathogens or parasites** that are harmful to them, is:

	inapplicable
	very low
	low
	medium
	high
X	very high

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

acomm26.	Comments:
	The bullfrog is a vector of two pathogens: *Batrachochytrium dendrobatidis* and ranavirus, which cause deadly amphibian diseases. Both are on the OIE list and both have been found in Poland (Kolenda et al. 2017 – P, Kolenda et al. – work in progress – N). Although these pathogens do not cause disease in livestock and domestic animals in the traditional sense, they can cause fatal diseases in amphibians of amateur breeding. However, it should be remembered that the share of American bullfrogs in the exotic amphibian trade in Poland is small (Kaczmarski and Kolenda 2013-2014 – A).

A4d | Impact on the human domain

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

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

X	inapplicable
	very low
	low
	medium
	high
	vert high

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

acomm27.	Comments:
	This species is not a parasite.

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

X	very low
	low
	medium
	high
	very high

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

acomm28.	Comments:
	Like any amphibian, American bullfrog contains toxins in its skin, which in the case of prolonged contact with human skin may cause minor irritations. Cases of allergic reaction have also been documented in people eating American bullfrog meat (CABI 2018 – B). However, the probability of such reactions should be considered low and their effect too small.

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 role of American bullfrogs as a carrier of zoonotic pathogens is limited (Adriaens et al. 2013 – B). Tadpoles can be carriers of *Escherichia coli* bacteria, a common pathogen for humans (CABI 2018 – B). In case of humans, these bacteria cause mainly gastrointestinal and urinary tract diseases which are usually completely curable.

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:

X	very low
	low
	medium
	high
	very high

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

acomm30.	Comments:
	So far, no harmful effect of the American bullfrog on the infrastructure has been found.

A5a | Impact on ecosystem services

Questions from this module qualify the consequences of *the organism* on ecosystem services. Ecosystem services are classified according to the Common International Classification of Ecosystem Services, which also includes many examples (CICES Version 4.3). Note that the answers to these questions are not used in the calculation of the overall risk score (which deals with ecosystems in a different way), but can be considered when decisions are made about management of *the species*.

a31. The effect of *the species* on **provisioning services** is:

	significantly negative
	moderately negative
X	neutral
	moderately positive
	significantly positive

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

acomm31.	Comments:
	The effect of the American bullfrog on supply services is neutral. Although it can eat fish in breeding ponds, this effect is considered to be unnoticeable.

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:
	The effect of American bullfrog on regulatory services has been assessed as moderately negative, as this species may have negative effect on biological regulation by regulating zoonotic diseases (transmission of pathogens: *B. dendrobatidis* and ranaviruses). The destruction and/or weakening of the native amphibian populations resulting from the emergence and development of American bullfrog population may affect other elements of the trophic network (cascade effects), however, there is no information on this subject

(Adriaens et al. 2013 – B). On the other hand, this species can positively influence this regulation by eating pests, including slugs and Colorado potato beetle. It seems, however, that the negative effect outweighs the positive.

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 X	high	level of confidence

acomm33.	Comments:
	So far, the effect of the American bullfrog on cultural services has not been found. Nevertheless, the hypothetical disappearance of the local amphibian population as a result of the development of American bullfrog population can be negatively perceived by the society (Hocking and Babbitt 2014 – P).

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

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

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

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm34.	Comments:
	Temperature in winter is a factor limiting the survival of American bullfrog individuals during this period. The average temperature increase will help the species survive the winter period and allow establishment in new areas (CABI 2018 – B).

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm35.	Comments:
	Increase in average temperature during spring and summer will have positive effect on the development of eggs, tadpoles and juveniles, which will probably allow the formation of stable populations in case of this species. The average temperature increase will also facilitate the survival during winter period (CABI 2018 – B).

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm36.	Comments:
	Higher temperatures during activity period of this amphibian will enable American bullfrog reproduction and spread in Poland. The temperature during winter is a factor limiting the survival of American bullfrog individuals during this period; the average temperature increase will facilitate the survival of this species during the winter period and enable inhabiting new areas, including those in temperate climate (CABI 2018 – B).

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
X	increase significantly

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

acomm37.	Comments:
	More stable habitat and climate conditions will aggravate the negative effect on other amphibian species – by increasing the size of the population, the risk of predation, competition and infection by pathogens carried by American bullfrog.

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 effect of the species on crops is unknown and climate changes are not expected to change it.

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 **X**	high	level of confidence

acomm39.	Comments:
	At the moment, American bullfrog is not found in the natural environment in Poland. Global warming may be the reason for the establishment and spread of this species in our country, which in turn may demonstrate negative effect on fish farming. Numerous wild populations of this species will increase the probability of introducing pathogens to closed (terrarium) breeding, both with food and decoration elements originating from the natural environment.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm40.	Comments:
	The effect of the species on humans is negligible and climate change is not expected to change this.

a41. IMPACT ON OTHER DOMAINS – Due to climate change, the consequences of *the species* on other domains in Poland will:

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm41.	Comments:
	The species does not affect other objects and climate warming is not expected to change this.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0,33	1,00
Establishment (questions: a09-a10)	0,50	1,00
Spread (questions: a11-a12)	0,50	0,75
Environmental impact (questions: a13-a18)	0,58	1,00
Cultivated plants impact (questions: a19-a23)	0,00	1,00
Domesticated animals impact (questions: a24-a26)	0,42	0,83
Human impact (questions: a27-a29)	0,25	0,75
Other impact (questions: a30)	0,00	1,00
Invasion (questions: a06-a12)	0,44	0,92
Impact (questions: a13-a30)	0,58	0,92
Overall risk score	0,26	
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 is regularly repeated.

acomm42.	Comments: This species is considered to be one of the most invasive in the world (including in Europe). However, so far there have been no American bullfrogs in the natural environment in Poland. When it comes to countries bordering Poland, few populations are present in central and western parts of Germany only, yet their expansion to the east has not been observed. The present climate conditions in Poland favor establishment and spread of this species only slightly. Because of that, the assessment of American bullfrog invasiveness in Poland is lower than on European scale.

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