



Appendix A

## Harmonia<sup>+PL</sup> – 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. Borys Kala
2. Bartłomiej Gorzkowski – external expert
3. Karolina Mazurska

acomment01.	Comments:	degree	affiliation	assessment date
		(1) mgr	Polish Society for Nature Conservation "Salamandra"	29-01-2018
		(2)	Epicrates Foundation, Lublin	26-01-2018
		(3) mgr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	31-01-2018

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

Polish name: Żółw ostrogrzbiety

Latin name: ***Graptemys pseudogeographica*** (Gray, 1831)

English name: Mississippi map turtle

acommm02.	Comments:		
	Polish name (synonym I)	–	Polish name (synonym II)
	Latin name (synonym I)	<i>Emys pseudogeographica</i>	Latin name (synonym II)
	English name (synonym I)	False map turtle	English name (synonym II)

**a03. Area under assessment:**

**Poland**

acommm03.	Comments:
	–

**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 checked="" type="checkbox"/>	alien, present in Poland in the environment, not established
<input type="checkbox"/>	alien, present in Poland in the environment, established

aconff01.	Answer provided with a	low	medium	high	level of confidence
			X		

acommm04.	Comments:
	<p>The species occurs in the natural environment in the area of Poland, although not as often as pond slider (<i>Trachemys scripta</i>). During the catches in the south-eastern part of the country, conducted in the years 2015-2017 as a part of the research project "Invasive turtle species as a source and vector of animal and human pathogens", only four individuals of this species were caught. This constitutes a small amount, considering the fact that 137 turtles were caught in total. It is worth noting that it is a smaller amount than in the case of turtles of the genus <i>Pseudemys</i>, which were caught in the number of six (5 individuals <i>P. concinna</i> and 1 individual <i>P. nelsoni</i>) (Gorzowski 2018). Moreover, the employees of the Lublin Exotarium caught three individuals (2012, 2014, 2015) in Zemborzyce lake and the Bystrzyca river. In the years 2015-2017 they also observed a female of Mississippi map turtle in a site situated at the mouth of the Czechówka river to the Bystrzyca river (Gorzowski 2018 – I). Mississippi map turtles have never been so popular in amateur breeding as pond sliders, therefore there are relatively fewer cases of abandoning these animals by their previous owners. In the years 2006-2010, 17200 individuals of these reptiles were imported directly from the US to our country (Kala et al. 2015 – I). There is no data about the import in later years. These turtles became the most popular in trade as a substitute for <i>T. scripta</i>, shortly after restrictions concerning its sale and keeping had been introduced. Although this species is currently included in the Regulation of the Minister of the Environment dated 9 September 2011 on the list of non-native species of plants and animals, which in the case of release into the environment can threaten native species or natural habitats – P, it is still found in trade, while pet stores and buyers are usually unaware of the applicable provisions of law (Gorzowski 2018 – I). So far, also no successful cases of reproduction of this species in Poland have been confirmed. However, considering omnivorous diet of this species, life expectancy and a relatively favourable climate, the invasion of this species can have a significant impact on local environmental resources. Similarly to other turtles of invasive species, this can also be a vector of pathogens hazardous not only to native species, but also to humans and domesticated animals.</p>

**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

acom05.

Comments:

Mississippi map turtle is a species, which is relatively rare in the natural environment in Europe. Therefore, information concerning the impact of this species on the European nature are very limited. Considering the biology of this species and the environment and climate in the region of its original occurrence, it should be assumed that its impact on the natural environment, humans and domesticated animals will be similar or identical to the impact of pond slider. Therefore, it is possible to assume with a high probability that Mississippi map turtle will constitute a threat to pond turtle *Emys orbicularis* due to both food and habitat competition (e.g. they will compete for sites for basking). However, so far no research on the interactions between these two species have been conducted. Similarly to other invasive species of turtles, Mississippi map turtle may be a vector of various pathogens hazardous both to humans and animals – including farm animals. It has been found that it carries, among others, a bacterium *Salmonella* spp. (Goławska et al. 2017 – P). Through predation, it can also affect populations of amphibians, fish and molluscs.

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

aconf02.

Answer provided with a

low	medium <b>X</b>	high
-----	--------------------	------

level of confidence

acom06.

Comments:

Although there is no literature data on the occurrence of Mississippi map turtle in the area of the countries bordering with Poland (Kala et al. 2015 – I), however, it does not seem to reflect the actual situation. Mississippi map turtle is a relatively popular species on the terraristic market. In the years of 2006-2014, a total of 1.5 million individuals was exported from the US to the countries all over the world. In the years 2008-2012 115000 individuals were imported to the Czech Republic alone (Kopecký et al. 2013 – P). With such a big number of individuals introduced to the market, the probability of intentional or unintentional introductions seems very high. The maximum distance migrated by a female of Mississippi map turtle over 5 months, reported by Ernst and Lovich (2009 – P) is 8 km. The presence of Mississippi map turtles in Poland has been already confirmed by observations and catches of single individuals (Gorzowski 2015, Kala et al. 2015- I).

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

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

aconf03.	Answer provided with a	low	medium	high	level of confidence
				<b>X</b>	

acommm07. Comments:  
 Introductions of Mississippi map turtles in Poland, similarly to other countries, are a result of intentional human actions (Kala et al. 2015 – I). There are no known cases of unintentional introductions of Mississippi map turtles as "stowaways".

**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
				<b>X</b>	

acommm08. Comments:  
 The appearance of Mississippi map turtles in the natural environment in Poland is a consequence of the release of individuals from captivity (Kala et al. 2015 – I). Unaware owners of turtles, are rarely prepared to provide long-term care for a big, adult individuals. Such animals are often released by their owners into ponds, rivers and lakes.

## A2 | Establishment

Questions from this module assess the likelihood for *the species* to overcome survival and reproduction barriers. This leads to *establishment*, defined as the growth of a population to sufficient levels such that natural extinction within *the area* becomes highly unlikely.

**a09.** Poland provides **climate** that is:

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

aconf05.	Answer provided with a	low	medium	high	level of confidence
				<b>X</b>	

acommm09. Comments:  
 Based on the map of Poland's climatic similarity in relation to the whole world, included in the Harmonia<sup>+PL</sup> document, it should be recognized that climatic conditions prevailing in our country are not optimal for Mississippi map turtle, mainly because of too low temperatures in the summer, which probably prevent a proper incubation of eggs – only a small part of the northern edge of the natural range of the species coincides with the area characterized by a climate equivalent to the climate prevailing in our country. There are no reports about a breeding success of this species under the natural conditions in Poland. Introduced individuals may potentially survive throughout the country.

**a10.** Poland provides **habitat** that is

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

aconf06. Answer provided with a 

low	medium <b>X</b>	high
-----	--------------------	------

 level of confidence

acomment10. Comments:  
Mississippi map turtles in the area of their natural occurrence are present mainly in large rivers and marshes, although they also occur in lakes, ponds and bogs. These reptiles prefer water courses with a slow current, with a lot of aquatic vegetation and numerous sites for basking. They can also be observed in rivers characterized by a fast current (Ernst and Lovich 2009 – P). Therefore, it can be assumed that habitat conditions prevailing in Poland are optimal for the establishment of the species. The exception will be mountainous areas, because the low temperature of water will be unfavourable for these turtles, therefore, their presence in creeks and mountain streams or seepage spring areas should not be expected.

### 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 <b>X</b>	high
-----	--------------------	------

 level of confidence

acomment11. Comments:  
Dispersion from a single source (Data type: A)  
No literature data on the migration of the introduced Mississippi map turtles are available. Ernst and Lovich (2009 – P) cite several results of the studies on the migration of these reptiles in the areas of their natural occurrence. They usually migrated at distances up to 5 km, however one female travelled 8 km within five months. Therefore, it should be recognized that although Mississippi map turtles live in a relatively small area, they have a potential for longer migrations.

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

- low
- medium
- high

aconf08. Answer provided with a 

low	medium	high <b>X</b>
-----	--------	------------------

 level of confidence

acomm12.

Comments:

Assuming that Mississippi map turtle will be widely dispersed in the natural environment in Poland, it should be expected that a translocation of individuals for different reasons will be relatively frequent (over 10 individuals per decade), e.g. turtles will be caught in good faith by random people, and subsequently released back into the wild, due to the lack of authorized entities ready to take over such animals (currently such situations occur most probably in relation to pond sliders) (Kala 2017).

### 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
- high

aconf09.

Answer provided with a

low	medium <b>X</b>	high
-----	--------------------	------

level of confidence

acomm13.

Comments:

There is no literature data on the impact of Mississippi map turtles on the European native species. Although these reptiles are opportunistic omnivores feeding on very diverse food in various developmental forms, food specificity (especially in females) directed towards molluscs is clearly visible (Ernst and Lovich 2009 – P) (among the species of special concern, these could be e.g. lesser ramshorn snail *Anisus vorticulus*, thick shelled river mussel *Unio crassus* or narrow-mouthed whorl snail *Vertigo angustior*. Assuming that the species will be widely dispersed in the environment, its impact of the native species (including e.g. molluscs of special concern), at high density, may be locally significant.

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

- low
- medium
- high

aconf10.

Answer provided with a

low	medium <b>X</b>	high
-----	--------------------	------

level of confidence

acomm14.

Comments:

There is no literature data on the impact of Mississippi map turtles on native species through competition. It can only be presumed that this effect is similar to the effect of pond slider, as both species are characterized by fairly similar biological parameters. This means that the presence of Mississippi map turtles in a habitat may have an effect

especially on native European pond turtles as a result of competition for various elements of the environment, e.g. a site for basking, hibernation, breeding grounds or food resources.

**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 <b>X</b>	level of confidence
----------	------------------------	-----	--------	------------------	---------------------

a15. Comments:  
The only native species potentially able to crossbreed with Mississippi map turtle is European pond turtle. Both species belong to the same family of *Emydidae*, however to different genera: *Graptemys* (Mississippi map turtle) and *Emys* (European pond turtle). However, the emergence of such a type of an intergeneric hybrid is unlikely.

**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 <b>X</b>	high	level of confidence
----------	------------------------	-----	--------------------	------	---------------------

a16. Comments:  
Until recently, available scientific literature showed significant deficiency concerning the knowledge about bacteria, parasites, viruses and fungi occurring in invasive and alien species of turtles (Goławska et al. 2017 – P). Although the situation has been recently improved to some extent, because of, among others, a research project conducted in the area of Poland and focused on this issue, data of parasites and pathogens transmitted by this analysed species are still little. For this reason, the answer to this question is based on the expert assessment.  
As part of the initially mentioned project, four individuals of Mississippi map turtle were caught from the natural environment. In the samples collected from these reptiles, the presence of *Klebsiella* spp., *Aeromonas* spp. on the skin, *Yersinia* spp., *Clostridium perfringens* (toxic type), *Citrobacter* on the skin and in parenchymal organs, *Shewanella* spp., *Pseudomonas* spp. was found (Gorzowski 2018 – I). They all have pathogenic potential and potentially can be transmitted to the species of special concern (e.g. *Shewanella* spp., *Pseudomonas* spp. or *Aeromonas* spp. have a high pathogenic potential in relation to, among others, fish, and can constitute a threat to e.g. lake minnow). Pękala et al. (2016 – P) also do not exclude infections caused by so far unknown bacteria, whose vector may be alien species of turtles (including Mississippi map turtle).  
There is a high probability that in the case of Mississippi map turtles, the risk of a transfer of parasites and pathogens is analogous as in the case of pond sliders (a similar specificity of the species, similar conditions of keeping animals in the period prior to the introduction). Pond sliders are vectors of numerous pathogens hazardous to native species of fish (including species of economic importance), amphibians, birds and mammals. Apart from pathogens, whose presence was found in Mississippi map turtles, they can transmit, among others: *Salmonella* spp. (Soccini and Ferri 2004, Martínez et al. 2005, Konieczna et al. 2016 – P), *Chlamydia* spp. (Mitura et al. 2016, Mitura et al. 2017 – P) and *Acinetobacter* spp. (Pękala et al. (2016 – P). Particularly noteworthy is the risk of *Chlamydia* spp. infections in

European pond turtles. Mitura et al. (2017 – P) describes a case of high mortality among newly hatched turtles of this species in a breeding centre, in which an individual of pond slider was also kept – which was, as it later appeared, an asymptomatic carrier of this pathogen. The examination of samples collected from that individual and dead European pond turtles demonstrated that it was the same pathogen.

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

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

aconf13.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acomment17. Comments:  
 There is no literature data on the effect of this species on abiotic properties of ecosystems. However, it can be assumed, with a very high probability, that in the worst case this species causes easily reversible changes in habitats of special concern. Depending of the type of the inhabited reservoir, at a high density of turtles, these changes may potentially consists in e.g. cloudiness and contamination of water.

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

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

aconf14.	Answer provided with a	low	medium	high	level of confidence
		<input checked="" type="checkbox"/>			

acomment18. Comments:  
 Assuming that this species establishes in Poland, and the number of individuals will systematically grow throughout the country, it can be expected that it will affect aquatic organisms, with which it will share the same reservoirs, which in turn will affect natural habitats, mostly those not belonging to the habitats of special concern. It can reduce the population size of, among others, amphibians, molluscs and insects (including species of special concern) in different developmental forms. In the worst case, in the situation of the appearance of the species in habitats of special concern, it can probably lead to hardly reversible changes – e.g. by introducing to the environment alien pathogens hazardous to native fauna. Low level of confidence reflects a poorly hypothetical nature of the response – there is no literature data addressing that issue in relation to Mississippi map turtle.

## 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:

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



- high
- very high

aconf15. Answer provided with a 

low	medium	high <b>X</b>
-----	--------	------------------

 level of confidence

acommm19. Comments:  
The species feeds only in water, therefore it does not affect cultivated plants.

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
-----	--------	------

 level of confidence

acommm20. 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

acommm21. 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:

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

aconf18. Answer provided with a 

low	medium	high <b>X</b>
-----	--------	------------------

 level of confidence

acommm22. Comments:  
The species does not affect the condition or yield of cultivated plants.

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

- very low
- low
- medium

- high
- very high

aconf19. Answer provided with a 

low <b>X</b>	medium	high
-----------------	--------	------

 level of confidence

acomm23. Comments:  
The research conducted as part of the project "Invasive turtle species as a source and vector of animal and human pathogens" demonstrated that alien species of turtles (including Mississippi map turtle) are vectors for, among others, a pathogen *Pseudomonas* spp. (Peřkala et al. 2016 – P), while *Pseudomonas syringae* is included in the EPPO A2 list and is one of the most dangerous bacterial pathogens of plants. This bacterium causes, among others, bacterial cancers of fruit trees, bacterial brown spot of bean, bacterial angular leaf spot of cucumbers, rot of cauliflower buds, bacterial spot of tomato or leaf sheath spot of corn. In view of the fact that the exact taxonomic status of the pathogen found in the above mentioned turtles is not known, the level of confidence has been determined to be low.

### 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
- high
- very high

aconf20. Answer provided with a 

low	medium <b>X</b>	high
-----	--------------------	------

 level of confidence

acomm24. Comments:  
Mississippi map turtle can probably affect domesticated animals kept in aquacultures by predation (e.g. on fish roe), however there is no available literature data on this issue. At a wide spread of this species, the probability of such situations is high (over 100 cases per 100000 animals per year – in the case of roe this ratio can be several times higher). Considering the fact that the effect of predation is the death of the victim, the result of predation was determined to be high. Consequently, the effect of the species (probability x result) was determined as very big. This species does not affect farm or domesticated animals through predation.

**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 <b>X</b>
-----	--------	------------------

 level of confidence

acom25.

Comments:

There is no literature data on the characteristics of Mississippi map turtles, which upon contact with farm or domesticated animals may affect them in a negative way (except the transmission of parasites and pathogens – vide question a26). Adult individuals of this species can bite animals (however, the effect of biting should be considered small – it will be followed by a full recovery of an animal), however such situations will undoubtedly be sporadic on the national scale (1-100 cases per 100000 of farm or domesticated animals per year), even assuming that the species is spread throughout the country. Biting can probably concern mainly domesticated animals (first of all dogs penetrating waterside zones of water reservoirs).

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 <b>X</b>	high
-----	--------------------	------

level of confidence

acom26.

Comments:

Until recently, available scientific literature showed significant deficiency concerning the knowledge about bacteria, parasites, viruses and fungi occurring in invasive and alien species of turtles (Goławska et al. 2017 – P). Although the situation has been recently improved to some extent, because of, among others, a research project conducted in the area of Poland and focused on this issue, data of parasites and pathogens transmitted by analysed species are still little. For this reason, the answer to this question is based on the expert assessment.

As part of the initially mentioned project, four individuals of Mississippi map turtle were caught from the natural environment. In the samples collected from these reptiles, the presence of *Klebsiella* spp., *Aeromonas* spp. on the skin, *Yersinia* spp., *Clostridium perfringens* (toxic type), *Citrobacter* on the skin and in parenchymal organs, *Shewanella* spp., *Pseudomonas* spp. were found (Gorzowski 2018 – I). They all have pathogenic potential and can potentially be transmitted to farm and domesticated animals. *Shewanella* spp., *Pseudomonas* spp. *Aeromonas* spp. or *Citrobacter* spp. have a high pathogenic potential and can cause the death of fish of any species, which makes them constitute a serious hazard to aquacultures. Therapy is possible only in small breeding reservoirs such as ponds. In large reservoirs and watercourses the use of therapy is not feasible (Pękala 2018 – I, oral communication).

Pękala et al. (2016) also do not exclude infections caused by so far unknown bacteria, whose vector may be alien species of turtles (including Mississippi map turtle).

There is a high probability that in the case of Mississippi map turtles, the risk of a transfer of parasites and pathogens is analogous as in the case of pond sliders (a similar specificity of the species, similar conditions of keeping animals in the period prior to the introduction). Pond sliders are vectors of numerous pathogens hazardous to fish (including species of economic importance), amphibians, birds and mammals. Apart from pathogens, whose presence was found in Mississippi map turtles, they can transmit, among others: *Salmonella* spp. (Soccini and Ferri 2004, Martínez et al. 2005, Konieczna et al. 2016 – P), *Chlamydia* spp. (Mitura et al. 2016, Mitura et al. 2017 – P) and *Acinetobacter* spp. (Pękala et al. (2016 – P).

## 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
-----	--------	------

 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 <b>X</b>
-----	--------	------------------

 level of confidence

acomm28. Comments:  
Upon direct contact, turtles can bite humans sorely, as these animals are actively defending themselves when attacked. The probability of such events was estimated as medium, or 1-100 cases per 100000 people per year. Probably, such situations may take place especially in areas used for recreational purposes, as well as by anglers, accidentally catching individuals of this species. Considering the fact that the result of biting is not hazardous for a human (except for the transmission of pathogenic organisms) – it was defined as low.

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 <b>X</b>	high
-----	--------------------	------

 level of confidence

acomm29. Comments:  
The transmission of parasites and pathogens by Mississippi map turtles is a poorly examined phenomenon, and therefore there are no studies on this issue. However, it should be assumed that the risk of a transfer of parasites and pathogens is analogous as in the case of pond sliders and other invasive species of turtles. Until now, it has been confirmed that pond sliders are vectors of such pathogens as: *Salmonella* spp. (Soccini and Ferri 2004, Martínez et al. 2005, Konieczna et al. 2016 – P), *Aeromonas* spp. (Soccini and Ferri 2004,

Pełka et al. 2016 – P), *Pseudomonas* spp. (Soccini and Ferri 2004, Pełka et al. 2016 – P), *Shewanella putrefaciens* (Pełka et al. 2016), *Chlamydia* spp. (Mitura et al. 2016, Mitura et al. 2017 – P), *Acinetobacter* spp. (Pełka et al. 2016 – P), *Yersinia* spp. (Soccini and Ferri 2004 – P), *Klebsiella* spp. (Goławska et al. 2017 – P), *Citrobacter* spp. (Pełka et al. 2016 – P). Most of the mentioned pathogens are hazardous to humans. The studies conducted in Spain revealed the presence of bacteria (*Salmonella* spp.) in 10% of the examined turtles. The Catalan Government Livestock Health Laboratory conducts research to determine the taxonomic classification of the isolated *Salmonella* bacterium. Initial test results constitute a warning against a potential risk associated with the presence of pond sliders in waters of the Foix, not only from ecological, but also from a sanitary and environmental (hazard to other species), as well as zoonotic (zoonoses) point of view (in relation to humans) (Martínez et al. 2005 – P). Food poisoning caused by zoonotic strains of *Salmonella* spp. most often have a mild course. However, sometimes they may have a generalized nature, including death (Goławska et al. 2017 – P). Among the listed pathogens, a zoonotic nature is manifested in particular by: *Salmonella* spp., *Acinetobacter* spp., *Yersinia* spp., *Klebsiella* spp., *Chlamydia* spp. and *Mycobacterium* spp., which in specific situations (a reduction in the immunity of the body) may pose a deadly threat to humans. Therefore, the effect on human health was determined to be high. None of the above-mentioned pathogens is included in the OIE list.

## A4e | Impact on other domains

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

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

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

aconf26.	Answer provided with a	low	medium	high	level of confidence
		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

acom30.	Comments:
	There is no data on the effect of Mississippi map turtle to infrastructure. However, in the case of establishment and increase in the population size in Poland, these reptiles can contaminate recreational areas, including urban reservoirs, fountains and bathing sites located around large cities, where the biggest numbers of these turtles are released.

## A5a | Impact on ecosystem services

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

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

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

aconf27. Answer provided with a 

low	medium	high
<b>X</b>		

 level of confidence

acomm31. Comments:  
There are no literature data on this issue. However, it seems that the species may have an impact on services related to food provisioning, through a transmission of parasitic and pathogenic organisms to domesticated animals. In the case of establishment and growth of population size in Poland, it can also affect animal production – e.g. as a result of predation on fish roe, as well as contaminate reservoirs used as sources of drinking water.

**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
	<b>X</b>	

 level of confidence

acomm32. Comments:  
Mississippi map turtle may affect biological regulations. Similarly to other invasive species of turtles, they are vectors of various pathogenic animals – therefore they may have an impact on the regulation of zoonotic diseases.

**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	high
	<b>X</b>	

 level of confidence

acomm33. Comments:  
The presence of turtles in city parks can potentially increase their attractiveness for walkers. However, in the case of establishment and increase in the population size in Poland, Mississippi map turtles can contaminate recreational areas (and therefore negatively influence their aesthetic and recreational functions), including urban reservoirs, fountains and bathing sites located around large cities, where the biggest number of these turtles is released. Therefore, their impact on cultural services should be considered neutral.

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

Below, each of the Harmonia<sup>+PL</sup> 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 <b>X</b>
-----	--------	------------------

 level of confidence

acom34. Comments:  
 There is no literature data on the spontaneous spread of the species beyond the natural range of its occurrence. Unpublished observations demonstrate that the spread of introduced Mississippi map turtles, as in the case of the remaining alien species of turtles, is a result of human actions consisting in the establishment of usually single individuals in random sites throughout the country. Forecast climate change will probably not increase this type of behaviour among people keeping those turtles. The ability of spontaneous spread of Mississippi map turtles over longer distances in their natural environment seems limited – the studies of Bodie and Semlitsch (2000 – P) on the Missouri River demonstrated that the average maximum migrations of Mississippi map turtle females within a year were approximately 5 km, and in the case of males nearly 4 km. In turn, Ernst and Lovich (2009 – P) demonstrate a result of the research, which revealed that Mississippi map turtles usually moved over distances up to 5 km, however, they also indicate that one of the females moved by even 8 km within five months. Considering a relatively high popularity of Mississippi map turtles on the terraristic market, it should be expected that this species is already present throughout the country, although probably at a much lower density than pond slider. Reports of observation of this turtle in the natural environment are rare. It is not excluded that it is related to the problems with the identification of this species by random observers. Therefore, climate warming by 1-2°C will not affect the probability of the species to overcome geographical barriers in relation to Poland, but it may be sufficient to overcome the incubation barrier of this species, which in turn will result in an increase in the population size.

**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 <b>X</b>
-----	--------	------------------

 level of confidence

acom35. Comments:  
 Habitat conditions prevailing in Poland seem optimal for Mississippi map turtle. The only barrier preventing it from a full establishment are climatic conditions, which effectively prevent the incubation of eggs. The northern part of the natural range of the occurrence of Mississippi map turtle is adjacent to the area with a climate corresponding to the conditions prevailing in Poland. At appropriate conditions in a breeding ground (well-exposed not overgrown breeding site), the expected climate warming by 1-2°C may be sufficient to overcome the incubation barrier of this species. Ernst and Lovich (2009 – P) report that under laboratory conditions at a temperature of 22-25°C, the incubation of eggs of Mississippi map turtle last 89.3 days, at a temperature of 25-25.5°C – 81 days, and at a temperature of 29.5-30°C – 52.1 days. In turn, Najbar (2008 – P) reports exemplary temperatures of breeding chambers of European pond turtle with information on the

incubation period: 15.5-32.5°C (average 23.6°C) – 86-104 days (average 96.5; data from Poland); 20.7-28°C (average 24.5°C) – 81-88 days (data from Germany); average 27°C – 70 days (data from Spain). Therefore, the average temperatures of incubation of European pond turtles are close to the minimum value of the temperature range of incubation of Mississippi map turtle.

**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 <b>X</b>
-----	--------	------------------

 level of confidence

acomment36. Comments:  
The species most probably spreads as a result of intentional introductions performed by humans. The ability to spontaneous migration of Mississippi map turtles over longer distances is limited, although potentially possible (Ernst and Lovich (2009 – P) report that one female of this species moved by 8 km within 5 months). It seems likely that global warming (especially mitigation of cold winters) will increase the chances to survive of the released individuals and potential migrants.

**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 <b>X</b>
-----	--------	------------------

 level of confidence

acomment37. Comments:  
The incubation temperature of eggs of Mississippi map turtle is similar to the incubation temperature of eggs of European pond turtle. The progressive process of temperature global warming undoubtedly favours the former. If the species overcomes a barrier related to breeding success, then its impact on aquatic organisms may significantly increase, e.g. due to the predation of young individuals, increased risk of transmission of parasites and pathogens, competition for breeding grounds or basking sites with native European pond turtle.

**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 <b>X</b>
-----	--------	------------------

 level of confidence



acomm38.

Comments:

Until now, no impact on cultivated plants or plant production has been demonstrated. Global warming should not change this situation.

**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 <b>X</b>	high
-----	--------------------	------

level of confidence

acomm39.

Comments:

Global warming may contribute to overcoming the reproductive barrier of the species, and consequently to its establishment and rapid increase in its population size. An increase in the number of these reptiles in the natural environment will potentially contribute to an increase in the probability of contacts with farm animals – fish and ungulate species, e.g. in wetland pastures, during which biting by turtles may take place. The hazard related to the transmission of pathogens and parasites will also increase.

**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 <b>X</b>	high
-----	--------------------	------

level of confidence

acomm40.

Comments:

Global warming may contribute to overcoming the reproductive barrier of the species, and consequently to its establishment and rapid increase in its population size. An increase in the number of Mississippi map turtles in the environment may contribute to a potential increase in the probability of interaction with humans – e.g. biting humans in bathing sites may take place more often. The hazard related to the transmission of pathogens and parasites will also 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 <b>X</b>	high
-----	--------------------	------

level of confidence

acomm41.

Comments:

Global warming may contribute to overcoming the reproductive barrier of the species, and consequently to its establishment and rapid increase in its population size. An increase in

the population size of Mississippi map turtles may result in a stronger pressure of these reptiles on recreational areas, including urban reservoirs, fountains and bathing sites located around large cities, where the biggest number of these turtles is released. As a consequence, a problem of contamination of this type of areas may escalate.

## Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.50	0.83
Establishment (questions: a09-a10)	0.75	0.75
Spread (questions: a11-a12)	0.88	0.75
Environmental impact (questions: a13-a18)	0.71	0.58
Cultivated plants impact (questions: a19-a23)	0.17	0.67
Domesticated animals impact (questions: a24-a26)	0.67	0.67
Human impact (questions: a27-a29)	0.50	0.75
Other impact (questions: a30)	0.25	0.00
Invasion (questions: a06-a12)	0.71	0.78
Impact (questions: a13-a30)	0.71	0.53
Overall risk score	0.50	
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.

acomment42. Comments:

–

## Data sources

### 1. Published results of scientific research (P)

Bodie JR, Semlitsch RD. 2000. Spatial and temporal use of floodplain habitats by lentic and lotic species of aquatic turtles. *Oecologia* 122: 138-146

Ernst CIH, Lovich JE. 2009. *Turtles of the United States and Canada*, 2nd edition. Johns Hopkins University Press

Goławska O, Demkowska-Kutrzepa M, Borzym E, Różański P, Zając M, Rzeżutka A, Wasyl D. 2017. Mikroflora i parazytofauna obcych i inwazyjnych gatunków żółwi. *Post. Mikrobiol.* 56: 163-170

Konieczna O, Zając M, Hoszowski A, Maluta A, Wasyl D. 2016. Występowanie *Salmonella* u obcych gatunków żółwi. In: XV Kongres Polskiego Towarzystwa Nauk Weterynaryjnych Lublin, 22-24.09.2016. Materiały Kongresowe: 621

Kopecký O, Kalous L, Patoka J. 2013. Establishment risk from pet-trade freshwater turtles in the European Union. *Knowledge and Management of Aquatic Ecosystems* 410, 02

Mitura A, Niemczuk K, Zaręba K, Zając M, Laroucau K, Szymańska-Czerwińska M. 2017. Free-living and captive turtles and tortoises as carriers of new *Chlamydia* spp. *PLoS ONE* 12(9): e0185407

Mitura A, Zaręba K, Szymańska-Czerwińska M, Jodełko A, Niemczuk K. 2016. Występowanie i charakterystyka molekularna bakterii z rodziny Chlamydiaceae u inwazyjnych gatunków żółwi w Polsce. In: XV Kongres Polskiego Towarzystwa Nauk Weterynaryjnych Lublin, 22-24.09.2016. Materiały Kongresowe: 620

Martínez A, Soler J, Augusti V. 2005. Estudi ecopatològic de les tortugues invasives (*Trachemys* sp.) del pantà de Foix: detecció de *Salmonella*. I Trobada d'Estudios del Foix, Diputacio de Barcelona: 85-88.

Najbar B. 2008. Biologia i ochrona żółwia błotnego (*Emys orbicularis*) w zachodniej Polsce. 162 pp. Uniwersytet Zielonogórski, Zielona Góra

Pękala A, Paździor E, Walczak M, Ambrożkiewicz J, Wasyl D. 2016. Bakterie chorobotwórcze dla ryb izolowane od inwazyjnych gatunków żółwi. In: XV Kongres Polskiego Towarzystwa Nauk Weterynaryjnych Lublin, 22-24.09.2016. Materiały Kongresowe: 618

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 environment (Journal of Laws No 210, item 1260).

Soccini C, Ferri V. 2004. Bacteriological screening of *Trachemys scripta elegans* and *Emys orbicularis* in the Po plain (Italy). *Biologia*, Bratislava 59/Suppl.: 201-207

## **2. Databases (B)**

–

## **3. Unpublished data (N)**

–

## **4. Other (I)**

Kala B, Kepel A, Solarz W, Więckowska M. 2015. Program postępowania z inwazyjnymi gatunkami żółwi na terenie Polski. Opracowanie na zlecenie Generalnej Dyrekcji Ochrony Środowiska

## **5. Author's own data (A)**

Gorzkowski B. 2015. Personal communication

Gorzkowski B. 2018. Personal communication

Kala B. 2017. Personal communication

Pękala A. 2018. Personal communication