



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. Henryk Okarma
2. Izabela Wierzbowska – external expert
3. Wojciech Solarz

acomment01.	Comments:	degree	affiliation	assessment date
(1)	prof. dr hab.		Institute of Nature Conservation, Polish Academy of Sciences in Cracow	10-01-2018
(2)	dr		Institute of Environmental Sciences, Jagiellonian University	30-01-2018
(3)	dr		Institute of Nature Conservation, Polish Academy of Sciences in Cracow	08-02-2018

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

Polish name: Mundżak
Latin name: ***Muntiacus reevesi*** Ogilby, 1839
English name: Reeves' muntjac

acommm02.	Comments:		
	Polish name (synonym I)	–	Polish name (synonym II)
	Latin name (synonym I)	<i>Cervulus sclateri</i>	Latin name (synonym II)
	English name (synonym I)	Chinese muntjak	English name (synonym II)
			Formosan Reeves' Muntjac

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

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

acommm04.	Comments:
	Muntjacs are kept in 9 zoological gardens in Poland (Topola 2016 – P). Single individuals are kept as a hobby in three private farms in Kudowa Zdrój (Dolnośląskie province), Kunowa (Podkarpackie province) and Lisowie (Świętokrzyskie province) (Hędrzak and Wierzbowska 2018a – A). Muntjacs are not kept on a large scale in commercial herds (Chief Veterinary Inspectorate 2017 – B, Hędrzak and Wierzbowska 2018b – A).

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

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

acommm05.	Comments:
	Muntjacs are herbivores with a wide spectrum of food, they feed on all parts of herbaceous plants, shrubs and tree shoots. In high densities, they can significantly affect vegetation and the integrity of ecosystems (Cooke and Farrell 2001, White et al. 2004 – P). In the places of introduction, e.g. the United Kingdom, muntjacs compete with the European roe deer (Parliament UK 2009 – I), change the species composition of forest undergrowth, contributing to the reduction of biodiversity, reduce the possibility of renewal of forests, including habitats of special care (Cooke et al. 1995, Cooke 1997, Cooke 1998, Dolman and Wäber 2008 – P). By limiting biodiversity, they can cause damage to old stands (Parliament UK 2009 – I). Indirect effects on insect and bird communities have also been demonstrated (Pollard and Cooke 1994, Gill and Fuller 2007 – P). The species may be a carrier of bovine tuberculosis, which is dangerous both for animals and humans, and bovine viral diarrhoea (Ward and Smith 2012, Najberek 2018 – N). Road accidents involving this species are also possible, causing damage to people's health and property (Dick et al. 2009 – P). In addition, muntjacs increase the number of urban areas, causing damage to private properties (Parliament UK 2009 – I).

A1 | Introduction

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

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

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

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

acomment06. Comments:
Introductions in European countries were conducted in the United Kingdom (Lever 1932, Wilson and Mittermeier 2011 – P, Timmins and Chan 2016), Ireland (Dick et al. 2016 – P) and in France – in the last country, muntjacs did not survive in nature (Long 2003, Timmins and Chan 2016 – P). Populations of this species in the natural environment occur in Belgium and the Netherlands (Baiwy et al. 2013 – P), and few individuals are observed in Denmark and in the western part of Germany (European Commission 2017 – I). However, it does not create there a population, whose expansion is related to the biological characteristics of the species, is fast enough to reach the Polish borders in the perspective of about 15 years. For this reason, the probability of the species emerging in the natural environment of our country as a result of independent expansion has been estimated as medium.

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
				X	

acomment07. Comments:
Due to the characteristics of the species, the probability of accidental bringing of muntjacs from other countries to Poland is very low.

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

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

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

acomment08. Comments:
So far, there has not been a registered case of muntjac observation in nature in Poland (Gatunki obce w Polsce 2018 – B). The species is not a subject of hunting interest. The legal regulations prohibit the intentional introduction of the species into the natural environment. However, due to the maintenance of individuals of this species in 3 private farms, there is very little risk of animal escapes. Such cases occurred, for example, in England (Long 2003 – P). It has been estimated that the probability of escape from closed conditions is small (less than 1 case in 10 years).

A2 | Establishment

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

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

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

aconf05.	Answer provided with a	low	medium	high X	level of confidence
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acomment09. Comments:
The species has been introduced and successfully spread in countries with a climate similar to Poland, in particular: Belgium, the Netherlands, the United Kingdom and parts of Japan (Baiwy et al. 2013 – P, European Commission 2017 – I). The climatic similarity of these European regions to Poland is large, but not more than 94% (according to the Harmonia^{+PL} methodology). In the case of Poland, the factor limiting the establishment of muntjacs can be severe winters. The climatic conditions in Poland for the establishment of the species were therefore assessed as moderately favorable.

a10. Poland provides **habitat** that is

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

aconf06.	Answer provided with a	low	medium	high X	level of confidence
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acomment10. Comments:
The species has been introduced and successfully spread in countries with habitats similar to habitats widely found in Poland: Belgium, the Netherlands, Great Britain and Japan. The species tolerates a wide spectrum of habitat conditions and is not limited by specific requirements (Chapman et al. 1994, Cooke and Farrell 2001, Ward 2005, Asada 2009 – P). Muntjacs adapt to habitats where they are introduced even if they are different than habitats in their natural range. They use wooded areas with a large variety of plant species, park vegetation, recreational allotments, etc. (Long 2003, Wilson and Mittermeier 2011 – P). Such conditions are available for this species throughout our country.

A3 | Spread

Questions from this module assess the risk of *the species* to overcoming dispersal barriers and (new) environmental barriers within Poland. This would lead to spread, in which vacant patches of suitable habitat become increasingly occupied from (an) already-established population(s) within Poland.

Note that spread is considered to be different from range expansions that stem from new introductions (covered by the Introduction module).

a11. The capacity of the species to disperse within Poland by natural means, **with no human assistance**, is:

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

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

Dispersion from a single source (Data type: A)
Muntjacs are relatively small animals and lead a secretive lifestyle, so they can move unnoticed along small shrubs, their way of wandering may be similar to the way the European roe deer moves. The distance of migration usually does not exceed 5 km, but there are also individuals that migrate up to 20 km (Harding 1986 – N, Ward 2005 – P).

Population expansion (Data type: B)
In the United Kingdom, within 80 years, muntjacs have increased their range from 120 to 300 km from the place of establishment (Long 2003 – P) and significantly increased their number. In 2005, the number amounted to 118,000 individuals (Wilson and Mittermeier 2011 – P), and in 2009 to already 150,000 (Parliament UK 2009 – I).

There is information (Anonymous 2017 – I) about a very fast increase in numbers: 50-fold increase in 14 years, but there is no data on the rate of spread. Taking into account the available literature data and biological characteristics of the species (size, life history, fertility, behaviour), the rate of population spread has been estimated to be large (from 1 km a year to 10 km a year).

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

X	low
	medium
	high

aconf08.	Answer provided with a	low	medium X	high	level of confidence
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acommm12. Comments:

There is no documented data from published sources. It should be assumed that due to the low interest of hunters and the general public, even if the species is widely spread in Poland, the frequency of individuals moving over a distance greater than 50 km will be small (less than 1 case per decade).

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/EEG 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/EEG 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
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 level of confidence

acomment13. Comments:
Muntjacs feed on shoots, growths, leaves and flowers. When they reach high densities, they can destroy large areas of low vegetation (including protected species) and significantly affect shrub vegetation and tree regeneration (Cooke 1998, Cooke and Farrell 2001 – P). In the places of introduction, e.g. the United Kingdom muntjacs change the species composition of forest undergrowth, contributing to the reduction of biodiversity, limiting the possibility of renewing forests, including habitats of special care. They change the species composition of herbaceous plants in old stands, strongly limiting the share of flowering plants and causing an increase in the proportion of grasses (Cooke et al. 1995, Cooke 1997, 1998, Dolman and Wäber 2008 – P, Parliament UK 2009 – I). The species that are strictly protected in Poland and which are found in the diet of muntjacs in England and have been significantly limited are: Orchids, including Fuchs cuckoo (*Dactylorhiza fuchsii*), violet helleborine (*Epipactis purpurata*), male orchid (*Orchis mascula*) and also non-stem primrose (*Primula vulgaris*) (Cooke and Farrell 2001, Cooke 2006 – P). Muntjacs strongly limited the occurrence of dog's mercury (*Mercurialis perennis*), whose seeds are an important ingredient of food for the protected common bullfinch (*Pyrrhula pyrrhula*) (Jefferson 2008 – P). The mentioned species of flowering plants have been replaced with grasses and sedges, including false-brome (*Brachypodium sylvaticum*) and pendulous sedge (*Carex pendula*) (Tabor 2005 – P). An indirect influence on insect and bird communities through strong changes in plant communities has also been documented (Pollard and Cooke 1994, Feber et al. 2001, Gill and Fuller 2007 – P).

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

low
 medium
 high

aconf10. Answer provided with a

low	medium	high X
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 level of confidence

acomment14. Comments:
The results of research conducted in the United Kingdom indicate that muntjacs are replacing the European roe deer as a result of food competition (Hemami et al. 2004 – P, Parliament UK 2009 – I). This applies mainly to deciduous forests. Weight loss and reduced fertility are observed in the roe deer occurring together with muntjacs (Dolman and Wäber 2008 – P). Similar processes are described for habitats in Belgium (Baiwy et al. 2013 – P). In Poland, the roe deer is a widely occurring and very numerous species, therefore the impact of this species on native species has been assessed as small: it may cause at most small decreases in the number of native species that do not belong to special care species.

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

no / very low
 low
 medium
 high
 very high

aconf11. Answer provided with a

low	medium	high X
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 level of confidence

acomment15. Comments:
There are no published scientific data indicating the cases of crossbreed between muntjacs and other species.

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

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

a16.16. Comments:
 The species is a possible source of bovine tuberculosis, which is subject to notification and may cause death of animals and humans, and viral diarrhea of cattle (Böhm et al. 2007 – P, Najberek, in preparation – N). There are known cases of bison disease in the Bieszczady Mountains (Krajewska et al. 2014 – P). Their source was most likely domestic cattle. The spread of muntjacs in Poland would undoubtedly increase the threat of bovine tuberculosis among wild animals, including special care species.

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

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

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

a17.17. Comments:
 There are no reports of abiotic factors being disturbed by the species.

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

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

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

a18.18. Comments:
 In high densities, the species may locally significantly affect whole plant communities (Cooke 1998, Cooke and Farrell 2001 – P), it changes the species composition of herbaceous plants thus disturbing the integrity of the ecosystem and interspecies relationships, including special care ecosystems, e.g. natural forests (Cooke et al. 1995, Cooke 1997, 1998, Dolman and Wäber 2008, Parliament UK 2009 – I). Limiting the number of species of flowering plants it may disturb the functioning of some species of invertebrates, including special care organisms, however, there is no documented research on this subject. Therefore, the impact of the species can be assessed as medium: in the worst case, the species causes hardly reversible changes in the processes occurring in habitats that do not belong to special care habitats, or easily reversible changes in the processes occurring in the areas of particular care.

A4b | Impact on the cultivated plants domain

Questions from this module qualify the consequences of *the species* for cultivated plants (e.g. crops, pastures, horticultural stock).

For the questions from this module, consequence is considered 'low' when presence of *the species* in (or on) a population of target plants is sporadic and/or causes little damage. Harm is considered 'medium' when *the organism's* development causes local yield (or plant) losses below 20%, and 'high' when losses range >20%.

a19. The effect of *the species* on cultivated plant targets through **herbivory or parasitism** is:

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

aconf15. Answer provided with a

low	medium X	high
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 level of confidence

acomment19. Comments:
The species feeds on a very wide spectrum of plants, and also on cultivated plants. Muntjac is a small animal, i.e. the nutritional needs of a single individual are not large, however at high densities, it can cause visible losses in most crops (Putman and Moore 1998, Asada 2009 – P). Damages caused to crops mainly concern cereals in the early stages of growth and can occur in home gardens (Cooke and Lakhani 1996 – P, Parliament UK 2009 – I). As a species with high food selectivity, eating mainly shoots (Hoffman 1989 – P), muntjacs feed on tree shoots, which can cause damage to forest crops and obstruct restorations in home groves (Cooke and Lakhani 1996 – P, Dolman et al. 2010 – P). It is predicted that if muntjacs spread in Poland, the impact of the species on crops would be the most average: it will affect from 1/3 to 2/3 of the crops being invaded and in the worst case the condition of plants or a single crop will be reduced from approx. 5% to around 20%.

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

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

aconf16. Answer provided with a

low	medium	high
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 level of confidence

acomment20. Comments:
The species is an animal.

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
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 level of confidence

acomment21. Comments:
The species is an animal.

a22. The effect of *the species* on cultivated plant targets by **affecting the cultivation system's integrity** is:

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

aconf18.	Answer provided with a	low	medium	high	level of confidence
			X		

acomment22. Comments:
 There is no direct literature data on the impact of the species on the condition or yield of crops by changing the properties of the agroecosystem, including the circulation of elements, hydrology, physical properties and trophic networks. Muntjacs can feed on arable crops, but due to the small size of the body, it is predicted that if this species spreads in Poland, its impact would be low: it would affect less than 1/3 of the crops being invaded; and in the worst case, the condition of plants or the yield of a single crop would be reduced to a small extent (less than approx. 5%).

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

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

aconf19.	Answer provided with a	low	medium	high	level of confidence
				X	

acomment23. Comments:
 There is no literature data that the species is a host or vector of pathogens or parasites harmful to crops.

A4c | Impact on the domesticated animals domain

Questions from this module qualify the consequences of *the organism* on domesticated animals (e.g. production animals, companion animals). It deals with both the well-being of individual animals and the productivity of animal populations.

a24. The effect of *the species* on individual animal health or animal production, through **predation or parasitism** is:

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

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

acomment24. Comments:
 The species is not a predator or a parasite.

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

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

aconf21. Answer provided with a

low	medium	high X
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 level of confidence

acomm25. Comments:
There is no literature data that the species has biological, physical and/or chemical properties that are harmful when in contact with farm or domestic animals or that it endangers animal production (e.g. toxins or allergens). Muntjacs are small animals and show no aggression towards humans and animals. There are reports, however, that muntjacs can attack dogs (Parliament UK 2009 – I). It was estimated that even if the species spreads in Poland, the probability of direct contact would be low (less than one case a year in the direct contact per 100,000 farm or domestic animals) and the effect would be small (mild symptoms, full recovery).

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	high X
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 level of confidence

acomm26. Comments:
The species is a possible source of bovine tuberculosis, which is subject to notification as it can cause death. It is also on the EPPO and OIE list. Another known disease is viral bovine diarrhoea (Böhm et al. 2007 – P, Najberek, in preparation – N). There are cases of bovine tuberculosis in European bison in the Bieszczady Mountains (Krajewska et al. 2014), so it is also possible to infect cattle

A4d | Impact on the human domain

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

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

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

aconf23. Answer provided with a

low	medium	high
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 level of confidence

acomm27. Comments:
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
- medium
- high
- very high

aconf24. Answer provided with a

low	medium X	high
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 level of confidence

acomm28. Comments:
There is no literature data that the species has biological, physical and/or chemical properties that are harmful when in direct contact with humans. Muntjacs are small animals and do not show aggression towards humans. It was estimated that even if the species spreads in Poland, the probability of direct contact would be low (less than one case a year in the direct contact per 100,000 people), and the effect – 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
- medium
- high
- very high

aconf25. Answer provided with a

low	medium	high X
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 level of confidence

acomm29. Comments:
Muntjacs are involved in the transmission of bovine tuberculosis (Najberek, in preparation – N), which in humans can cause permanent damage to health and is not fully 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:

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

aconf26. Answer provided with a

low	medium X	high
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 level of confidence

acomm30. Comments:
There are no cases of the species influence on the infrastructure (e.g. allotments, buildings, wells, dams, ponds, mines, canals, roads, etc.). It should be noted, however, that in places

where they are numerous muntjacs are the most frequently recorded species among deer, involved in road accidents. According to estimates, approximately 15.000 individuals die each year in England. The total costs of accidents involving wild animals are estimated at 13.6 million pounds, of which 25% are caused by muntjacs (Langbein 2007, 2011, Langbein and Putman 2006, Williams et al. 2010 – P). There is no reason to believe that if the species spreads in Poland, the scale of this threat would be smaller (from 1 to 100 events per 100,000 objects per year, with partially reversible effects).

A5a | Impact on ecosystem services

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

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

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

aconf27. Answer provided with a

low	medium X	high
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 level of confidence

acomment31. Comments:
Muntjacs can have some negative impact, especially at high densities, on arable crops and locally can cause severe damage to forest crops. In the case of transmission of bovine tuberculosis to livestock, it may contribute to a reduction in the efficiency of animal production. It is worth noting that the meat of muntjacs is quite valued by wild game enthusiasts.

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 X	high
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 level of confidence

acomment32. Comments:
The species may to a certain extent affect the functioning of plant ecosystems, limit forest renewal processes that fulfil important regulatory functions in the ecosystem. Muntjacs can carry bovine tuberculosis, so they affect the regulation of zoonoses.

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

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

aconf29.	Answer provided with a	low	medium X	high	level of confidence
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acomm33. Comments:
There is no known impact of the species on aesthetic functions, recreation, cultural and artistic resources, the spiritual sphere, religiosity, science and education. We can, however, pay attention to the fact that muntjacs are hunted for wild game, which is a meat valuable by consumers.

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

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

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

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

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

aconf30.	Answer provided with a	low	medium X	high	level of confidence
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acomm34. Comments:
The species has been introduced and its populations are maintained in countries with a climate similar to Poland: Belgium, the Netherlands, Great Britain (European Commission 2017 – I). Therefore, the climate is not likely to be a barrier to the emergence of species in Poland. However, forecasted global warming may increase the degree of Poland's climatic similarity to those regions of Europe where the species is already established, therefore it was estimated that the probability will increase moderately.

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 X	high	level of confidence
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acomm35. Comments:
The climate in Poland is similar to the countries where the species was introduced and its population is maintained, including Belgium, the Netherlands, Great Britain (European Commission 2017 – I). The climate is no longer a barrier that would prevent it from surviving and reproducing in Poland. Forecasted global warming may, however, increase

the degree of Poland's climatic similarity (especially in mountainous areas with more severe winters) to those regions of Europe where the species is already established, therefore it was estimated that the probability will increase moderately.

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 X	high
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 level of confidence

acomment36. Comments:
The species does not occur in the wild in Poland. The climate in Poland is similar to the countries where the species was introduced and its population is maintained, including Belgium, the Netherlands, Great Britain (European Commission 2017 – I).
Therefore, it is most likely that the climate is no longer a barrier that would prevent it from spreading after a possible appearance in Poland. Forecasted global warming may, however, increase the degree of Poland's climatic similarity (especially in mountainous areas with more severe winters) to those regions of Europe where the species is already established, therefore it was estimated that the probability will increase moderately.

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 X	high
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 level of confidence

acomment37. Comments:
The forecasted climate changes will not alter the scale of the species impact on wild plants and animals as well as habitats and ecosystems in Poland.

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 X	high
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 level of confidence

acomment38. Comments:
The forecasted climate changes will not alter the scale of the species impact on arable crops or crop production in Poland.

a39. IMPACT ON THE DOMESTICATED ANIMALS DOMAIN – Due to climate change, the consequences of *the species* on domesticated animals and animal production in Poland will:

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

aconf35. Answer provided with a

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

 level of confidence

acomm39. Comments:
The forecasted climate changes will not alter the scale of the species impact on farm and domestic animals as well as animal production in Poland.

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

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

aconf36. Answer provided with a

low	medium X	high
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 level of confidence

acomm40. Comments:
The forecasted climate changes will not alter the scale of the species impact on people in Poland.

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 X	high
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 level of confidence

acomm41. Comments:
The forecasted climate changes will not alter the scale of the species impact on other objects in Poland.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.17	0.67
Establishment (questions: a09-a10)	0.75	1.00
Spread (questions: a11-a12)	0.38	0.75
Environmental impact (questions: a13-a18)	0.42	0.92

Cultivated plants impact (questions: a19-a23)	0.25	0.67
Domesticated animals impact (questions: a24-a26)	0.50	1.00
Human impact (questions: a27-a29)	0.38	0.75
Other impact (questions: a30)	0.50	0.50
Invasion (questions: a06-a12)	0.43	0.81
Impact (questions: a13-a30)	0.50	0.77
Overall risk score	0.22	
Category of invasiveness	potentially invasive alien species	

A6 | Comments

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

acomm42. Comments:

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