



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. Karolina Mazurska

acomment01.	Comments:	degree	affiliation	assessment date
	(1)	prof. dr hab	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	01-02-2018
	(2)	dr	Institute of Environmental Sciences, Jagiellonian University, Kraków	24-01-2018
	(3)	mgr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	07-02-2018

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

Polish name: Jeleń wirginijski
Latin name: ***Odocoileus virginianus*** (Zimmermann, 1780)
English name: White-tailed deer

acomm02.	Comments:	
	Polish name (synonym I)	Polish name (synonym II)
	jeleń wirgiński	–
	Latin name (synonym I)	Latin name (synonym II)
–	–	
English name (synonym I)	English name (synonym II)	
Key deer	Toy deer	

a03. Area under assessment:

Poland

acomm03.	Comments:
	–

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

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

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

acomm04.	Comments:
	The species is not kept in zoological gardens (Topola 2016 – P), neither it is included in registers developed by the General Veterinary Inspectorate [Główny Inspektorat Weterynarii]. General information contained in the GIW register (Główny Inspektorat Weterynarii 2017 – B) is confirmed in Powiat Veterinary Inspectorates (Hędrzak and Wierzbowska 2018a – A). According to the information obtained from the Board of Directors of Polish Union of Deer Breeders [Polski Związek Hodowców Jeleniowatych] (Hędrzak and Wierzbowska 2018b – A), the species is not kept by any of the breeders belonging to this association. An analysis of Internet sources and direct contact with owners of agrotourism farms, educational pens and farm having the mini-zoo status have shown no presence of this species in Poland either, although there is a hard to estimate number of hobbyist farms, which cannot be reached. There are absolutely no reports on the occurrence of the species in the natural environment at present and in the past.

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

acomm05.	Comments:
	The species is a dietary specialist (the term used colloquially in ecology - a species adapted to feeding on a strictly defined type of food (Hofmann 1989 – P), mainly shoot-eating. It eats grass rarely (Smith 1991 – P). Its diet changes depending on the season and geographical region. Because of its feeding behaviour, it may damage trees in their early stage of growth, similarly as is the case in the natural rangeland of the white-tailed deer (Patton 2017 – P). In North America, the species feeds also on agricultural crops (corn, lucerne, soya, wheat, oats), causing significant losses (Brittingham et al. 1997, Stewart et al. 2007 – P). White-tailed deer is highly competitive for roe deer <i>Capreolus capreolus</i> , and to a lesser degree, also for red deer <i>Cervus elaphus</i> and fallow deer <i>Dama dama</i> (Homolka et al. 2008 – P). The

species may be a carrier for *Parelaphostrongylus tenis* parasite, while being resistant to it. The parasite is lethal for deer species living in Poland (Hovi et al. 2010 – P). White-tailed deer is a carrier of many dangerous diseases (e.g. bovine tuberculosis, chronic wasting disease (CWD)), which are detrimental for other deer species, including *Cervus* deer and elk *Alces alces*, and ungulate farm animals (Bourne 2015, Williams and Young, 1980, 1982), and also for humans potentially (European Commission Health & Consumer Protection Directorate-General 2003 – I). Via ectoparasites, it may transmit Lyme disease (Piesman et al. 1979, Wilson et al. 1986 – P) and bartonellosis to humans (Samuel et al. 2012 – P). Also, it may be a potential, however limited, source of cryptosporidiosis infection (Kotkova et al. 2016 – P). In the USA, white-tailed deer participate in a large number of collisions with motor vehicles (National Highway Traffic Safety Administration 2013 – P) and planes (Biondi et al. 2011 – P), resulting in heavy economic losses. Biondi et al. (2011 – P) analysed 879 cases of collisions between white-tailed deer and planes, in 1999-2009. The biggest number of them took place in 1994. It was found that collisions were seasonal – their number increased from January to November (the biggest number was noted in October and November). The most cases (65%) took place at night and dawn. The most often the collisions were registered during plane circulation at the airport and during take off (61%). In the research period, 24 fatal cases were noted and 217 cases of humans injured. Economic losses amounted to 75 million USD. This species has the largest share in collisions with vehicles in Scandinavia (Niemi et al. 2015 – P).

A1 | Introduction

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

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

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

aconf02.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acomm06.	Comments:
	<p>White-tailed deer has been introduced in neighbouring countries of Poland: the Czech Republic and Slovakia (Gallina and Arevalo 2016 – P). There is no information on the spots of occurrence or the rangeland in Slovakia. On the other hand, a dozen or so locations are known in the Czech Republic, mostly in the central Czech Republic, but several of them is located near the Czech-Polish border (Anděra 2018 – I). Abundance of the animals is estimated at approx. 800 and they do not exhibit a tendency for spreading. The white-tailed deer has poor reproduction results in natural environment in Czech Republic and their spread is the consequence of their introduction (Mlíkovský and Stýblo 2006 – P, Travel 2018 – I). In 1930s, white-tailed deer have been introduced in Finland; their abundance increases rapidly and at present, it is estimated at several thousand animals (Hovi et al. 2010 – P). They occur mostly in the southwestern part of the country and they are spreading towards Russia (Kekkonen et al. 2012 – P). There is no information available on the southward migration. The home range occupied by a herd including different numbers of individuals is small and amounts to 1-3 km². They migrate only in a case of hard conditions, but only to small distances (6-23 km) (Wilson and Mittermeier 2011 – P). Due to the presence of white-tailed deer in the Czech Republic, also not far from our border, there is a medium probability of occurrence of the species in Poland.</p>

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
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acomment07. Comments:
 White-tailed deer is a timid animal species and it rather avoids humans (Smith 1991 – P, Wilson and Mittermeier 2011 – P). The probability of accidental trailing along is close to zero.

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

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

aconf04.	Answer provided with a	low	medium	high	level of confidence
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acomment08. Comments:
 The legislation of our country forbids intended releases of alien species to the natural environment. White-tailed deer is not kept in zoological gardens in Poland (Topola 2016 – P), and there is no information known on its presence in private farms either. However, due to the development of the so-called mini-zoos or agrotourism farms, it may become an object of interest. Escapes of white-tailed deer from farms are possible (Travel 2018 – I), but their probabilities depend on the degree of protection of the animals, and frequently, also on the herd size.

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

aconf05.	Answer provided with a	low	medium	high	level of confidence
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acomment09. Comments:
 The natural rangeland of the species encompasses various climatic zones, including the temperate climate zone (Smith 1991, Wilson and Mittermeier 2011 – P), in which Poland is located. Moreover, the successful introductions of the species to Finland (Hovi et al. 2010 – P) and the Czech Republic (Gallina and Arevalo 2016 – P) indicate that there are optimal conditions for settling down the white-tailed deer in our country.

a10. Poland provides **habitat** that is

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

aconf06.	Answer provided with a	low	medium	high X	level of confidence
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acommm10.	Comments: In its natural rangeland, the white-tailed deer is connected with areas of earlier succession of plants and grassland/forest ecotones. It prefers edges of forests and open forest stands without undergrowth in the vicinity of cultivated fields. It is found also in the vicinity of agricultural farms and animal farms. It may be found in the areas up to 4500 m a.s.l. (Wilson and Mittermeier 2011 – P). In the Czech Republic, it is found in agroecosystems (Komosińska and Podsiadło 2002 – P). Its adaptive success in the forests of Finland (Hovi et al. 2010 – P, Kekkonen et al. 2012 – P) and its stable abundance in the Czech Republic (Homolka et al. 2008 – P), confirm the assumption that the habitat conditions in Poland are optimal for the settling down of the species.
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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:

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

aconf07.	Answer provided with a	low	medium X	high	level of confidence
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acommm11.	Comments: Evaluation (Data type: C) In the case of the white-tailed deer, population spreading and seasonal migrations should be distinguished. The population rangeland is expanded by migrations, particularly of subadults. The dispersion distance of these individuals exceeds even 150 km in a forest environment (Nelson and Mech 1992 – P), and in agricultural lands it amounts to up to 50 km per year (Nixon et al. 2007 – P). The dispersion is independent or slightly dependent on the density of animals (Nelson and Mech 1992, Nixon et al. 2007 – P). The seasonal migrations mainly depend on the harshness of winters, and most of all – on the thickness of the snow cover (Fieberg et al. 2008, Sabine et al. 2002 – P). Their distance is 6-23 km. The animals move to places with more favourable conditions, and after the regression of snow, they return to their permanent places of living. Considering the biological features of the species (size, life history, fertility, behaviour), histories of the populations in Finland (Hovi et al. 2010 – P) and the Czech Republic (Travel 2018 – I), and climatic conditions in Poland, the population spreading rate was estimated as high (from 1 km to 10 km per year).
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a12. The frequency of the dispersal of *the species* within Poland by **human actions** is:

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

aconf08.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acomm12. Comments:
 The applicable regulations do not allow for introducing the species to the natural environment. White-tailed deer is not kept in zoological gardens in Poland (Topola 2016 – P), and there is no information known on its presence in private farms either (General Veterinary Inspectorate 2017 – B, Hędrzak and Wierzbowska 2018a, 2018b – A). However, interest in the species cannot be excluded in the future, particularly for the needs of small agrotourism farms. In such places, the animals are very well secured usually, and escapes, although possible, are very unlikely, and they may occur rather in large production herds. The frequency of translocations at distances longer than 50 km is estimated as low (lower 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/EWG Directive. Ecosystems that are of conservation concern refer to natural systems that are the habitat of many threatened species. These include natural forests, dry grasslands, natural rock outcrops, sand dunes, heathlands, peat bogs, marshes, rivers & ponds that have natural banks, and estuaries (Annex I of the 92/43/EWG Directive).

Native species population declines are considered at a local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as (near) extinction. Similarly, limited ecosystem change is considered as transient and easily reversible; severe change is considered as persistent and hardly reversible.

a13. The effect of *the species* on native species, through **predation, parasitism or herbivory** is:

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

aconf09.	Answer provided with a	low	medium	high	level of confidence
			<input checked="" type="checkbox"/>		

acomm13. Comments:
 The majority of the available papers is focused on the impact of the white-tailed deer on bush and forest vegetations. It was proven that these deer may limit the renewal of natural forests by gnawing of deciduous seedlings, which is confirmed by publications on food selectivity and preferences for deciduous seedlings in the natural rangeland of its occurrence (Patton 2017, VerCauteren et al. 2006 – P). The high selectivity level is confirmed also by studies carried out in Europe, indicating that animals of this species are eating the preferred food till its depletion, and then, they start to feed on alternative food (Homolka et al. 2008 – P). Very few papers include information on the impact of grazing herbaceous plants, particularly herbs. This is important because a significant change in the diet composition of the white-tailed deer has been proven, from the prevailing lignified foods in winter to herbaceous plants during spring (Skinner and Telfer 1974 – P). In the vegetative season, herbaceous plants are an important component of the white-tailed

deer's diet (McCullough 1985 – P). The studies indicate that foraging by the white-tailed deer may affect strongly the regeneration, abundance and distribution of some plant species, when the deer population is large. In the USA, it has been shown that the diet of the white-tailed deer includes 98 species of endangered monocotyledons (39.8%) and dicotyledons (56.1%). Among these species, 38.7% has belonged to *Liliaceae* and orchids (Miller et al. 1992 – P). As the actual impact of this species on the native species is hard to predict, the influence is adopted as medium, which means that the species may cause at most small abundance drops of native species populations of particular care or severe abundance drops of other native species populations.

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

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

aconf10.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acomm14. Comments:
 The white-tailed deer may possibly compete with native deer species, however there are no species of special protection status among them. In the Czech Republic, it has been proven that food niches of the white-tailed deer overlap to a high degree with those of the roe deer (>90%) and red deer, and moreover, a negative dependence in abundance trends of the white-tailed deer and the roe deer was observed (Homolka et al. 2008 – P). On the other hand, reports are known, also from that population, that there is no competition between deer species, and even some type of anti-predator cooperation occurs (Bartos et al. 2002 – P).

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	level of confidence
				<input checked="" type="checkbox"/>	

acomm15. Comments:
 There is no information on crossbreeding attempts of the white-tailed deer with native deer species. Various chromosome numbers in relation to the elk, roe deer and red deer excludes the possibility to breed fertile offspring with these species (Wurster and Benirschke 1967, Marisol et al. 2014 – P).

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

acomm16. Comments:
 The white-tailed deer may be a carrier of several very dangerous diseases or disease-causing pathogens. They include, among others, bovine tuberculosis and herpesvirus

(Najberek 2018 – N). Cases of infecting the European bison *Bison bonasus* with bovine tuberculosis in the Bieszczady Mountains are known (Krajewska et al. 2013 – P). These are notifiable diseases (OIE list) and they may be fatal for humans and animals. Moreover, the white-tailed deer carry a lethal disease, the so-called chronic wasting disease (CWD), which may pose a danger for other deer species, including red deer and elk, and ungulate farm animals (Williams and Young 1980, 1982, Bourne 2015 – P). The white-tailed deer may be a carrier of the *Parelaphostrongylus tenis* parasite, which is lethal for deer species living in Poland (Hovi et al. 2010 – P). Other parasites found with it include *Toxoplasma gondii*, causing toxoplasmosis in many animal species and humans (Hill and Dubey 2002 – P). In Finland, it has been found that 26.7% of the tested white-tailed deer are seropositive for this protozoon (Jokelainen et al. 2010 – P). Moreover, the white-tailed deer are carriers of ticks, which in turn are a transmission vectors of Lyme disease to dogs, cattle and rodents (Levi et al. 2012, Stafford i Williams 2014 – P).

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

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

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

acomm17. Comments:
There is no literature data indicating an impact of the species on ecosystems by disturbing their abiotic factors.

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		

acomm18. Comments:
In the case of Poland, it is hard to estimate the scale of the white-tailed deer’s impact on ecosystems by disturbing biotic factors. Obviously, strong gnawing of vegetation will result in, e.g., a change in the renewal process pattern as an effect of the food preference for deciduous seedlings (Patton 2017 – P), or an impact on regeneration, abundance and distribution of some species of herbaceous plants. In the USA, it has been proved that the white-tailed deer are a vector carrying seeds of a number of invasive plant species (Myers et al. 2004 – P), and by feeding on and trampling down of plants locally, they indirectly affect the abundance dynamics of some protected invertebrate species, e.g. butterflies (Koontz and Root 2009 – I). In connection with the above studies, it may be estimated that in the worst case scenario, the species will cause hardly reversible changes of processes occurring in habitats which do not belong to habitats of particular care, or easily reversible changes of processes occurring in particular care habitats.

A4b | Impact on the cultivated plants domain

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

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

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

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

aconf15. Answer provided with a

low	medium X	high
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 level of confidence

acomment19. Comments:
 There are no published results of scientific research on possible damage in plant crops, caused by the white-tailed deer in European countries. On the other hand, in its natural rangeland in North America, the species feeds also on agricultural crops (corn, lucerne, soya, wheat, oats), causing significant losses (Brittingham et al. 1997, Stewart et al. 2007, VerCauteren et al. 2006 – P). However, it should be expected that in a case of reaching a high abundance by the white-tailed deer, because of its preference for field/forest and forest/grassland ecotones (Wilson and Mittermeier 2011 – P), and because of presence of divided fields in the vicinity of forests, damages in crops may be expected. It is anticipated that the influence of the species on plant crops will be medium: it will pertain to from 1/3 to 2/3 plant crops being the object of the invasion, and, in the worst case scenario, the plant condition or yield of a single crop will be reduced by from approx. 5% to approx. 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:
 This is an animal species.

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:
 This is an animal species.

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 X	high
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 level of confidence

acomment22. Comments:
There is no scientific data on the impact of the species on condition or yielding of cultivated plants caused by changing the agroecosystem properties, including the cycles of the elements, hydrology, physical properties, food webs. In the natural rangeland of the species, when the population abundance is high, the white-tailed deer use also plant crops intensively (Brittingham et al. 1997, Stewart et al. 2007, VerCauteren et al. 2006 – P). The losses caused by the white-tailed deer in crops are much larger than damages made by all herbivorous animals in the USA. For example in, Michigan State losses amounted to more than 25% of crops area, while agriculture producers tolerate 10% losses caused by wildlife per year. Also in Poland, in a similar situation, a crop yield decrease may be expected. It is estimated that the influence of the species will be low: less than 1/3 of plant crops being the object of the invasion, and, in the worst case scenario, the plant condition or yield of a single crop will be reduced to a small degree (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:

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

aconf19. Answer provided with a

low	medium	high X
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 level of confidence

acomment23. Comments:
There are no published scientific studies on transmission of pathogens or parasites harmful for cultivated plants by the white-tailed deer.

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	high
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 level of confidence

acomm24. Comments:
The species is not a parasite nor a predator.

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 X	high
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 level of confidence

acomm25. Comments:
There is no information known that the species has biological, physical and/or chemical properties, exerting harmful influence during contact with farm and domestic animals or animal production (e.g. toxins or allergens). Studies on interactions of the white-tailed deer with species of ungulate farm animals concern a scenario when the cattle is kept in the free range grazing system (Jenks et al. 1996, Cooper et al. 2008 – P). They indicate that being physically weaker, the white-tailed deer, rather avoid closer contact with cattle. It may be only presumed that in a case of a direct contact with smaller ruminants, e.g., sheep, goats, kick or antler strike may occur. However, it has been estimated that the probability of direct contact is low: less than one direct contact case yearly per 100,000 farm animals or domestic animals.

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 white-tailed deer may be a carrier of several very dangerous diseases or disease-causing pathogens. Farm animals kept in the grazing system are exposed to a potential contact with animals of this species or with their excrements, which may cause an infection with, among others, bovine tuberculosis and herpesvirus (Najberek 2018 – N). These are notifiable diseases (OIE list) and they may be fatal. Moreover, the white-tailed deer carry a lethal disease, the so-called chronic wasting disease (CWD), which may pose a danger for other deer species kept in breeding farms, and farm animals (Williams and Young 1980, 1982, Bourne 2015 – P). The species is a carrier of the *Toxoplasma gondii* parasite, which causes toxoplasmosis in many animal species (Hill and Dubey 2002 – 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
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 level of confidence

acomm27. Comments:
The species in not parasitic.

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:
No literature data is known that the species has biological, physical and/or chemical properties, exerting harmful influence during a direct contact with humans. However, in North America, in the rangelands with an abundant population of the white-tailed deer occurring in urban areas, in the vicinity of humans, cases – although rare – of attacks of the white-tailed deer on humans were recorded, particularly in the breeding season and during fawn rearing (Grovenburg et al. 2009, Hubbard and Nielsen 2009 – P). In some cases, the attacks resulted in bodily harms, and in extreme cases – death (Conover 2002 – P, Hubbard and Nielsen 2009 – P). As the probability of a direct contact has been estimated as medium: 1-100 cases per 100,000 humans per year, the total influence of the species on human’s life and health in a direct contact is estimated as medium.

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:
The white-tailed deer is a carrier of a number of dangerous diseases, which may be transmitted to humans. They include bovine tuberculosis and herpesvirus (Najberek 2018 – N). Tuberculosis may be a fatal disease for human. Other parasites found with it include *Toxoplasma gondii*, causing toxoplasmosis, also in humans (Hill and Dubey 2002 – P). Moreover, it is a carrier of ticks, which in turn are a transmission vector of Lyme disease caused by *Borrelia burgdorferi* to humans (Piesman et al. 1979, Wilson et al. 1986 – P). The white-tailed deer is a host for the *Lipoptena cervi* parasite, which is common e.g. in Scandinavia. A bite of this parasite may cause a secondary allergic reaction. Also, the parasite is a carrier of the *Bartonella* bacterium, causing bartonellosis with humans

(Samuel et al. 2012 – P). The species may be a potential, but limited source of cryptosporidiosis (*Cryptosporidium muris*) infection for humans (Kotkova et al. 2016 – P). The probability of infecting of humans with chronic wasting disease (CWD) cannot be excluded in any place where the white-tailed deer occur, although there are no documented cases (European Commission Health & Consumer Protection Directorate-General 2003 – I).

A4e | Impact on other domains

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

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

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

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

acommm30. Comments:
 Frequent participation of the white-tailed deer in animal-vehicle collisions is being recorded in the places of the species' occurrence. In 2013, damages were estimated at 1.1 million USD in the USA, and they resulted in death of 150 people (National Highway Traffic Safety Administration 2013). Moreover, in years 1990-2009, 879 collisions of the white-tailed deer with airplanes occurred in the USA, and the damages were estimated at 36 mln USD. In their effect 26 people were injured, and 1 person died (Biondi et al. 2011 – P). In accidents, both cars, and road surfaces or roadsides are being damaged, and in urban areas – even private lots or buildings. Considering the intensity of such events in Finland (Niemi et al. 2015 – P) and in North America (VerCauteren 2006 – P), one may estimate that the probability of an accident is medium with medium consequences, so the whole impact of the species on damage to infrastructure was estimated as medium.

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 X
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 level of confidence

acomm31. Comments:
The white-tailed deer may cause damage in forest ecosystems and agricultural crops (Brittingham et al. 1997, Russell et al. 2001, Stewart et al. 2007, VerCauteren et al. 2006 – P), which leads to a reforestation slowdown and a decrease in plant production. Moreover, in the case of farm animals being infected with tuberculosis or chronic wasting disease, a decrease in the animal production efficiency, and thus, affect the supply services locally.

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

acomm32. Comments:
To a certain degree, the species may impact the functioning of plant ecosystems: forests, natural open ecosystems, and crops. The influence of the white-tailed deer may emerge also by spreading various diseases, among others, tuberculosis (Najberek 2018 – N). In the places of co-existence e.g. with the European bison, it may result in an increased incidence of this disease with the species of particular care (Krajewska et al. 2013 – P). Its presence may also contribute into displacement of native deer species, most of all, roe deer (Homolka et al. 2008 – P).

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

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

aconf29. Answer provided with a

low	medium X	high
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 level of confidence

acomm33. Comments:
No relationships of the species with and no influence on aesthetic functions, recreation, cultural and artistic resources, spiritual realm and religiosity, science and education are known. The white-tailed deer may be a locally attractive element of the landscape or it may increase interest in the offer of agrotourism farms focused on, e.g., building of Native American villages, etc. However, taking into account the attitude of various social groups towards alien animal species, it seems that also social conflicts may arise as a consequence of the white-tailed deer's invasion (McNeely 2001 – 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
- increase moderately
- increase significantly

aconf30. Answer provided with a

low	medium	high X
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 level of confidence

acomment34. Comments:
In its natural rangeland, the white-tailed deer occupies areas belonging to the moderate, subtropical, tropical, and even equatorial climate zones (Gallina and Arevalo 2016 – P). However, it is not a migratory species. In its places of introduction, it behaves in various ways: in Finland, it is undertaking longer migrations because of hard conditions in winter, while in the Czech Republic, where the climate is warmer, it forms small local populations. In Europe, the species settled down successfully in a climate colder than in Poland on the average (Finland) and in a warmer climate (the Czech Republic), therefore the predicted climate warming rather should not affect the probability of occurrence in Poland in the case of this species.

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
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 level of confidence

acomment35. Comments:
Current climatic conditions in Poland are optimal for the species. To a certain degree, hard winter conditions, particularly a thick snow cover are limiting factors for the white-tailed deer. Therefore a warmer climate, particularly in winter season, may favour its settling down.

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

acomm36. Comments:
At present, there are no climatic barriers which would hinder spreading of the white-tailed deer in Poland. The climate warming may even limit the migration tendency of the white-tailed deer, thus also the tendency to spread. Taking into account the current situation of the white-tailed deer population in the Czech Republic, where there the climate is warmer and where the species has reproduction problems in nature, it can be assumed that the climate change will not affect spreading of this species. Moreover, its spreading is slightly dependent or not dependent on density, which can locally be noted.

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

acomm37. Comments:
An increase in the density of the white-tailed deer as a result of climate changes may lead to local increases in the impact on the natural environment.

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

acomm38. Comments:
An increase in the density of the white-tailed deer as a result of climate changes may lead to local increases in the influence on plant crops.

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	high X
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 level of confidence

acomm39. Comments:
The predicted climate changes will not alter the scale of the influence of the species on farm animals and domestic animals, or the animal production in Poland. For years, a decrease in the number of farm animals has been noted in Poland. Intensification of animal production

results from technological development and improvements of breeding traits. Less and less often, the farm animals are kept in pasture system. Even local increase in the deer number, which is not likely to be significant, will not increase the intensity of contact between the white-tailed deer and farm animals in scale disturbing animal production.

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	high X
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 level of confidence

acomm40. Comments:
The predicted climate changes will not alter the scale of the influence of the species on humans in Poland. The increase in the number of white-tailed deers will probably not be high and will affect local populations. Therefore, the national scale of the impact of this species on humans should not change.

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 density of white-tailed deer can increase locally due to the predicted climate changes, It may result in more frequent collisions with vehicles in Poland, particularly in urban areas.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.33	0.83
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.38	0.75
Environmental impact (questions: a13-a18)	0.33	0.83
Cultivated plants impact (questions: a19-a23)	0.17	0.67
Domesticated animals impact (questions: a24-a26)	0.50	0.75
Human impact (questions: a27-a29)	0.75	0.75
Other impact (questions: a30)	0.50	1.00

Invasion (questions: a06-a12)	0.57	0.86
Impact (questions: a13-a30)	0.75	0.80
Overall risk score	0.43	
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:

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