



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. 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	11-01-2018
	(2)	dr	Institute of Environmental Sciences, Jagiellonian University	31-01-2018
	(3)	dr	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	07-02-2018

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

Polish name: Jeleń aksis (czytal)  
Latin name: ***Axis axis*** (Erxleben, 1777)  
English name: Chital

acommm02.	Comments:		
	Polish name (synonym I) Czytal		Polish name (synonym II) –
	Latin name (synonym I) <i>Cervus axis</i>		Latin name (synonym II) –
	English name (synonym I) Axis deer		English name (synonym II) Spotted deer

**a03. Area under assessment:**

**Poland**

acommm03.	Comments: –
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**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 <b>X</b>	level of confidence
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acommm04.	Comment: In Poland, chital occurs only in captivity, it is kept in 3 zoological gardens (Topola 2016 – P). According to the information contained in the register of the Chief Veterinary Inspector (2017 – B) and data verified by district veterinary officers (Hędrzak and Wierzbowska 2018a – I) and in the Polish Deer Farmers Association, individuals of this species are not kept on farms under veterinary supervision, or on farms of breeders associated in the PDFA. The analysis of data published on the Internet related to the offers of agritourism farms, educational homesteads etc. did not reveal the presence of chitals, kept on private farms. However, it should be considered that there is a certain, difficult to estimate number of farms that have not been reached, where single individuals can be kept as a hobby. The probability of this, however, is low.
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**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.	Comment: Chitals consume a variety of plant food: grasses, leaves, flowers, fruits, herbs, mushrooms, young shoots and branches, seeds and tree bark (Gurung and Singh 1996, Nowak 1999, Long 2003 – P). They can bite grass and other plants down to the ground, strongly affecting the condition of the plant cover, and males rubbing trees with their antlers, may cause their death as a result of bark destruction (Anderson 1999 – P). Chitals can intensively feed on many species of native plants (de Vos et al. 1956 – P). Because of the formation of larger groups and following one another, they also destroy vegetation by trampling (Global Invasive Species Database 2018 – B). They can significantly affect natural regeneration in forests (Novillo and Ojeda 2008 – P). Chitals introduced to New Zealand, strongly affected forests, threatening the functioning of existing animals to such an extent that a reduction hunt was started (Komosińska and Podsiadło 2002 – P).
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Chitals often cause significant damage to crops, if the available feeding base is not too abundant (Anderson 1999 – P). They also had a negative impact on cultivated plants in the area of Croatia, which was a reason to eliminate them from the natural environment in some areas (Frkovic 2014 – P). As they bite grass and other plants down to the ground, much lower than species of farm animals (Anderson 1999 – P), they can compete with cattle for feed directly. Studies conducted in Argentina have demonstrated that there is a negative correlation between the number of wild boars and chitals (Gürtler et al. 2017 – P).

The species may transmit bovine tuberculosis and CWD (Tomeček et al. 2015 – P) and other diseases: leptospirosis, cryptosporidiosis (Anderson 1999 – P, Najberek 2018, under preparation – N), which can directly affect animal breeding, as well as human health, if animal faeces are introduced to sources of drinking water.

Chitals are often the cause of road collisions in the countries, where they were introduced (Anderson 1999, Brooks 2006 – P). In some areas they generate severe damage, e.g. on golf courses and other places arranged to be recreation facilities (Kubota 2001 – P). In Hawaii, behaviours associated with the movement of numerous herds led to erosion, and its indirect result – a damage to archaeological sites and traditional stone constructions (Global Invasive Species Database 2018 – B). In numerous places, chitals also damaged fences (Anderson 1999, Kubota 2001 – 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 checked="" type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high

aconf02.	Answer provided with a	low	medium	high	level of confidence
				<b>X</b>	

**acom06.** Comment:

The natural range of the occurrence of chital includes the Indian Peninsula, but it has been introduced to many other countries, e.g. the USA, Argentina, and in Europe to: Croatia, Slovenia, Moldova, Lithuania, Ukraine, France, Russia and Great Britain (Komosińska and Podsiadło 2002 – P, Long 2003 – P, Putman et al. 2011 – P, Wilson and Mittermeier 2011 – P, Frkovic 2014 – P, Duckworth et al. 2015 – P). Among the countries bordering with Poland, these deer have been introduced to the area of Ukraine and Lithuania. In Lithuania, in 1961, the population size of free-living chitals was estimated at 67 individuals (Long 2003 – P), currently there is no information on the population size of this species. In the Kaliningrad Oblast, chitals do not occur in the wild. Long (2003 – P) reports that in Ukraine chitals occur in the wild near Dnipro, as well as in the Volga Region, or over 1000 km from the border with Poland. Within 15 years their population size increased from 25 to 448 individuals (Anderson 1999 – P). However, there are no reports on their migration towards the west. The most certain data concern existing free-living populations in Croatia, on the islands of Brijuni and Rab (Long 2003 – P, Kusak and Krapinec 2010 – P). Studies conducted in the natural range of their occurrence indicate that chitals lead a rather sedentary lifestyle if they have access to grassland areas (Moe and Wegge 1994 – 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
				<b>X</b>	

acomm07. Comment:  
Due to the characteristics of the species, the probability for chital to be introduced to Poland’s natural environments by unintentional human actions 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
				<b>X</b>	

acomm08. Comment:  
So far, there has been no registered case of an observation of a chital in the natural environment in Poland. Provisions of law in force in Poland prohibit the introduction of alien species, including chital, to the natural environment (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 – P). Effective means of supervision in zoological gardens and the lack of chitals on local farms do not create the possibility of an intentional release of individuals of this species, even against the law in force.

## 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 checked="" type="checkbox"/>	non-optimal
<input 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>	

acomm09. Comment:  
Within the natural range of its occurrence, chital occupies areas located in the tropical climate zone (Wilson and Mittermeier 2011 – P). Places, to which it was introduced and where these introductions were successful, are also characterised by a relatively warm climate (south-eastern areas of Ukraine, southern slopes of the Caucasus, Moldova, Croatia, the USA (Texas, California), Argentina, Australia, New Zealand (Lever 1985 – P, Komosińska and Podsiadło 2002 – P, Long 2003 – P, Frkovic 2014 – P). In Europe, the most successful establishment of the species took place on the islands of Brijuni and Rab (Long 2003 – P, Kusak and Krapinec 2010 – P). The climatic similarity of this region to Poland is small, no more than 45% (according to the Harmonia<sup>+PL</sup> methodology). However, attempts to

introduce the species to places having a climate similar to Poland, e.g. to Great Britain, did not lead to the formation of local populations (Lever 1985 – P, Nowak 1999 – P, Long 2003 – P). Therefore, it can be concluded that the climate prevailing in Poland is not favourable for the occurrence of the species. Winter conditions, especially strong frosts and thick snow cover seem to be a limiting factor (Sokolov 1989 – P).

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

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

aconf06.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acom10. Comment:  
 It is a herbivorous species, with a broad spectrum of plant foods in its diet: it consumes grass, leaves, flowers, fruits (Gurung and Singh 1996 – P, Nowak 1999 – P, Long 2003 – P), seeds, shoots, young bark, fungi (Long 2003 – P, Wilson and Mittermeier 2011 – P). It also intensively uses agricultural crops. Chital is associated with ecotones connecting forest areas and grasslands, whereas it prefers moist or dry forests located near water. It willingly uses shrubland plants and marshy meadows located near water. It avoids dense forests and mountain areas (Sokolov 1989 – P, Wilson and Mittermeier 2011 – P). The species is limited by abiotic (it does not occur in mountain areas) and habitat (significant preference to semi-open and grassy areas) conditions, both in its native and introduced range. In Poland, therefore, such habitat conditions suitable for the species are present only partially: moderately favourable conditions can prevail only in the central and a part of western area of the 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:

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

aconf07.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acom11. Comment:  
 Assessment (Type of data: C).  
 There is no published scientific data on the spread rate of individuals or broadening the range of population. Due to the information on the lack of success of previous introductions in the continental part of Europe and biological characteristics of the species (size, life history, fertility, behaviour), the spread rate was estimated to be small (on average, from 10 m to 100 m per year).

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
			<b>X</b>		

acomment12. Comment:  
 Moreover, there are no reasons justifying the possibility of intentional dispersal of the species in Poland. It should be assumed that due to the low interest of hunters and the public at large, even in the case of a wide spread of the species, the frequency of migration of individuals originated from wild populations as a result of intentional and unintentional human actions at a distance longer than 50 km would be 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 type="checkbox"/>	medium
<input checked="" type="checkbox"/>	high

aconf09.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acomment13. Comment:  
 Chitals are deer having a wide spectrum of consumed food. Their diet mainly includes grasses, but also leaves, flowers and fruits (Gurung and Singh 1996 – P, Nowak 1999 – P, Long 2003 – P), herbs, fungi, young shoots and branches, seeds and tree bark (Long 2003 – P). They can bite grass and other plants down to the ground, much lower than species of farm animals (Anderson 1999 – P). Chitals introduced to Hawaii have a significant effect on individual trees (often causing their death) and noticeably limit reforestations (Côté 2004 – P), when males rub bark with their antlers (Anderson 1999 – P). The species can intensively feed on many species of native plants (de Vos et al. 1956 – P). In Croatia, the diet of chital, except grasses, contains ingredients such as leaves of manna ash (*Fraxinus ornus*), leaves and shoots of evergreen oak (*Quercus ilex*), leaves of common myrtle (*Myrtus communis*), suckers of blackberry (*Rubus* spp.), mosses growing on rocks and seeds of cedar (*Cedrus* spp.) (Nikica et al. 2008 – P).  
 The introduction of chitals to the Andaman Islands (India) lead to a local extinction of several species of plants because of excessive biting. These deer consume there over 70 species of plants and are considered the most invasive alien species (Sivakumar 2003 – P,

Ali 2004 – P). In Argentina, it has been demonstrated that chitals can significantly affect natural regeneration in forests (Novillo and Ojeda 2008 – P). The presence of chitals (but also of other species of introduced deer) on Victoria Island (northern Patagonia, Argentina) caused a significant modification of the forest floor and weakened the regeneration of tree species forming the upper layer of the forest (Veblen et al. 1989 – P).

Therefore, it can be assumed that in the case of spreading in Poland, the effect would be similar, which could even lead to serious decreases in the population size of native species of special concern.

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

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

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

**acommm14.** Comment:  
 In Texas, a competition between chital and white-tailed deer was observed, which occurs when the population size of chital significantly increases (Traweek and Welch 1992 – P, Anderson 1999 – P, Brooks 2006 – P). Chitals are larger than white-tailed deer and exploit plant resources more intensively (Fass and Weckerly 2010 – P). Chital bites tree shoots and herbaceous plants, similarly to white-tailed deer, but when the shoot feeding is over, chital easily switches to grasses, while white-tailed deer, as a diet specialist of high selectivity, dies of hunger, as it does not digest mature grasses (Brook 2006 – P). Feeding on blackberries and on shoots and leaves of deciduous trees, which was observed in Croatia (Nikica 2008 – P), could be a reason for limitation of feeding on evergreen plants by native deer species, also in Poland. Studies conducted in Argentina have demonstrated a negative correlation in the trends in the population size of chital and wild boar, while both of those species are alien in the area of Argentina (Gürtler et al. 2017 – P). There, it has also been proven than chitals have a competitive advantage over native species of deer and replace them (Novillo and Ojeda 2008 – P).  
 Therefore, in Poland, it can be expected that chital may have some negative effect on native deer species, however, none of them is a species of special concern. However, as chitals use grassy areas near forests, a possible competition with European bison *Bison bonasus* can be assumed. However, even assuming that chitals were widely spread in Poland, such competition would lead to only small decreases in population size of European bison.

**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"/>	

**acommm15.** Comment:  
 There were attempts to interbreed the species with sika deer (Asher et al. 1999 – P) and with fallow deer (Willard et al. 2005 – P) by insemination method, partially successful. However, there are no reports on interbreeding of chital with these species in a natural way. In the literature, there are no reports on interbreeding of chital with native species of deer in Poland.

**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 <b>X</b>	level of confidence
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a16. Comment:  
The species is a carrier of numerous diseases and parasites, which may be harmful to native species. Chital is involved in the transmission of bovine tuberculosis (Najberek 2018, under preparation – N), which is a deadly disease for native ruminants, including bison. This disease is notifiable. Moreover, the species is a vector of Chronic Wasting Diseases (CWD) (Tomeček et al. 2015 – P). It is a highly infectious prion disease of the nervous system, which has a progressive course and ends with the death of an animal. Infected individuals lose weight, move away from other animals, are apathetic, keep their head down and move along the same fixed route. Other diseases transmitted by chitals include leptospirosis and cryptosporidiosis (Anderson 1999 – P, Najberek 2018 under preparation – N).

**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 <b>X</b>	high	level of confidence
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a17. Comment:  
Chitals introduced to Hawaii cause a local dieback of trees, as a result of rubbing them with their antlers. A dieback of trees on the banks of streams, where large numbers of these deer often reside (Anderson 1999 – P), results in the destabilization of the banks, changes water flow and sediment accumulation, as well as increases erosion (Global Invasive Species Database 2018 – B). Moreover, a characteristic behaviour of the animals, consisting in mutual following of individuals, along the same paths, at a larger number of these animals leads to the formation of muddy, well-trodden paths even in very dense vegetation. Such exposed sites lead to significant erosion and, in moist forests, increase a surface runoff of water by destroying moss layer, which usually retains this water (Anderson 1999 – P). It has been assessed that the effect of the species on system's integrity by interfering with its abiotic factors will be medium: in the worst case the species causes hardly reversible changes related to processes occurring in habitats that do not belong to the habitats of special concern or easily reversible changes occurring in habitats of special concern.

**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 <b>X</b>	high	level of confidence
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a18. Comment:  
By intensive biting of some plant species, chital in the worst case causes hardly reversible changes related to processes occurring in habitats that do not belong to the habitats of special concern or easily reversible changes occurring in habitats of special concern. Herd behaviour and a tendency to follow one another cause that they also destroy vegetation by



trampling (Global Invasive Species Database 2018 – B). On the Andaman Archipelago (India), chitals lead to the disappearance of several species of plants as a result of feeding, and the population size of 70 other species decreased significantly. There, chitals are considered the most invasive alien species (Sivakumar 2003 – P, Ali 2004 – P). Chitals can also cause cascading effects affecting other species of animals. In Argentina, chitals contributed to limiting the process of reforestation, which indirectly influenced the functioning of other species of herbivorous mammals (Novillo and Ojeda 2008 – P). In the Andaman Archipelago (India), it has been demonstrated that a strong reduction of the plant cover in the forest understory lead to a 5-fold decrease in the population size of partially arboreal species of lizards (Mohanty et al. 2016 – P).

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

aconf15.	Answer provided with a	low	medium	high	level of confidence
			<b>X</b>		

acommm19. Comment:  
 In the natural range of the occurrence of the species, chitals often cause significant damage to crops, if another available feeding base is not too abundant (Anderson 1999 – P). They usually bite grass and other plants down to the ground, much lower than species of farm animals (Anderson 1999 – P). It has been demonstrated that chitals introduced to Hawaii cause damage to corn and pineapple crops (the harvest losses in Maui Pineapple Co were estimated at 35,000-55,000 USD) (Kubota 2001 – P). In Croatia, one of the reasons for the reduction of the population size of this species was a significant damage it caused, especially in vineyards (Frkovic 2014 – P). In the case of local increase in population size, chitals may cause damage related to trampling crops in the vicinity of forests, as it takes place in the natural range of their occurrence (Kumar et al. 2017 – P). It is expected that the effect of the species on cultivated plants will be medium: it will concern from 1/3 to 2/3 of plant cultivations being invaded and in the worst case, the condition of plants or a single cultivation yield will be reduced by approx. 5% to approx. 20%.

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

aconf16.	Answer provided with a	low	medium	high	level of confidence

acomment20. Comment:  
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

acomment20. Comment:  
The species is an animal.

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

acomment22. Comment:  
There are no published results of scientific research on the effect of the species on the condition or yield of cultivated plants by a change in the properties of agroecosystem, including the circulation of elements, hydrology, physico-chemical properties, and trophic networks. Therefore, this effect was estimated as very low.

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 <b>X</b>
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 level of confidence

acomment23. Comment:  
There are no literature data reporting that this species is a host or vector of pathogens or parasites harmful to cultivated plants.

### 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
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acomm24. Comment:  
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:

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

aconf21.	Answer provided with a	low	medium	high	level of confidence
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acomm25. Comment:  
There are no known information that the species has biological, physical and/or chemical properties, that are hazardous upon contact with farm or domesticated animals or to animal production (e.g. by toxins or allergens). It was estimated that even if the species spreads throughout Poland, the probability of negative impact as a result of a direct contact would be low (less than one case per 100,000 of farm or domesticated animals per year), and the effects – small.

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

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

aconf22.	Answer provided with a	low	medium	high	level of confidence
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acomm26. Comment:  
The species may transmit tuberculosis to cattle, sheep and pigs (Tomeček et al. 2015 – P). Transmission may be airborne, through fodder, water and through direct contact. The species also carries other disease: leptospirosis, cryptosporidiosis (Anderson 1999 – P, Najberek 2018, under preparation – N). Some of these diseases are notifiable, are on the OIE list, and they may result in the death of animals.

## 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

acomment27. Comment:  
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	high <b>X</b>
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 level of confidence

acomment28. Comment:  
There are no known information that the species has biological, physical and/or chemical properties, that are hazardous upon direct contact with humans. It was estimated that even assuming that the species spreads extensively throughout Poland, the probability of a direct contact would be low (less than one case per 100,000 of humans per year), and the effects – 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 <b>X</b>
-----	--------	------------------

 level of confidence

acomment29. Comment:  
The species is involved in the transmission of bovine tuberculosis (Najberek, under preparation). Moreover, it is a carrier of a number of parasites, which can directly affect human health if animal faeces are introduced to sources of drinking water. Zoonoses (infectious or parasitic animal diseases), which are caused by chitals include: leptospirosis, cryptosporidiosis and *Escherichia coli* strains (Anderson 1999 – P, Najberek 2018 under preparation – N).

## 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 <b>X</b>	level of confidence
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acommm30.	Comment:
	Chitals are often the cause of road collisions in the countries, where they were introduced, especially if they are expansive and enter urban areas (Anderson 1999 – P, Brooks 2006 – P). In Hawaii, the number of such events have been reduced by a decrease in a speed limit (Anderson 1999 – P). It should be emphasized that chitals very well adapt to the presence of humans and reside near human settlements, in the open areas, forming larger herds. In some cases such herds generate severe damage, e.g. on golf courses and other places arranged to be recreation facilities (Kubota 2001 – P). Moreover, e.g. in Hawaii, a behaviour of chitals associated with the movement of numerous herds led to erosion, and its indirect result – a damage to archaeological sites and traditional stone constructions (Global Invasive Species Database 2018 – B). In numerous places, chitals also damaged fences (Anderson 1999 – P, Kubota 2001 – P).
	Assuming a wide spread of the species in Poland, it can be expected that its harmful effect on the infrastructure would be medium and would concern 1 per 100 events per 100,000 of facilities per year, with a partially reversible effect.

## 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 <b>X</b>	high	level of confidence
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acommm31.	Comment:
	The species may have some effect, especially at high concentrations, on cultivated plants, and also in the case of disease spread, it can contribute to a decrease in the efficiency of animal production. It should also be noted that wherever chitals have been introduced, because of the fact that they bite grass and other plants down to the ground, much lower than species of farm animals (Anderson 1999 – P), they can compete with cattle for feed directly. As a result, they may lead to the starvation of cattle, it was observed that cattle coexisting with chitals was in very poor physical condition, poorly nourished, while deer

functioned well during a long-lasting drought (Traweek and Welch 1992 – P, Anderson 1999 – P, Global Invasive Species Database 2018 – B). Moreover, a positive effect of the species on provisioning services is possible, as the meat of these animals is a highly valued venison. For this reason, the total impact of the species was assessed as moderately negative.

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

acomm32. Comment:  
This species can, to some extent, affect the functioning of plant ecosystems, including forests, natural open ecosystems, as well as cultivations. Chitals may transmit bovine tuberculosis and a number of other diseases (Najberek 2018 under preparation – N), therefore, they can affect the control 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 <b>X</b>	high
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 level of confidence

acomm33. Comment:  
There are no known connections or effect of the species on aesthetic functions, recreation, cultural and artistic resources, the spiritual sphere and religion, science and education. It can only be noted that chitals are hunted and kept on farms, for the production of venison, which is meat highly appreciated by consumers.

## 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>
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 level of confidence

acom34. Comment:  
This species does not occur in the countries neighbouring Poland, and most of the introductions in Europe were unsuccessful (except for Croatia). The forecast warming of the climate will not cause a sufficient reduction in climatic differences between the locations where the introductions were successful and Poland, so that an increase in the probability of the introduction of the species to our country could be expected.

**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>
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 level of confidence

acom35. Comment:  
The attempts to introduce the species to locations having a climate similar to Poland did not lead to the formation of local populations, as it is a subtropical and tropical species. The forecast warming of the climate will not cause a sufficient reduction in climatic differences between the locations where the introductions were successful and Poland, so that an increase in the probability of the establishment of the species in Poland could be expected.

**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>
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 level of confidence

acom36. Comment:  
The introduction of the species to Europe was successful only in Croatia, as it is a subtropical and tropical species (Moe and Wegge 1994 – P). The forecast warming of the climate will not cause a sufficient reduction in climatic differences between the locations where the introductions were successful and Poland, so that an increase in the probability of this species (after establishment) to spread in our country could be expected.

**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>
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 level of confidence

acomment37. Comment:  
Forecast climate change will not change the scale of the possible impact of the species on wild plants and animals, 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 <b>X</b>	high
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 level of confidence

acomment38. Comment:  
Forecast climate change will not change the scale of the impact of the species on cultivated plants and plant 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 <b>X</b>	high
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 level of confidence

acomment39. Comment:  
Forecast climate change will not change the scale of the impact of the species on animal farming 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 <b>X</b>	high
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 level of confidence

acomment41. Comment:  
Forecast climate change will not change the scale of the impact of the species on other domains 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



<input checked="" type="checkbox"/>	not change
<input type="checkbox"/>	increase moderately
<input type="checkbox"/>	increase significantly

aconf37.	Answer provided with a	low	medium <b>X</b>	high	level of confidence
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acom41. Comment:  
Forecast climate change will not change the scale of the impact of the species on other domains in Poland.

## Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.00	1.00
Establishment (questions: a09-a10)	0.25	0.75
Spread (questions: a11-a12)	0.13	0.50
Environmental impact (questions: a13-a18)	0.58	0.67
Cultivated plants impact (questions: a19-a23)	0.17	0.67
Domesticated animals impact (questions: a24-a26)	0.50	1.00
Human impact (questions: a27-a29)	0.50	1.00
Other impact (questions: a30)	0.50	1.00
Invasion (questions: a06-a12)	0.13	0.83
Impact (questions: a13-a30)	0.58	0.87
Overall risk score	0.07	
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.

acom42. Comments:  
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## **2. Databases (B)**

Global Invasive Species Database 2018. Species profile: Axis axis. (<http://www.iucngisd.org/gisd/species.php?sc=972>)  
Data dostępu: 2018-01-25

Główny Inspektorat Weterynarii 2017. Rejestr podmiotów prowadzących działalność nadzorowaną z dn. 18.12.2017

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

Najberek K. 2018. work in progress Pathogens, parasites and disease of invasive alien species of European concern.

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

Hędrzak M, Wierzbowska IA. 2018a. Kontakt z lekarzami Powiatowych Inspektoratów Weterynarii w celu ustalenia gatunków jeleniowatych utrzymywanych na fermach objętych nadzorem, a nie wykazanych w rejestrze GIW z listopada 2017 r.

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

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