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. Rafał Kowalczyk
2. Andrzej Zalewski
3. Henryk Okarma

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	Mammal Research Institute, Polish Academy of Sciences, Białowieża	28-01-2018
(2)	dr hab.	Mammal Research Institute, Polish Academy of Sciences, Białowieża	30-01-2018
(3)	prof. dr hab.	Institute of Nature Conservation, Polish Academy of Sciences in Cracow	05-02-2018

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

Polish name: Jenot

Latin name: ***Nyctereutes procyonoides*** Gray, 1834

English name: Raccoon dog

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acomm02.	Comments:	
	Polish name (synonym I) Junat	Polish name (synonym II) –
	Latin name (synonym I) *Canis procyonoides*	Latin name (synonym II) –
	English name (synonym I) Chinese raccoon dog	English name (synonym II) Raccoon

a03.**Area** under assessment:

Poland

acomm03.	Comments: –

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

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

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

acomm04.	Comments: Raccoon dog was imported from East Asia to the former Soviet Union in 1928-1957, acclimatised and released in the environment (Pielowski and Nowak 1964 – P). Since then, it colonised a significant part of Eastern and Central Europe. In Poland, it was observed for the first time in the Białowieża Forest in 1955 (Dehnel 1956 – P). In next years, the raccoon dogs were colonising the territory of Poland, and they colonised almost whole Poland to the end of 1960s, excluding the mountains in the southern part of the country (Nowak and Pielowski 1964, Pielowski et al. 1993 – P). At present, the raccoon dog belongs to the most widespread invasive species of predatory mammals in Europe (Kauhala and Kowalczyk 2011 – P). In Poland, the raccoon dog is a game species without a close season (Decree of the Minister of Environment of 16 March, 2005, on determination of hunting periods of game animals – P). The density of the raccoon dogs oscillates between 1 and 5 per 1 km^2, depending on the environment (Kauhala et al. 2010, Sutor and Schwarz 2011 – P). Breeding of raccoon dogs in farms in Poland started in the beginning of 1960, and in 1988, more then 10 thousand individuals were kept (the breeding herd plus the number of the produced hides) (Jarosz 1993 – P). At present, the raccoon dogs are still bred in farms in Poland, approx. 12 thousand pelts are produced yearly (Fur Europe 2018 – B).

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

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

acomm05.	Comments: The raccoon dog may affect the natural environment, first of all, by transmitting diseases and parasites, and to a lesser degree – by predation or competition with native carnivores. As a carrier of zoonotic pathogens, it causes an increase in the prevalence of parasites and diseases (Holmala and Kauhala 2006, Cha et al. 2012, Al-Sabi et al. 2013, Sutor et al. 2014,

Duscher et al. 2017 – P). The most important pathogen transmitted by the raccoon dogs is rabies (Holmala and Kauhala 2006 – P), but also scabies (Kołodziej-Sobocińska et al. 2014 Sutor et al. 2014 – P). Both diseases have an impact on abundances of populations of native animal species. Transmitting parasites and pathogens, the raccoon dogs may affect animal farms. The influence of this species on plant crops is rather small and limited to places, where the raccoon dogs adapted to human-changed environments (Drygała and Zoller 2013 – P). They may decrease yields in these places, by fortaging on cultivated plants or fruits. Due to the transmission of pathogens and parasites such as rabies, scabies, *Echinococcus multilocularis*, *Spirometra*, and others, the raccoon dogs may pose a threat for humans.

A1 | Introduction

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

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

	low
	medium
X	high

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

acomm06. Comments:

In Poland, the species has been occurring for more than 60 years and is established (Dehnel 1956 – P). In late 1960s, it was occurring in the majority of the territory of Poland, excluding higher parts of the mountains in the southern regions of the country (Kauhala and Kowalczyk 2011 – P). Poland was colonised by raccoon dogs from the east, from the territory of Belarus and Ukraine, where they were introduced (Nowak and Pielowski 1964 – P). At present, the raccoon dog belongs to the most widespread invasive species of predators in Europe, occurring permanently in the natural environment of Poland (Kauhala and Kowalczyk 2011 – P).

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

	low
	medium
X	high

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

acomm07. Comments:

The species is established in Poland since 1950s (Kauhala and Kowalczyk 2011 – P).

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

	low
	medium
X	high

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

acomm08. Comments:

The raccoon dogs are still being bred in farms; in 2016, approx. 12 thousand pelts has been produced in Poland (Fur Europe 2018 – B). Approximately 40 farms keeping the raccoon dogs is still functioning in Poland, where up to a dozen or so thousand individuals is kept periodically, so the probability of animal escapes from farms to the natural environment is relatively high. It is confirmed by research analysing the genetic variability of farm and wild individuals, in which a very slight gene flow from farms to wild populations has been found (Kasperek et al. 2015 – P). However, other publications indicate a slightly higher share of farm escapees in wild populations (Norgaard et al. 2017 – P). Escapes from farms were the source of introduction of the species to the natural environment in Hungary (Heltai et al. 2001). There is a risk of release of the raccoon dogs from fur farms in case of legal changes aimed to forbid furred animal husbandry. The raccoon dogs may be released from decommissioned farms from spring to autumn, because their furs are not saleable, and utilisation of the animals is costly.

A2 | Establishment

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

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

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

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

acomm09. Comments:

The raccoon dog originates from Asia, where it occurs in areas with very diverse climates: from the semitropical climate zone (in China and Japan) to the continental subarctic climate zone (in Russia and Mongolia) (Kauhala and Saeki 2004 – P). The climatic conditions of Poland are very favourable for this species and they have not been a barrier for its establishing (Kowalczyk and Zalewski 2011 – P).

a10.Poland provides habitat that is

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

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

acomm10. Comments:

The raccoon dog occurs in diverse habitat types such as: deciduous, mixed and coniferous forests, fenlands, lake shores and river banks (Drygała and Zoller 2013, Sutor and Schwarz 2013 – P). Also, it inhabits human-modified landscapes: arable lands, village and town outskirts (Kauhala et al. 2016 – P). Due to a broad habitat niche of this species, a high forest cover, and the availability of wet habitats, landscapes of Poland are very favourable for this species (Kauhala and Kowalczyk 2011 – P). Only areas characterised by lower temperatures, retention of a thick snow cover, a shorter vegetative season, and a lower availability of

	food, such as higher parts of mountains in Poland, may be barriers for spreading and occurrence of the species (Helle and Kauhala 1991 – P).

A3 | Spread

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

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

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

	very low
	low
	medium
	high
X	very high

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

acomm11. Comments:

Dispersion from a single source (data type: A)
The raccoon dog has been occurring permanently in Poland since the beginning of 1960s (Dehnel 1956 – P, Nowak and Pielowski 1964). Its distribution range encompasses almost whole territory of Poland, excluding southern areas. The colonisation occurred rather without humans participation, despite the fact the raccoon dog was also kept in farms while colonising the territory of Poland. It is one of invasive species rapidly spreading after settling, which results from a high environmental and food plasticity, and from the dispersion of youngsters (Kauhala and Kowalczyk 2011 – P). The dispersion may occur at large distances, reaching 90-100 km during several months (Sutor 2008, Drygala et al. 2010 – P), enabling a very fast colonisation of new areas. Expansion of the raccoon dog onto yet-uncolonised areas of Poland is limited probably due to unfavourable environments (mountains) in southern Poland.

Population expansion (data type: B)
Till the end of 1980s, the raccoon dogs colonised an area of more than 1.4 mln km^2 in Europe (Nowak and Pielowski 1964, Kauhala and Kowalczyk 2001 – P). Observed in eastern Poland in 1955 for the first time, they reached the western border of the country already in 1961/62 (Dehnel 1956 – P, Nowak and Pielowski 1964).

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

	low
X	medium
	high

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

acomm12. Comments:

The species has been spreading naturally in Poland, however, environmental emergence of individuals escaping from farms in some areas cannot be excluded. First raccoon dog farms in Poland were created in 1960s (Jarosz 1993 – P). In next decades, the number of individuals being bred increased to approx. 10 thousand and remained on this level (FurEurope 2018 – B). Inflow of farm-escapees to wild populations is rather small or medium, which is indicated by genetic analyses of farm and wild populations (Kasperek et

al. 2015, Norgaard et al. 2017 – P). There are no legal regulations concerning decommissioning of farms and control of the farms being closed, which may result in release of the raccoon dogs from these farms to the environment. Their estimated number amounts to from 1 to 10 cases per decade probably.

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 herbivoryis**:

	inapplicable
	low
X	medium
	high

aconf09. Answer provided with a

low	medium	high
	X	

level of confidence

acomm13. Comments:

The influence of this predator on the native fauna is poorly documented in the literature, which may result from the lack of studies on the subject or from a low impact of this species on populations of its prey, however, at most, it causes small decreases of population abundances of the native species of particular concern. The raccoon dog is a generalist (eats various types of food) and a food opportunist (forage on the most available food). It hunts various prey: invertebrates, amphibians, reptiles, birds and mammals, consume carrion, as well as plant food (Kauhala et al. 1998, Kauhala and Auniola 2001, Drygala and Zoller 2013 – P). The composition of its diet vary seasonally and depends on the habitat (Kauhala et al. 1998, Kauhala and Auniola 2001, Sutor et al. 2010, Drygala and Zoller 2013 – P). The raccoon dogs eat bird eggs relatively frequently, the frequency of occurrence of egg shells in the analysed scats of the raccoon dog reaches up to 18% in the spring (Kauhala et al. 1998, Kauhala and Auniola 2001 – P). Therefore, potentially, the raccoon dogs may affect populations of birds nesting on the ground, causing losses in clutch of these birds. Predation on common eider (*Somateria mollissima*), which is under strict protection in Poland, has been observed in Finland (Kauhala and Auniola 2001 – P), however there is no convincing data on the influence of the raccoon dog on breeding success of birds and on the bird numbers (Kauhala and Kowalczyk 2011 – P). The raccoon dog may affect clutches of forest *Galliformes*, such as the hazel grouse (*Bonasia bonasia*) and black grouse (*Tetrao tetrix*) (Kauhala and Kowalczyk 2011 – P). Other species which are subject to strict or partial protection are found in its diet, such as: common shrew, Eurasian water shrew, red squirrel, common frog, common toad; however, the predation of the raccoon dog is of marginal importance for these species (Jędrzejewska B. and Jędrzejewski W. 1998, Kauhala and Auniola 2001 – P). Potentially, the raccoon dog may limit population of an endangered species – the European pond turtle *Emys orbicularis* – because in some regions, it prey on this reptile and its eggs (Krizmanić et al. 2015 – P). The raccoon dogs may use dens of red foxes *Vulpes vulpes* and European badgers *Meles meles* (Kowalczyk et al. 2008 – P), which

	may lead to aggressive interactions between these species, including killing of badger's cubs (Jędrzejewski and Jędrzejewska 1998 – P).

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

	low
X	medium
	high

aconf10.	Answer provided with a	low	medium	high **X**	level of confidence

acomm14. Comments:

As the raccoon dogs have inhabited habitats used by foxes, badgers, pine martens *Martes martes* and European polecats *Mustela putorius*, it may be supposed that competition for food or shelter occurs between them. Food niches of the raccoon dog overlap to a significant degree with those of fox and badger, and to a slighter degree – with those of the European polecat and pine marten (Jędrzejewska B. and Jędrzejewski W. 1998 – P), so the competition between these species is highly probable. However, introduction of the raccoon dog have not caused a dramatic decrease in the abundances of these species (Kauhala 1995, Drygala and Zoller 2013 – P). Some authors suggest an adverse effect of the raccoon dog on its competitors' populations (fox, pine marten, and even brown bear *Ursus arctos*) in Belarus, as a result of reduction of the food supply availability, particularly of carrion in winter (Sidorovich et al. 2000 – P). There is no such research in Poland. The raccoon dogs may use badger and fox den systems, utilising various parts of the systems (Kowalczyk et al. 2008 – P), however it results in abandonement of dens by foxes and badgers only rarely (Kowalczyk et al. 2008 – P).

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

X	no / very low
	low
	medium
	high
	very high

aconf11.	Answer provided with a	low	medium	high **X**	level of confidence

acomm15. Comments:

There is no risk of hybridisation in the case of this species, as the raccoon dog is not closely related with native species of carnivores inhabiting Europe. It is the only member of the *Nyctereutes* genus, and cases of hybridisation with other species have not been observed.

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

	very low
	low
	medium
	high
X	very high

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

acomm16. Comments:

35 species of endoparasites, 5 species of ectoparasites, 6 species of bacteria or protozoans, and 5 species of viruses were found with the raccoon dog (Sutor et al. 2014 – P). It is a carrier of pathogens causing numerous diseases, among others, rabies, distemper, avian flu, toxoplasmosis, tularaemia, leishmaniasis (*e.g.* Holmala and Kauhala 2006, Cha et al. 2012,

Sutor et al. 2014 – P). In some regions of Europe, the level of rabies-infected raccoon dogs is relatively high (Holmala and Kauhala 2006 – P), which poses a threat for other species. The raccoon dogs contributed to 6-8% all cases of rabies recorded in wild animals in Europe in years 2007-2011 (Sutor et al. 2014 – P). As an additional rabies transmission vector, the species (together with red foxes and common raccoons *Procyon lotor*) may cause a significantly increase in frequency of the disease occurrence, despite the oral vaccination of the predators, carried out in many places. Rabies and leishmaniasis are OIE-listed. Leishmaniasis caused by protozoans may be transmitted to other predatory species by bloodsuckers. Untreated leishmaniasis may be fatal. Also, the raccoon dog is a carrier of numerous parasites, *i.a.* nematodes (of *Trichinella*, *Toxocara*, *Uncinaria* genera), tapeworms (*Echinococcus multilocularis*, *Teania* spp.) or trematodes (*Alaria alata*) (Al-Sabi et al. 2015, Laurimaa et al. 2015, Duscher et al. 2017 – P). Echinococcosis (*Echinococcus multilocularis*) and trichinosis (*Trichinella* sp.), transmitted by the raccoon dogs, are also OIE-listed. Other predator species (gray wolf *Canis lupus*, Eurasian lynx *Lynx lynx*, badger *Meles meles*, or fox *Vulpes vulpes*) may be infected with those parasites more frequently together with the increase in the prevalence of these parasites in the environment. The infection may occur directly (by predation of wolf and lynx on the raccoon dog) or indirectly (by contact with excrement or contaminated food, by sharing the dens) (Kowalczyk et al. 2009, Kauhala and Kowalczyk 2011). The raccoon dog is susceptible to *E. multilocularis* and, together with the red fox, may be the main reservoir and infection vector for this parasite. In eastern Germany, the percentage of individuals infected with *E. multilocularis* oscillates between 6 and 12% (Schwarz et al. 2011 – P); in Poland, it has been on the level of 8% in Pomerania (Machnicka-Rowińska et al. 2002 – P). The increase in the *E. multilocularis* in Europe is connected probably with the increase in the abundance of fox and expansion of the raccoon dog (Romig et al., 2006 – P). Studies carried out in Denmark indicated that the levels of infection of the raccoon dogs with various parasites are high, and in most cases, the results were shared with the fox (Al-Sabi 2013 – P). In Poland, the percentages of raccoon dogs infected with some parasites are very high: *Alaria alata* – 94%, *Molineus* spp. – 41%, *Toxocara* –15% (Karamon et al. 2016 – P). The main causes of the raccoon dog's mortality includes predation (27% of mortality cases) – mostly by wolves *Canis lupus* and stray dogs, and diseases – particularly rabies and scabies (27%), which may contribute significantly to transmission of parasites and pathogens (Kowalczyk et al. 2009 – P).

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

X	low
	medium
	high

aconf13. Answer provided with a

low	medium	high	level of confidence
		X	

acomm17. Comments:

The species does not affect abiotic factors.

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

	low
X	medium
	high

aconf14. Answer provided with a

low	medium	high	level of confidence
	X		

acomm18. Comments:

Under optimum conditions, the raccoon dog may occur in high densities (Kauhala and Kowalczyk 2011 – P). In wet habitats, the strong impact of the raccoon dog on waterfowl may lead to decreases in their populations (Kauhala et al. 1993 – P). Excrement of the raccoon dog may be a source of parasitic infections, particularly for rodents and small bird

	species, inhabiting oak-hornbeam forests (9170) and bog woodlands (91D0) (which constitute habitats of particular concern), leading to an increase in mortality of these species and, by cascade effect on the trophic web, causing easily reversible disturbances of biotic factors in these habitats. However, there are no studies confirming these assumptions.

A4b | Impact on the cultivated plants domain

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

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

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

	inapplicable
X	very low
	low
	medium
	high
	very high

aconf15.	Answer provided with a	low	medium	high **X**	level of confidence

acomm19.	Comments: The raccoon dog is an omnivore, its diet varies by seasons. In autumn, fruita are an important component of its diet (up to 55%) (Drygala and Zoller 2013 – P). It may feed in the fields, orchards and gardens, causing damage in corn and fruit crops (strawberries, blackberries, raspberries), but no economic significance of this effect has been ascertained, because of a low probability and consequence of the impact (Mulder 2012 – P).

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

X	inapplicable
	very low
	low
	medium
	high
	very high

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

acomm20.	Comments: Animals do not compete with plants.

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

X	inapplicable
	no / very low
	low
	medium
	high
	very high

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

acomm21. Comments:

The raccoon dog is an animal and it cannot crossbreed with plants.

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

X	very low
	low
	medium
	high
	very high

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

acomm22. Comments:

There is no information on the influence of the raccoon dog on plant crops by disturbing their integrity.

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

X	very low
	low
	medium
	high
	very high

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

acomm23. Comments:

There is no information on the influence of the raccoon dog on plant crops connected with the fact that it is a host or vector of pathogens and parasites harmful for these 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:

	inapplicable
	very low
	low
X	medium
	high
	very high

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

acomm24. Comments:

There is no record on the impact of predation on animal production. The species is not an efficient hunter, it is rather a gatherer (Kauhala and Kowalczyk 2011 – P). Probably, single

	domestic animals are being killed very rarely, the probability is low – less than 1 case per 100,000 animals per year. However, due to a significant consequence in the form of killing or injuring animals, this effect is of a medium character. Sporadically, the raccoon dogs may eat eggs in poultry farms.

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

	very low
X	low
	medium
	high
	very high

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

acomm25. Comments:

In a threat situation, the raccoon dogs play dead and are not aggressive towards the majority of farm animals. When attacked, they may be aggressive towards dogs, so biting may occur, however, the literature lacks reports on this subject. Due to the fact that the raccoon dogs avoid terrains used by humans, the probability of this species affecting health of single farm animals or animal production in the result of direct contact with the raccoon dog is generally low, and its effect – medium.

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

	inapplicable
	very low
	low
	medium
	high
X	very high

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

acomm26. Comments:

The raccoon dog may be a carrier of pathogens causing numerous diseases dangerous for farm animals. In the case of emergence of infected raccoon dogs in the vicinity of farms and meadows, on which the animals graze, direct or indirect contact with raccoon dogs may occur. The diseases that may pose a threat for farm animals and domestic animals include: rabies (fatal disease, OIE list), distemper, scabies, leishmaniasis (OIE list), yersiniosis (Xu 1982, Fukushima and Gomyoda 1991, Westerling 1991, Frölich et al. 2000, Holmala and Kauhala 2006, Kołodziej-Sobocińska et al. 2014 – P). The two latter occur mainly in the east of Asia. Yersiniosis was found in animals only in some EU countries, particularly pigs, rarely cattle, sheep, goats, domestic fowls. Despite the operation of dissemination of anti-rabies oral vaccination carried out widely in Poland, the probability of rabies infections among the raccoon dogs still exists, particularly in the east of Poland. The disease is obligatorily notifiable based on the veterinary regulations (OIE list). Also, the raccoon dog is a carrier of many parasites, such as *Echinococcuss multilocularis* (OIE list), *Trichinella spiralis* (OIE list), *Baylisascaris procyonis*, *Dipylidium caninum*, *Taenia* spp., *Uncinaria stenocephala* (Oivanen et al.2002, Al-Sabi et al. 2013, Kołodziej-Sobocińska et al. 2014, Laurimaa et al. 2015 – P). The *Baylisascaris procyonis* ascarid poses a significant threat. The farm species in which it occurs include hens, pheasants, rabbits, dogs. The increasingly more frequent occurrence of the raccoon dogs in areas inhabited by humans increases the risk of contact of the predators with farm animals, thereby increasing also the risk of infections with the

	pathogens and parasites transmitted by the raccoon dog, as a result of direct contact or by parasite eggs excreted by the raccoon dogs in the vicinity of human settlements.

A4d | Impact on the human domain

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

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

X	inapplicable
	very low
	low
	medium
	high
	vert high

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

acomm27.	Comments: The raccoon dog is a mammal which does not parasitise on humans.

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

X	very low
	low
	medium
	high
	very high

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

acomm28.	Comments: At direct contact, there is a risk of being biten by the raccoon dogs. It is connected with the characteristic demeanour of the species to play dead in threat situations, which may facilitate approaching these animals by humans. However, the cases of biting are very rare (R. Kowalczyk – Author's observation). Also, unlike foxes, the raccoon dog individuals infected with rabies are calm, dejected, and they do not attack humans (A. Zalewski – Author's observation).

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
X	very high

aconf25.	Answer provided with a	low	medium	high **X**	level of confidence

acomm29.	Comments: The raccoon dogs may transmit pathogens and parasites harmful for humans, such as rabies (OIE list), scabies, *Echinococcuss multilocularis*, *Spirometra* and others. The raccoon dog is

the second most important carrier of rabies (a disease fatal for humans) in Poland, after the fox (Smreczak et al. 2004, Holmala and Kauhala 2006 – P). In years 1999-2004, more than 700 raccoon dogs in Poland (approx. 8% of all cases) were infected with rabies (Kowalczyk 2011), however, in last dozen or so years, due to the program of disposition of anti-rabies vaccines, the number of cases observed among wild animals, including the raccoon dogs, decreased significantly (Flis 2016). Approximately 8% of raccoon dogs in Poland were infected with *E. multilocularis* (Machnicka-Rowińska et al. 2002 – P), which may pose a risk of direct infection for humans (*e.g.*, by eating forest fruits contaminated with the parasite eggs). The raccoon dog is a host of parasites dangerous for humans, among others, those of the *Echinococcus* (OIE list), *Toxocara*, *Trichinella* (OIE list) genera (Al-Sabi et al. 2015, Laurimaa et al. 2015, Karamon et al. 2016, Duscher et al. 2017 – P). In Austria, the degree of infection of the raccoon dogs with some parasites was relatively high: *Alaria alata* was found with 30% of individuals and *E. multilocularis* – with 10% of individuals (Duschner et al. 2017 – P). The raccoon dogs transmit also, among others, *Francisella tularensis* bacteria, causing tularaemia in humans, which is a curable acute bacterial infectious disease (Sutor et al. 2014 – P). The increasingly more frequent occurrence of the raccoon dogs in areas inhabited by humans increases the risk of contact with these predators or their excrements, thereby, the risk of being infected with pathogens and parasites transmitted by them increases too.

A4e | Impact on other domains

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

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

X	very low
	low
	medium
	high
	very high

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

acomm30. Comments:

The raccoon dogs are animals avoiding urban areas and other terrains utilised by humans (*e.g.*, recreational areas), thus the risk of an adverse impact on the infrastructure is very low.

A5a | Impact on ecosystem services

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

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm31. Comments:

In the case of high raccoon dog population densities in forest areas, the risk of parasitic infection (*E. multilocularis*) for humans gathering forest fruits (fruits, mushrooms) may increase. Transmission of diseases and parasites by the raccoon dog to domestic animals and farm animals (*e.g.* dogs, cats, cows) may result in a decrease in animal production.

a32. The effect of *the species* on**regulation and maintenance services** is:

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf28.	Answer provided with a	low	medium **X**	high	level of confidence

acomm32. Comments:

The influence of this species on regulating services is defined as moderately negative due to the fact that it affects adversely the biological regulation, namely regulation of zoonotic diseases, because the presence of the raccoon dog in ecosystems may result in a higher level of infections with zoonotic diseases such as rabies or scabies, hosted by the raccoon dog. The impact of the raccoon dog on the food chain may be moderately negative due to its local influence on populations of native species or food availability.

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf29.	Answer provided with a	low	medium **X**	high	level of confidence

acomm33. Comments:

The raccoon dogs have a slight influence on cultural services. Potentially, they may reduce the abundance of game-fowl (ducks, pheasants, partridges), affecting hunting; however, there is no data on the subject. The raccoon dogs with rabies or scabies, roaming in urban areas, may arouse fear and loathing. The raccoon dog is a game species, but it is not culled for trophies or meat, rather the hunters are obligated to reduce its abundance. Positive cultural influence for hunters is rather marginal.

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

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

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

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm34. Comments:

The species occurs in climates from semitropical to continental (Helle and Kauhala 1991 – P, Kauhala and Kowalczyk 2011) and in the majority of terrains, there are no barriers for its introduction. The raccoon dog has colonised already a larger part of Poland and there are no barriers limiting its occurrence, so the climate change will not affect barrier overcoming significantly. The climate warming may cause only its emergence in higher parts of mountains.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm35. Comments:

The species is established in the majority of Poland. The climate warming may affect its establishing in higher parts of mountains and may cause an increase their densities in the areas already colonised.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

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

acomm36. Comments:

The northern boundary of the distribution range of this species reaches the polar circle (Helle and Kauhala 1991 – P). As a result of the climate warming, the distribution range may expand to the north of Europe. However, increased snowfall in winter may compensate the effect of warming (Melis et al. 2010 – P). Considering the very broad climatic niche of the species, the climate change will not affect its spreading in Poland significantly. The climate warming may affect only the increase in the raccoon dog abundance in the already colonised areas, and may increase its occurrence in higher part of mountains (Helle and Kauhala 1991 – P, Kauhala and Kowalczyk 2011 – P).

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
X	increase moderately
	increase significantly

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

acomm37. Comments:

The influence on the natural environment will be increasing probably to a slight degree together with the increase in the species abundance, resulting from the climate warming, which has been connected already with its widespread. An increase in the influence may occur mainly in higher parts of mountains or in periods when the raccoon dogs activity has been reduced (winter sleep) (Helle and Kauhala 1991, Singer et al. 2009 – P)

a38. IMPACT ON THE CULTIVATED PLANTS DOMAIN – Due to climate change, the consequences of *the species* on cultivated plants and plant domain in Poland will:

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

aconf34.	Answer provided with a	low	medium	high **X**	level of confidence

acomm38. Comments:

The impact of the raccoon dog on plant crops and plant production in Poland is slight and it will not increase with the climate warming probably.

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

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf35.	Answer provided with a	low	medium	high **X**	level of confidence

acomm39. Comments:

The climate warming may result in increases in densities and spreading of the raccoon dogs (Helle and Kauhala 1991, Singer et al. 2009 – P), which may lead to an increase in the risk of transmission of pathogens and parasites to farm animals.

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
X	increase moderately
	increase significantly

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

acomm40. Comments:

The climate warming may result in increases in densities and spreading of the raccoon dogs and affect their activity (shorter duration of winter sleep) (Helle and Kauhala 1991, Singer et al. 2009 – P), which may lead to an increase in the risk of transmission of pathogens and parasites, which, in turn, may increase the threat for humans.

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm41. Comments:

No influence of this species on other objects has been observed till now; probably, the climate warming will not change this situation.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	1.00	1.00
Establishment (questions: a09-a10)	1.00	1.00
Spread (questions: a11-a12)	0.75	0.75
Environmental impact (questions: a13-a18)	0.42	0.83
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.58	0.83
Human impact (questions: a27-a29)	0.50	1.00
Other impact (questions: a30)	0.00	1.00
Invasion (questions: a06-a12)	0.92	0.92
Impact (questions: a13-a30)	0.58	0.93
Overall risk score	0,53	
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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