



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. Dagny Krauze-Gryz
2. Jerzy Romanowski – external expert
3. Wojciech Solarz

acomment01.	Comments:	degree	affiliation	assessment date
		(1) dr	Faculty of Forestry, Warsaw University of Life Sciences – SGGW	17-01-2018
		(2) dr hab.	Faculty of Biology and Environmental Sciences, Cardinal Stefan Wyszyński University, Warsaw, Poland	16-01-2018
		(3) dr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	23-02-2018

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

Polish name: –

Latin name: ***Callosciurus erythraeus*** Pallas, 1779

English name: Pallas's squirrel

acommm02.	Comments:		
	Polish name (synonym I)	Wiewiórczak rdzawobruchy	Polish name (synonym II) –
	Latin name (synonym I)	<i>Callosciurus flavimanus</i>	Latin name (synonym II) <i>Callosciurus sladeni</i>
	English name (synonym I)	Red-bellied tree squirrel	English name (synonym II) Belly-banded squirrel

a03. Area under assessment:

Poland

acommm03.	Comments:
	–

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

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

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

acommm04.	Comments:
	Presence of this species in Polish natural environment has not been confirmed. Different species of squirrels are available for sale (Krauze, Gryz 2012 – P). Also, <i>Callosciurus erythreus</i> can be bred and sold illegally therefore it cannot be ruled out that an individual / individuals will be introduced to the natural environment.

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

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

acommm05.	Comments:
	Under favourable conditions, introduced populations can reach very high population density (up to 15-18 indiv./ha) (Bertolino and Lurz 2011 – P). The squirrel has similar nutritional requirements to those of a red squirrel and can effectively compete with it (Mazzamuto et al. 2017a, 2017b – P). This species can cause damage to forest plantations, horticultural crops and to parks and gardens by gnawing the bark of trees. By eating fruit and nuts squirrels cause losses on plantations (Bertolino and Lurz 2011 – P). They can act as vectors of diseases and parasites, which are dangerous for humans and animals (Najberek 2018 – N). There are also reports of egg stealing on bird farms (Bertolino and Lurz 2011 – P). They also cause damage to property (electrical cables, irrigation systems, etc.) (Palmer et al. 2007 – P, Bertolino and Lurz 2011 – 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
				X	

acomment06. Comments:
Since the Pallas's squirrel does not occur in wild in countries neighbouring Poland, the probability of the occurrence of this species in the natural environment of Poland as a result of independent expansion is low. In Europe, wild-living populations are or have been present in France, the Netherlands and Belgium (CABI 2018 – B, Bertolino and Lurz 2011 – P) and remain isolated (UNEP-WCMC. 2010 – I).

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

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

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

acomment07. Comments:
No case of unintentional introduction of the species has been recorded. The introduction of the species into the natural environment was the result of deliberate actions or an escape of squirrel from keeping (UNEP-WCMC 2010 – I).

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
			X		

acomment08. Comments:
Pallas's squirrels were regularly recorded in trade and breeding in many European countries (UNEP-WCMC 2010 – I, Bertolino and Lurz 2011 – P, Schockert 2012 – I). Poland was not included into aforementioned reports. Nevertheless, it can be assumed that this species was/is a breeding object also in Poland. Currently, their breeding is subject to significant legal restrictions - the species was enlisted as an alien species that poses a threat to natural environment of EU and its breeding/sealing is illegal (Commission Implementing Regulation (EU) 2016/1141 of 13 July 2016 – I). However, the illegal trade and exchange of individuals cannot be excluded. Nevertheless, it can be expected that this species will be eliminated gradually from breeding in Poland. So far, there has been no case of introduction of the Pallas's squirrel in Poland. It should be noted, however, that deliberately introduced specimens (as a decoration of the garden) or those who had fled

from a farm initiated populations in France, Belgium and the Netherlands, so traded animals should be treated as a significant source of risk of invasion (Bertolino and Lurz 2011 – P). According to Bertolino (2009 – P), out of 21 introductions of the species in the world, 14 resulted in the establishment of numerous and growing populations, and another three – in local populations. The probability of forming a stable population as a result of introducing one pair of animals of the *Callosciurus* genus is higher than 50% (Bertolino 2009 - P).

A2 | Establishment

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

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

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

aconf05. Answer provided with a

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

 level of confidence

acomment09. Comments:
 The Pallas's squirrel naturally lives in the north-eastern part of South Asia – in the most part of central and southern China and in the south-eastern part of the Asian continent (Duckworth et al. 2017 – I). It occurs up to 3000 m above sea level (Lurz et al. 2013 – I). Generally, the natural range of occurrence covers areas with a much warmer climate than that of Poland, and severe climatic conditions are an obstacle to the settling in new areas. For example, in Japan, introduced squirrels failed to settle in forests in the north, where there are significant snowfalls and average temperature in the coldest months falls below 4°C (Setoguchi 1990 – P, Bertolino 2009 – P). Although probability of establishment of new population is higher in countries located in similar latitudes as a natural range of the species (Bertolino 2009 – P), the Pallas's squirrel managed to settle in Europe. The places of introduction of the species in Western Europe are characterized by a moderately warm climate in which the Pallas's squirrel is resistant to harsh winters (Le Louarn and Quéré, 2003 – P). Polish climate should be regarded as moderately favourable for the establishment of the species (climatic similarity: 45-94%) (Di Febbraro et al. 2016 – P). However, since the species is very flexible and can also be found in the mountains, it can be assumed that its survival in certain areas of our country (e.g. south-western Poland) is possible, especially in urbanised areas with milder climatic conditions.

a10. Poland provides **habitat** that is

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

aconf06. Answer provided with a

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

 level of confidence

acomment10. Comments:
 Occupied habitats: tropical and subtropical forests, humid forests of the temperate zone but also subalpine coniferous forests and mixed forests in China. It prefers deciduous, evergreen trees but also makes use of coniferous species (Lurz et al. 2013 – I). In the countries in which it was introduced, it is found in various types of forests (deciduous, coniferous and mixed forests; Schockert 2012 – I). In the Netherlands, the species avoids monocultures of coniferous species, perhaps because more favourable forest habitats are

available (Schockert 2012 – I). In Poland, deciduous forest habitats are about 50% of all forest habitats, pine and spruce monocultures are planted less often and mixed stands are becoming more popular, the share of deciduous trees is increasing, the share of deciduous species – including oaks, ash trees, maples, sycamores and hornbeams – is increasing (<http://www.lasy.gov.pl/pl/nasze-lasy/polskie-lasy> – I), it can therefore be assumed that the availability of optimal habitats for Pallas's squirrels grows. This species is very flexible in habitat selection (Duckworth et al. 2008 – P) and also functions well in the urbanised environment, where it uses anthropogenic food. The availability of such food (including food residues found in rubbish bins) makes it possible to survive through the periods of natural food shortage (Bertolino and Lurz 2011 – P). In the south of France, the highest population density is reached in suburban trees (females were non-territorial) and the species is also able to live in the backyard gardens (Dozieres et al. 2015 – P). In the urban areas it uses trees of a small surface (Miyamoto et al. 2004 – 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:

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

aconf07.	Answer provided with a	low	medium	high	level of confidence
				<input checked="" type="checkbox"/>	

acommm11. Comments:
 The Pallas's squirrel can be regarded as an 'effective invader': it successfully colonises new areas, easily spreads in the urban environment, it is able to use even small and single trees and electrical cables as 'stepping-stones' dispersion corridors (Miyamoto et al. 2004 – P, Guichón et al. 2005 – P, UNEP-WCMC 2010 – I). It is believed that the distance between subsequent favourable habitats should not exceed 100 m, but the presence of cables, fences, hedges, etc. allows for further dispersal (see: Schockert 2012 – I).
 Dispersion from a single source (Data type: A)
 It is assumed that the maximum dispersion range of individual specimens usually does not exceed 5 km (Lin and Yo 1981 – P, Guichon and Doncaster 2008 – P).
 Population expansion (Data type: B)
 In the Netherlands, within 10 years the local population spread over a distance of 6 km from the place of escape of the founding individuals (Dijkstra et al. 2009 – P). In France (Cap d' Antibes), the rate of population spread was estimated at 0.08-0.20 km/year (Dozieres et al. 2015 – P), while in Argentina, depending on the population, between 0.05 and 0.61 km/year (Benitez et al. 2013 – P).

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

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

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

acomment12. Comments:
 The squirrels are attractive and generally liked, so they can be intentionally moved to new areas by people (Schockert 2012 – I). This is the case with the eastern gray squirrel in Italy (Martinoli et al. 2010 – P). Similarly, in Argentina, the resettlement of individuals into subsequent regions resulted in the establishment of further populations (Bertolino and Lurz 2011 – P). Provided that the species settles in Poland, it is possible that the individuals will move to new areas. Between 1 to 10 resettlement cases per decade are expected.

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 X	high	level of confidence
----------	------------------------	-----	--------------------	------	---------------------

acomment13. Comments:
 Predation: The Pallas's squirrel feeds mainly on plants supplemented with insects, snails and birds' eggs (CABI 2018 – B). All arboreal squirrels, as food opportunists, are also predators of nestlings (Newson et al. 2010 – P). Such an influence of the Pallas's squirrel cannot be excluded, and occasional cases of feeding on eggs or nestlings are reported in literature (Bertolino and Lurz 2011 – P). On the other hand, study conducted by Messetta et al. (2015 – P) did not show that squirrels affect birds through predation in Argentina, although the authors did not exclude the negative impact of the species.
 Herbivory: This species affects native tree species by stripping them of bark. Such behavior was observed in Japan and Argentina, outside the natural range of the squirrel (see: Bertolino and Lurz 2011 – P, UNEP-WCMC 2010 – P). This problem was also observed in the local populations in the Netherlands, France and Belgium (Dijkstra et al. 2009 – P, Stuyck et al. 2009 – P, Chapuis and Menigaux 2010 – P). On the other hand, the species may contribute to the spread of tree and shrub seeds (Chung and Cortell 2006 – P).
 In case of the spread of the species in Poland, due to predation and herbivory, it can be assumed that – in the worst-case scenario – it will cause a small decrease in the population of native species of particular concern (e. g. protected birds) or a serious decrease in the population of other native species.

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

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

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

acom14. Comments:
 In Argentina and Japan, the influence of the species on native squirrels was assessed as high. Similarly, in Europe (the Netherlands) it has been assessed that the species poses a threat to the native red squirrel, and lack of control measures against the Pallas's squirrel may result in elimination of the native species from the wild (UNEP-WCMC 2010 – I). A recent study from Italy (Mazzamuto et al. 2017a – P) showed that the presence of Pallas's squirrel (which occurs at much higher densities than red squirrel) negatively affects the demographic parameters of the native squirrels: they were less numerous, the population was fragmented and did not exist in many parts of the habitat occupied by alien squirrels. Moreover, the survival rate of adult red squirrels was lower. The authors conclude that the presence of alien species influences the viability of the Pallas's squirrel population. Subsequent research carried out by the team (Mazzamuto et al. 2017b – P) showed that red squirrels in the presence of Pallas's squirrels occupied smaller and more overlapping areas and were in a weaker condition, while juveniles were smaller than in populations living without contact with alien species. Both species were feeding on the same seeds, and the food niche overlap was very high in relation to the seeds of different tree species.
 It may be assumed that when the species is widely distributed in Poland a significant decrease of the red squirrel population will be observed.

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 X	level of confidence
----------	------------------------	-----	--------	------------------	---------------------

acom15. Comments:
 There is no data on the possibility of cross-breeding of Pallas's squirrel with native red squirrel. The two species belong to different genera.

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

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

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

acom16. Comments:
 The Pallas's squirrel can carry parasites into the introduction regions, acting as a vector. In Japan, the species is host to six new macro-parasites, four of which are probably introduced together with it (Bertolino and Lurz 2011 – P).
 At least 16 taxa of pathogens, parasites and disease agents are associated with this species, including 4 species of nematodes and 3 species of fleas (Najberek 2018 – N). The species is

a vector of 1 pathogen that is subject to mandatory notification (tularemia). The disease is carried by fleas, fleas may transmit the disease to wild rodents and lagomorphs.

It is possible that the nematodes of the genus *Strongyloides* found in *C. erythraeus*, including *S. callosiureus* (Najberek 2018 – N) may be transferred to the native squirrel. Therefore, it can be assumed that a species is a host or vector of at least 1 parasite, which infects native species of particular concern (e.g. red squirrel), causing at most a small decline of their population or infects other native species causing a serious decline of their population.

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		

acomment17. Comments:
Lack of data on the influence of Pallas's squirrel on disturbance of abiotic factors in the ecosystem.

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		

acomment18. Comments:
Feeding on tree seeds has a negative effect on natural regeneration in Japan (UNEP-WCMC 2010 – I). It has been shown in Argentina that, since the Pallas's squirrels willingly inhabit areas transformed by man, including gardens where foreign species of trees and shrubs grow, they contribute to their spread into the Pampas (grassland areas in South America) (distribution in the digestive tract) (Bobadilla et al. 2016 – P). The species also damages the trees by gnawing the bark. These damages can lead to i.a. reduction of growth and deformation of trees. Threats to stands (forests, parks and crops) were recorded in the local populations of the species in the Netherlands, France and Belgium (Dijkstra et al. 2009 – P, Stuyck et al. 2009 – P, Chapuis and Menigaux 2010 – P). Gnawing bark of trees may cause their dieback, which in the case of high squirrel density may result in disturbance in functioning of a stand.
In the worst-case scenario, the spread of the species in Poland, may result in changes difficult to reverse, concerning processes occurring in habitats that do not belong to special care habitats (e.g. cultivations of forest trees).

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 X	high	level of confidence
----------	------------------------	-----	--------------------	------	---------------------

acomm19.	Comments: <p>Within its natural range (Taiwan) the species causes damage to coniferous tree plantations. Bark gnawing reduces the market value of the wood and can lead to tree dieback. This phenomenon is also observed in France, Japan and Argentina, where Pallas's squirrel is an alien species, although no precise quantitative data are available (Tamura and Ohara 2005 – P, Palmer and others 2007 – P, Bertolino and Lurz 2011 – P). On the island of Izu-Oshima (Japan), the seeds of <i>Camellia japonica</i>, an important cultivational species, are largely destroyed by squirrels. The issue is so serious that some farmers stop growing them. Bark gnawing on coniferous tree plantations in Taiwan and Japan: up to 80-90% of trees were destroyed on Japanese cypress <i>Chamaecyparis obtusa</i> plantations (CABI 2018 – B). In Argentina and Japan, squirrels also cause damage to fruit tree plantations (e. g. citrus fruit, pears or nuts; Palmer et al. 2007 – P, Bertolino and Lurz 2011 – P). Squirrels are also predicted to cause damage to forestry and agriculture in Europe (UNEP-WCMC 2010 – I): it is estimated that this species can cause damage to fruit crops in southern France by gnawing bark from fruit trees and bushes, eating fruit and olives on plantations. In Belgium, on the other hand, the species causes damage by gnawing bark from trees. The squirrel can cause significant damage to fruit tree plantations by gnawing bark of trees, as pointed out by Chapuis and Menigaux (2010 – P) in France.</p> <p>It is predicted that the impact will affect less than 1/3 of the crops being invaded (low probability), and in the worst-case scenario the condition of plants or the harvest of a single crop may be reduced by more than 20% (result - high).</p>
----------	---

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

acomm20.	Comments: The species is not a plant.
----------	--

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

<input checked="" type="checkbox"/>	inapplicable
<input type="checkbox"/>	no / very low
<input type="checkbox"/>	low
<input type="checkbox"/>	medium
<input type="checkbox"/>	high
<input type="checkbox"/>	very high

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

acomm21. Comments:
The species is not a plant.

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

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

aconf18. Answer provided with a

low	medium	high
	X	

 level of confidence

acomm22. Comments:
Forest damage caused by the Pallas's squirrel may deter introduction of valuable deciduous and coniferous species to the forest, as is the case with the eastern gray squirrel in Great Britain. This may result in the deterioration of crop structure and, as a consequence, reduce forest ecosystem species diversity, leading to reduced resistance to pests, diseases and climatic factors (Forestry Commission England 2014 – I).
The impact on fruit crops is difficult to assess due to the lack of detailed data. However, the species may cause significant damage to fruit tree plantations, as Chapuis and Menigaux have indicated in France (2010 – data type P).
It is predicted that the impact of the species will affect from 1/3 to 2/3 of the crop (probability- medium), and in the worst-case the condition of plants or the harvests of a single crop will be reduced by ca. 5% to ca. 20% (result – medium).

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

 level of confidence

acomm23. Comments:
There is no reason to believe that the Pallas's squirrel may be a host or a vector of pathogens harmful to plants and parasites.

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 X	medium	high	level of confidence
----------	------------------------	-----------------	--------	------	---------------------

acomm24. Comments:
 There are no reports on predation of the species on farmed animals, except for one on Pallas's squirrels eating eggs on bird farms in Argentina (Bertolino and Lurz 2011 – P).
 It can be assumed that this phenomenon is of incidental character (less than one predatory or parasitic case per year on 100 000 livestock or domestic animals) (probability – low), but due to predation, the effectiveness of breeding on farms may be reduced (result – medium).

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

X	very low
	low
	medium
	high
	very high

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

acomm25. Comments:
 If the Pallas's squirrel is attacked by a dog or cat, it can potentially bite the animal, especially in urban areas, where such contacts can occur frequently. However, such situations are rare.
 It can be assumed that there will be less than one direct contact with 100 000 livestock or domestic animals per year, resulting in mild signs of disease, short illness and a full recovery.

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

	inapplicable
	very low
	low
	medium
X	high
	very high

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

acomm26. Comments:
 At least 16 taxa of pathogens, parasites and disease agents are associated with Pallas's squirrel, including 4 species of nematodes and 3 species of fleas (Najberek 2018 – N).
 However, in recent years, a new cyclovirus has been detected in Pallas's squirrels in Japan. Although the pathogenicity of the virus for vertebrate animals has not been conclusively confirmed this is the first report on the possibility of transmitting zoonoses by this species (Sato et al. 2015 – P). Studies conducted in Japan have shown the presence of three ectoparasites (*Haemaphysalis flava*, *Ceratophyllus anisus*, *Neohaematopinus callosciuri*), which potentially may be vectors of i.a. rickettsiae causing typhus, *Yersinia pestis* rods causing plague and bacteria causing tularemia (Shinozaki et al. 2004 a, b – P). Research in Argentina has shown that squirrels were carriers of fleas and mites that are potential vectors of animal diseases (Gozzi et al. 2012 – P), i.e. tularemia, which is highly infectious for rabbits. Studies carried out in Europe (France and Belgium) showed that Pallas's squirrels had a low level of infestation by macro-parasites, hence the risk of transmission to native animal species was low (Dozieres et al. 2010 – P).

The species is a host or a vector of 1 pathogen/parasite which must be reported (tularemia); a disease caused by this pathogen/parasite may cause permanent damage to the animal's health and is not fully curable.

A4d | Impact on the human domain

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

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

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

aconf23. Answer provided with a

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

 level of confidence

acomm27. Comments:
The species is not a parasite.

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

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

aconf24. Answer provided with a

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

 level of confidence

acomm28. Comments:
It can be assumed that animals may bite, e.g. during feeding attempts (as in case of red squirrels, Krauze-Gryz D. – A). However, such events are unlikely to occur (medium probability) and the consequences should not be severe (result – low).

a29. The effect of *the species* on human health, by hosting **pathogens or parasites** that are harmful to humans, is:

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

aconf25. Answer provided with a

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

 level of confidence

acomm29. Comments:
At least 16 taxa of pathogens, parasites and disease agents are associated with this species, including 4 species of nematodes and 3 species of fleas (Najberek 2018 – N). A new cyclovirus was detected in Pallas's squirrels in Japan. Although the pathogenicity of the virus for humans has not been conclusively confirmed this is the first report on the

possibility of transmitting zoonoses by this species (Sato et al. 2015 – P). Studies conducted in Japan have shown the presence of three ectoparasites (*Haemaphysalis flava*, *Ceratophyllus anisus*, *Neohaematopinus callosciuri*), which potentially may be vectors of i.a. rickettsiae causing typhus, *Yersinia pestis* rods causing plague and bacteria causing tularemia (Shinozaki et al. 2004 a, b – P). Research in Argentina has shown that squirrels were carriers of fleas and mites that are potential vectors of human diseases (Gozzi et al. 2012 – P). Studies carried out in Europe (France and Belgium) showed that Pallas's squirrels had a low level of infestation by macro-parasites, hence the risk of transmission to native animal species or humans was low (Dozieres et al. 2010 – P).

There is at least 1 pathogen/parasite common for the species and humans, disease caused by this pathogen/parasite is dangerous (e.g. tularemia) and can cause permanent damage to health, is not fully treatable.

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:

In Argentina, squirrels gnaw on electrical and telephone cables elements of irrigation systems. They eat seeds from grain silos as well (Palmer et al. 2007 – P, Bertolino and Lurz 2011 – P, UNEP-WCMC 2010 – I).

In the Netherlands, cases of building damage were reported in the habitats of local population of the species (Dijkstra et al. 2009 – P).

Assuming that the species will be widely distributed in Poland, more than 1 but not more than 100 events per 100 000 objects per year can be expected and the impact of squirrels should be at least partially reversible.

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 X	high
-----	--------------------	------

 level of confidence

acomm31. Comments:
The destruction of trees by the Pallas's squirrel may cause damage to forests and agriculture, but the significance of damage to the entire supply services in Poland is difficult to assess. The Pallas's squirrels can also feed on birds' eggs on farms, eat fruit in orchards or affect crop harvests by damaging irrigation systems.

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

 level of confidence

acomm32. Comments:
The species can affect biological regulation (regulation of zoonosis) negatively by transmission of pathogens and parasites (i.e. tularemia).

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

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

aconf29. Answer provided with a

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

 level of confidence

acomm33. Comments:
Many people can perceive the presence of the species positively, just as the presence of native red squirrels is perceived. However, the expected (in the case of introduction to Poland) educating about negative role of this foreign species may counteract such a positive reception. Because the presence of the species may lead to a decrease in the red squirrel population and cause damage to forest and fruit crops, gardens and infrastructure, the presence of the species may also be assessed as very negative.

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

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

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

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

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

aconf30. Answer provided with a

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

 level of confidence

acomm34. Comments:
There are no reasons to believe that climate change will affect the likelihood of introduction of the species to Poland. All introductions of the species were intentional. Probability of its expansion is low and does not depend on climatic conditions but on distribution of the species across Europe and in neighbouring countries.

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

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

aconf31. Answer provided with a

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

 level of confidence

acomm35. Comments:
In Western Europe, the species is highly resistant to harsh winters that do not prevent the species from becoming established (Le Louarn and Quéré 2003 – P). However, it can be assumed that higher temperatures (especially in winter) resulting from climate change may be crucial for the species' survival and establishment in Poland, whose natural range covers areas much warmer than Poland.

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

 level of confidence

acomm36. Comments:
The species may spread in Poland even under the current climatic conditions, but higher temperatures (especially in winter), which can result in higher winter survivability will probably ease the process.

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

 level of confidence

acomm37. Comments:
A milder climate is likely to allow the population growth, therefore more negative impact on environment can be expected.

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

 level of confidence

acomm38. Comments:
A milder climate is likely to allow the population growth, therefore more negative impacts on plant crop can be expected.

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

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

aconf35. Answer provided with a

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

 level of confidence

acomm39. Comments:
A milder climate is likely to allow the population growth, therefore more negative impact on farmed animals can be expected.

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

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

aconf36. Answer provided with a

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

 level of confidence

acomm40. Comments:
A milder climate is likely to allow the population growth, therefore more negative impact on humans can be expected.

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
X	increase moderately
	increase significantly

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

acomm41.	Comments:
	A milder climate is likely to allow the population growth, therefore more negative impact on buildings and other infrastructure can be expected.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.17	0.83
Establishment (questions: a09-a10)	0.75	0.50
Spread (questions: a11-a12)	0.50	0.75
Environmental impact (questions: a13-a18)	0.46	0.67
Cultivated plants impact (questions: a19-a23)	0.33	0.67
Domesticated animals impact (questions: a24-a26)	0.33	0.33
Human impact (questions: a27-a29)	0.50	0.50
Other impact (questions: a30)	0.50	0.50
Invasion (questions: a06-a12)	0.47	0.69
Impact (questions: a13-a30)	0.50	0.53
Overall risk score	0.24	
Category of invasiveness	low 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:
	The Pallas's squirrels can reach densities much higher than those recorded for native species (Dozieres et al. 2015 – P). The Pallas's squirrels, including Pallas's squirrel, are an appealing element of parks and forests and evoke enthusiasm. Their removal from the environment may cause public resistance, as in the case of the eastern gray squirrel in Italy. Therefore, if the species is registered in the environment, immediate and strong action is needed.

Data sources

1. Published results of scientific research (P)

- Adriaens T, Baert K, Breyne P, Casaer J, Devisscher S, Onkelinx T, Pieters S, Stuyck J. 2015. Succesfull eradication of a suburban Pallas's squirrel *Callosciurus erythreus* (Pallas 1779) (Rodentia, Sciuridae) population in Flanders (northern Belgium). *Biological Invasions* 17: 2517-2526
- Bbadilla SY, Benitez VV, Guichon L. 2016. Asiatic *Callosciurus* squirrels as seed dispersers of exotic plants in Pampas. *Current Zoology* 62: 219
- Bertolino S, Lurz PW. 2011. *Callosciurus* squirrels: worldwide introductions, ecological impacts and recommendations to prevent the establishment of new invasive populations. *Mammal Review* 43: 22-33
- Bertolino S. 2009. Animal trade and non-indigenous species introductions: the world-wide spread of squirrels. *Diversity and Distributions* 15: 701-708
- Chapuis, J L, Menigaux, H. 2010. Etude de cas 7: l'écureuil a ventre rouge dans les Alpes Maritimes [in French]. In: Muller, S. and Soubeyran, Y. (eds.). Mieux agir contre les especes exotiques envahissantes. Conférence française pour la biodiversité, 10-12 mai 2010: 17
- Chung KPG, Corlett R. 2006. Rodent diversity in a highly degraded tropical landscape: Hong Kong, South China. *Biodiversity and Conservation* 15: 4521-4532
- Dijkstra, V, Overman, W, & Verbeylen, G. 2009. Inventarisatie Pallas' eekhoorn bij Weert. Zoogdiervereniging rapport 2009. 21. Arnhem, Nederland.
- Dozieres A, Pisanu B, Gerriet O, Lapeyere C, Stuyck J, Chapuis J-L. 2010. Macroparasites of Pallas's squirrels (*Callosciurus erythraeus*) introduced into Europe. *Veterinary Parasitology* 172: 172-176
- Dozieres A, Pisanu B, Kamnova S, Bastelica F, Gerriet O, Chapuis J-L. 2015. Range expansion of Pallas's squirrel (*Callosciurus erythreus*) intriduced in southern France: Habitat suitability and space use. *Mammalian Biology* 80: 518-526
- Gozzi AC, Guichon ML, Benitez VV, Lareschi M. 2013. Arthropod parasites of the red-bellied squirrel *Callosciurus erythraeus* introduced into Argentina. *Medical and Veterinary Entomology* 27: 203-208
- Guichón ML, Doncaster CP. 2008. Invasion dynamics of an introduced squirrel in Argentina. *Ecography* 31: 211-220
- Hori, M, Yamada, M, Tsunoda, N. 2006. Line census and gnawing damage of introduced Formosan squirrels (*Callosciurus erythraeus taiwanensis*) in urban forests of Kamakura, Kanagawa, Japan. In: Koike F. et al. (eds.), Assessment and control of biological invasion risks. pp. 204-209. Shoukadoh Books Sellers and IUCN, Kyoto, Japan and Gland, Switzerland
- Krauze D, Gryz J. 2012. Wiewiórka szara (*Sciurus carolinensis*) w Polsce: science fiction czy realne zagrożenie? *Studia i Materiały CEPL w Rogowie* 33: 327-334
- Le Louarn, H, Quéré, J-P. 2003. Les rongeurs de France : faunistique et biologie. INRA Editions
- Lin Y, Yo S. 1981. Population dynamics of the red-b ellied tree squirrel (*Callosciurus erythraeus*). *Bulletin of the Institute of Zoology, Academia Sinica* 20: 31-42
- Lurz PW, Hayssen V, Geissler K, Bertolino S. 2013. *Callosciurus erythreus* (Rodentia: Sciuridae). *Mammalian Species* 45: 60-74
- Martinoli A, Bertolino S, Preatoni DG, Balduzzi A, Marsan A, Genovesi P, Tosi G, Wauters LA. 2010. Headcount 2010: the multiplication of the grey squirrel introduced in Italy. *Hystrix Italian Journal of Mammalogy* 21: 127-136
- Mazzamuto MV, Bisi F, Wauters LA, Preatoni DG, Martinoli A. 2017a. Interspecific competition between alien Pallas's squirrels and Eurasian red squirrels reduces density of the native species. *Biological Invasions* 19: 723-735
- Mazzamuto MV, Morandini M, Panzeri M, Wauters LA, Preatoni DG, Martinoli A. 2017b. Space invaders: effects of invasive alien Pallas's squirrel on home range and body mass of native red squirrel. *Biological Invasions* 19: 1863-1877
- Messetta ML, Milesi FA, Guichon ML. 2015. Impacts of red-bellied squirrel on the bird community of the Pampas Region, Argentina. *Ecologia Austral* 25: 37-45
- Miyamoto, A, Tamura, N, Sugimura, K, Yamada, F. 2004. Predicting habitat distribution of the alien formosan squirrel using logistic regression model. *Global Environmental Research* 8: 13-21
- Palmer GH, Koprowski J, Pernas T. 2007. Tree squirrels as invasive species: conservation and management implications. In: Witmer GH, Pitt WC, Fagerstone KA. (eds.). *Managing Vertebrate Invasive Species*, pp. 273-282.

Proceedings of an International Symposium, USDA/APHIS/WS, National Wildlife Research Center, Fort Collins, CO

Sato G, Kawashima T, Kiuchi M, Tohya Y. 2015. Novel cyclovirus detected in the intestinal contents of Taiwan squirrels (*Callosciurus erythraeus thaiwanensis*). *Virus Genes* 51: 148-151

Setoguchi P. 1990. Food habits of red-bellied tree squirrels on a small island in Japa. *Journal of Mammalogy* 71: 570-578

Shinozaki Y, Shiibashi T, Yoshizawa K, Murata K, Kimura J, Maruyama S, Hayama Y, Yoshida H, Nogami S. 2004a. Ectoparasites of the Pallas squirrel, *Callosciurus erythraeus*, introduced to Japan. *Medical and Veterinary Entomology* 18: 61-63

Shinozaki Y, Yoshizawa K, Murata K, Shiibashi T, Kimura J, Maruyama S, Hayama Y, Yoshida H, Nogami S. 2004b. The first record of sucking louse, *Neohaematopinus callosciuri*, infesting Pallas squirrels in Japan. *Parasitology* 66: 333-335

Stuyck, J, Baert, K, Breyne, P, Adriaens, T. 2009. Invasion history and control of a Pallas squirrel *Callosciurus erythraeus* population in Dadizele, Belgium. Proceedings of the Science Facing Aliens Conference, Brussels, 11th May 2009.

Tamura N, Ohara S. 2005. Chemical components of hardwood barks stripped by the alien squirrel *Callosciurus erythraeus* in Japan. *Journal of Forest Research* 10: 429-43

2. Databases (B)

CABI. 2018. *Callosciurus erythraeus* (Pallas's squirrel) [Original text by Tamura N. In: Invasive Species Compendium. Wallingford, UK: CAB International (<https://www.cabi.org/isc/datasheet/91200>) Date of access: 2018-01-17

Duckworth, J W, Timmins, R J, Molur, S. 2017. *Callosciurus erythraeus*. In: The IUCN Red List of Threatened Species. e.T3595A22254356. <http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T3595A22254356.en>. (<http://www.iucnredlist.org/details/3595/0>) Date of access: 2018-01-31

3. Unpublished data (N)

Najberek K. 2018. (in preparation). Pathogens, parasites and diseases of invasive alien species in European concern.

4. Other (I)

Forestry Commission England. 2014. Grey Squirrels and England's Woodland. Policy and Action. Department for Environment, Food and Rural Affairs. ([https://www.forestry.gov.uk/pdf/Grey-squirrels-policy-and-action-plan.pdf/\\$FILE/Grey-squirrels-policy-and-action-plan.pdf](https://www.forestry.gov.uk/pdf/Grey-squirrels-policy-and-action-plan.pdf/$FILE/Grey-squirrels-policy-and-action-plan.pdf)) Date of access: 2018-02-27

Lasy Państwowe. 2018. Polskie Lasy. (<http://www.lasy.gov.pl/pl/nasze-lasy/polskie-lasy>) Date of access: 2018-01-17

Commission Implementing Regulation (EU) 2016/1141 of 13 July 2016 adopting the list of invasive alien species identified of Union concern pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council. Official Journal of the European Union L 189/4. 07.14.2016

Shockert V. 2012. Risk analysis of the Pallas's squirrel, *Callosciurus erythraeus*. Risk analysis report of non-native organisms in Belgium Cellule interdepartementale sur les Espèces Invasives (CiEi), DG03, SPW/Editions

UNEP-WCMC. 2010. Review of *Callosciurus erythraeus* and *Sciurus niger*. UNEP-WCMC, Cambridge

5. Author's own data (A)

–