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. Grzegorz Cierlik – external expert
2. Wojciech Bielański – external expert
3. Wojciech Solarz

acomm01. Comments:

	degree	affiliation	assessment date
(1)	mgr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	15-12-2017
(2)	dr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	18-12-2017
(3)	dr	Institute of Nature Conservation of the Polish Academy of Sciences in Cracow	18-12-2017

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

Polish name: Ibis czczony

Latin name: ***Threskiornis aethiopicus*** (Latham, 1790)

English name: Sacred ibis

Współfinansowano w ramach projektu nr POIS.02.04.00-00-0100/16 pn. *Opracowanie zasad kontroli i zwalczania inwazyjnych gatunków obcych wraz z przeprowadzeniem pilotażowych działań i edukacją społeczną* ze środków Unii Europejskiej w ramach Programu Infrastruktura i Środowisko 2014-2020

acomm02.	Comments:

Polish name (synonym I) –	Polish name (synonym II) –
Latin name (synonym I) *Tantalus aethiopicus*	Latin name (synonym II) –
English name (synonym I) African Sacred Ibis	English name (synonym II) –

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
X	alien, present in Poland in the environment, not established
	alien, present in Poland in the environment, established

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

acomm04.	Comments: The Avifaunistic Commission of the Ornithological Section of the Polish Zoological Society (KF 2018 – I) has classified this species into category E of non-native avifauna (species escaped from captivity, as well as unintentionally and intentionally introduced, which do not create viable populations; an unnatural occurrence). It has been observed sporadically in the natural environment of Poland (about 9 known reports in 1993-2010: 1993 – 1 report; 2001 – 3 reports; 2006 – 1 report; 2009 – at least 8 reports, most likely the same 2 individuals, later one of these two; 2010 – 3 reports, KF 2010, 2011 – P, KF 2012, 2018b – I, Solarz 2017 – A). Usually, reports concern single individuals or pairs. It does not breed in Poland (Alien species in Poland 2018 – B).

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

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

acomm05.	Comments: The species has a negative impact on the natural environment, and potentially can also have a negative impact on production animals and the human domain. The impact on the environmental domain is manifested mainly through predation on species of waterbirds, including terns, waders and seabirds (Clergeau and Yésou 2006, Clergeau et al. 2010 – P) and through competition for nest sites with herons *Ardeidae* (Yésou and Clergeau 2005 – P). The potential negative impact on the natural environment, production animals and humans is associated with the risk of sacred ibises transmitting dangerous pathogens, including avian influenza virus A H5N8, bacteria *Chlamydia* spp., *Salmonella* spp. and *Pasteurella multocida* (Crawford 1992, Bastian et al. 2010, Vorimore et al. 2013 – P, OIE 2017 – I), which can cause death or serious diseases in wild and domesticated animals, and humans. When present in large colonies, the species can have a negative impact on infrastructure through soiling it with droppings, which can lead to damage and destruction.

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:

X	low
	medium
	high

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

acomm06. Comments:

The species is very unlikely to occur in the natural environment of any of the countries neighbouring Poland (Robert et al. 2013 – P, CABI 2018 – B). However, it is kept in many zoos in countries surrounding Poland (Zootierliste 2018 – B). The sacred ibis has established populations in France, Italy and the Netherlands (Robert et al. 2013 – P, BuWa 2018 – I). Despite its great mobility, the probability of the species expanding into Poland's natural environment as a result of self-propelled expansion from populations in Western Europe is low.

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

X	low
	medium
	high

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

acomm07. Comments:

All previous reports on the species in Poland most likely concern individuals that escaped from captivity. The probability of the species being introduced into Poland by unintentional human actions, e.g. as a hitchhiker, is low.

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

	low
X	medium
	high

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

acomm08. Comments:

According to the CITES database, a total of 22 sacred ibises have been imported to Poland under exchange agreements between zoos (3 from the Netherlands in 1995, 9 from the Czech Republic in 1998, and 10 from Germany in 1998; CITES 2018 – B). At present, 3 zoos in Poland (Topola 2017 - P) and several dozen zoos in other European countries, including Germany, Denmark, Sweden, the Czech Republic, Hungary, Lithuania and Latvia, keep individuals of this species (Zootierliste 2018 – B). Certainly, these birds are also kept by private owners as decorative and exotic animals, although their number is unknown. There are still sales offers from private breeders on the internet, evidencing illegal trade and reproduction. Escapes from captivity, mainly from zoos (especially those where these birds

can fly freely), are probably the source of all introductions of this species in European countries (Smits et al. 2010, Wright 2011, Robert et al. 2013 – P), including Poland (Kepel 2001 – P, KF 2018a – I). The species is very mobile. It has been speculated, for example, that some of the birds spotted in the Netherlands and Great Britain could come from established populations in France, located hundreds of kilometres away (Smits et al. 2010, Wright 2011 – P). The number and frequency of reports on this species made to date in Poland indicate that the probability of its introduction into the natural environment, mainly due to escapes from captivity in Poland and surrounding countries, should not be higher than 1 to 10 cases per decade.

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

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

acomm09. Comments:

The climate in Poland is significantly different from that in the native range of the species, as well as in the main area of the European introductions, i.e. in western France (see Fig. 1 in *Harmonia*[+PL] document – Procedure of negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland). Nevertheless, the Polish climate is to some degree similar to that in the Netherlands, where sacred ibises have repeatedly bred successfully (Smits et al. 2010 – P), and in Belgium, where nesting attempts have been observed (Robert et al. 2013 – P). The species is highly adaptable to various climatic and habitat conditions (Clergeau and Yésou 2006 – P, CABI 2018 – B), as evidenced by its expansion and establishment in the northern part of Western Europe. Nevertheless, it is suspected that in the Netherlands, in addition to the containment measures of ibises from captivity introduced in 2008, the free-living population was significantly reduced (to approx. 4 individuals in 2010) because of high mortality rates during the harsh winter of 2008/2009 (Smits et al. 2010 – P, BuWa 2018 – I). There is a lack of information about the capacity of free-living sacred ibises to survive typical winters in Poland, which are usually colder than in the Netherlands. Wintering seems possible, although it would probably depend on access to food supplied by humans (see France, Yésou and Clergeau 2005 – P; the Netherlands, Smits et al. 2010 – P).

a10. Poland provides **habitat** that is

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

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

acomm10. Comments:

The species shows high plasticity and adaptability to new conditions. It can live in a wide spectrum of habitats, such as wetlands, often around lakes and rivers, wet meadows, reedbeds, coastal areas, estuaries, agricultural areas and even suburban habitats (Clergeau and Yésou 2006 – P). It forages on wet meadows, marshes, reedbeds and ploughed fields,

	in farmyards, poultry farms, on landfills, around sewage treatment plants, etc. (Clergeau and Yésou 2006 – P, CABI 2018 – B). It nests in trees, in scrubs, and on the ground, often in colonies with other species, e.g. cormorants, herons, and spoonbills (del Hoyo et al. 1992, Kopij 1999, Clergeau and Yésou 2006 – P). There are many habitats in Poland suitable for this species. However, a significant obstacle for its establishment may be the limited availability of (natural) food during cold winters, when the snow cover is thick. For example, it was suspected that the high growth rate of the Dutch population in 2001-2007 could have been strongly influenced by winter feeding and the inflow of subsequent sacred ibises escaped from captivity (Smits et al. 2010 – 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: Spread of populations (Data type: B) The species is nomadic in a large part of its range, shows great mobility, and spreads fast to new areas. In addition, it is long-lived and has a high breeding success, which in the areas of its introduction can be even higher than in the natural range (Smits et al. 2010, Robert et al. 2013 – P). Rozprzestrzenianie się gatunku ułatwia powszechne korzystanie z pokarmu pochodzenia antropogenicznego. However, the effect of predators, parasites or diseases that could be limiting population growth has not been proven (Robert et al. 2013 – P). The rate of dispersal of this species is well illustrated by the history of the population from western France: in 1993 the first feral breeding colonies were observed within a radius of 25 and 70 km from the site where the birds were released (the Branféré zoological garden); by 1998 their number increased to 130 pairs, and new colonies were formed within a radius of up to 350 km from the site of release (Clergeau and Yésou 2006 – P); the total breeding population increased exponentially – to approx. 450 pairs in 2001, approx. 1100 pairs in 2005, and 1700 pairs (5000 individuals) in 2006 (Clergeau and Yésou 2006, Smits et al. 2010 – P). The species dispersed mainly along the Atlantic coast and the Loire River, but single individuals were reported within a radius of hundreds of kilometres, even near the border with Belgium (e.g. Clergeau and Yésou 2006 – P).

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:

There are no known cases of the dispersal of the species from populations in the wild by human actions. Escapes from zoos and other sites of captivity have taken place in many European countries, including Poland (Smits et al. 2010, Robert et al. 2013 – P). The species is probably still illegally bred and traded in Poland. Further escapes are possible, and their frequency (based on previous reports on the species in Poland) is not expected to exceed 10 cases per decade.

A4a | Impact on the environmental domain

Questions from this module qualify the consequences of *the species* on wild animals and plants, habitats and ecosystems.

Impacts are linked to the conservation concern of targets. Native species that are of conservation concern refer to keystone species, protected and/or threatened species. See, for example, Red Lists, protected species lists, or Annex II of the 92/43/EWG Directive. Ecosystems that are of conservation concern refer to natural systems that are the habitat of many threatened species. These include natural forests, dry grasslands, natural rock outcrops, sand dunes, heathlands, peat bogs, marshes, rivers & ponds that have natural banks, and estuaries (Annex I of the 92/43/EWG Directive).

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

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

	inapplicable
	low
X	medium
	high

aconf09. Answer provided with a

low	medium	high
	X	

level of confidence

acomm13. Comments:

The sacred ibis is an omnivorous bird, wykorzystującym pokarm najłatwiejszy do zdobycia. It feeds mainly on insects and their larvae, annelids, crustaceans and molluscs, but also eats fish, amphibians, reptiles, bird eggs and chicks, small mammals, carrion, food waste and seeds, depending on their availability (Clergeau et al. 2010, Marion 2013, Robert et al. 2013 – P). It often forages in large flocks, and can travel even tens of kilometres in search of food. Several individuals (out of 400), specialized in predation on seabird colonies, were reported from marine islands in the native range of the sacred ibis in South Africa (Williams and Ward 2006 - P). In the areas where the sacred ibises were introduced in France, predation was confirmed or suspected on eggs and nestlings of wetland birds, especially terns, herons, ducks, seabirds and waders (Clergeau and Yésou 2006, Clergeau et al. 2010 – P). The reported case of two ibises plundering a whole colony of the sandwich tern *Sterna sandvicensis* within a few hours (Yésou and Clergeau 2005 – P) was questioned (Marion 2013 – P). If the species spreads throughout Poland, its potential impact on native fauna through predation could occur in many protected areas and cover a range of rare species and species of special concern (subject to strict protection under the regulation of the Minister of the Environment of 16 December 2016 on the protection of animal species, as well as those listed in the Polish Red Data Book of Animals and in Annex I of the Birds Directive), primarily terns, waders, ducks, grebes and herons. In France, predation of sacred ibises has been found with regard to the following species, which in Poland should be regarded as species of special concern: sandwich tern, whiskered tern *Chlidonias hybrida*, black tern *Chlidonias niger*, common tern *Sterna hirundo*, black-winged stilt *Himantopus himantopus*, and lapwing *Vanellus vanellus* (Clergeau and Yésou 2006, Clergeau et al. 2010 – P). For example, the predation of sacred ibises on the only breeding colony of sandwich tern in Poland could have a significant

impact on the state of the whole Polish population of this species; a similar negative impact is possible from predation on the clutches of bird species extremely rare in Poland, such as Eurasian curlew *Numenius arquata*, black-tailed godwit *Limosa limosa*, oystercatcher *Haematopus ostralegus*, or ringed plover *Charadrius hiaticula*. In addition, sacred ibises may also have a negative impact on endangered species of amphibians, as suggested (without confirmation), e.g. in France with respect to newts (Yésou and Clergeau 2005 – P).

The negative impact of sacred ibis predation on native fauna is debatable and seems to be poorly investigated. The above-mentioned examples from France seem to confirm this impact (Clergeau et al. 2010 – P), but Marion (2013 – P), based on long-term studies in the same area, showed that no bird species is really threatened by predation because the diet of ibises consists mainly of aquatic invertebrates and a small amount of waste from landfill sites, while the share of vertebrates is negligible and they are completely accidental food. There is also no clear evidence of the significant impact of ibises' predation on any of the species endangered in Europe or globally (acc. to BirdLife Int. and IUCN criteria). In view of the above, it was considered that if the sacred ibis spreads on a wide scale in Poland, it would cause a small decline in the population of native species of special concern.

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:

After the increase of the sacred ibis population in southern France, its competition for nest sites with the cattle egret *Bubulcus ibis* and the little egret *Egretta garzetta* was observed (Yésou and Clergeau 2005 – P) and pairs of both species were forced to leave their colony. It has been suspected that this impact may also concern other colonial species with habitat requirements similar to ibises, such as the spoonbill *Platalea leucorodia* and several ardeids (Kopij 1999, Smits et al. 2010 – P). In Poland, the sacred ibis could potentially compete for nest sites with an important native species of special concern, the night heron *Nycticorax nycticorax* (under strict and active protection, Annex I of the EU Birds Directive, Polish Red Data Book of Animals). There is no information on competition for food with other species, although it seems that it may be significant if the population of sacred ibis becomes large, and will concern birds that prefer a similar diet (mainly aquatic invertebrates, annelids, crustaceans, molluscs). Considering the above, it was assessed that the sacred ibis may cause a small decline in the population of species of special concern.

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:

Interbreeding of the sacred ibis and native species has not been reported. However, hybrids with other non-native ibises from the *Threskiornithidae* family are known, including *Platalea alba*, *Eudocimus ruber*, *Threskiornis melanocephalus*, *Threskiornis molucca*, and *Threskiornis spinicolli*s (McCarthy 2006 – P). The potential impact of unreported but possible interbreeding with the spoonbill *Platalea leucorodia,* a species related to the sacred ibis and a rare migrant to Poland, is very low.

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 **X**	high	level of confidence

acomm16. Comments:

The sacred ibis is known to host pathogens responsible for the most serious animal diseases, listed by the World Organization for Animal Health (OIE): highly pathogenic avian influenza virus A H5N8 (OIE 2017 - I), causing high mortality among wild birds (all bird species are susceptible to it); bacteria *Chlamydia ibidis* and *Chlamydia psittaci* (Vorimore et al. 2013 – P), causing chlamydiosis in wild birds, which can lead to serious diseases and even the death of birds; *Salmonella* spp. (Bastian et al. 2010 – P), causing salmonellosis in various groups of wild animals, and in birds also fowl typhoid and pullorum disease; infections with some *Salmonella* serovars may be incurable and lead to death. Moreover, mortality of ibises in southern Africa caused by infection with the bacterium *Pasteurella multocida* (Crawford 1992 – P; pathogen not listed by OIE) was reported; the pathogen causes dangerous avian cholera, very common in birds from wetland habitats. It is believed that sacred ibises can potentially pose a high risk by transmitting various diseases and parasites because of their foraging strategy (often in large flocks), the diversity of visited places, including those that promote the development and transmission of parasites and pathogens (landfills and rubbish bins, sewage works, silos, slurry pits), foraging on free-range poultry farms, pastures, and also the possibility of contact with many wild bird species on nesting and foraging sites and night roosts. However, the transmission of pathogens and parasites between the sacred ibis and other species has not yet been confirmed, and the prevalence and intensity of detected infections was low (Bastian et al. 2010, Wright 2011, Robert et al. 2013 – P). Therefore, there is no evidence that the sacred ibis poses a greater risk in this respect than native species (cf. Marion 2013, Robert et al. 2013 – 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 **X**	level of confidence

acomm17. Comments:

The negative impact of the species on ecosystem integrity by affecting its abiotic properties has not been reported. This refers both to the natural range of the species and regions of its introduction. Potentially, a significant faecal deposition under large breeding colonies or roost sites of sacred ibises can increase the fertility of soil and cause eutrophication of waters, which in turn may cause changes in the composition and/or succession of plant communities and the functioning of organisms within the ecosystem. However, the effect of the species on ecosystem integrity caused by these processes has been assessed as low.

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 **X**	high	level of confidence

acomm18. Comments:

Ibises foraging in large groups can cause local quantitative and qualitative changes in the fauna of invertebrates, which is the staple food of this species. Predation, competition for nest sites and depletion of the food base used by other species (mainly birds) can potentially cause the decline or withdrawal of some species from places which are under particularly strong pressure from the sacred ibis, and this may disturb inter-species relationships at the ecosystem level. If the species spreads on a wide scale in Poland, such impact could be seen in many habitats of special concern, located in valuable natural areas, such as the Ramsar wetlands, Natura 2000 sites, or important bird areas of international significance (IBAs). Some reports also suggest that sacred ibises in large densities may cause damage around the breeding colonies, roosts and foraging sites, by trampling vegetation and the production of large amounts of droppings, causing the death of trees, shrubs and grassy vegetation, often observed, e.g. in colonies of herons and cormorants (Robert et al. 2013 – P, CABI 2018 – B). There is no evidence for the significant contribution of the sacred ibis to the above-mentioned processes, and if such impacts occur, their scale will probably be limited. Therefore, the effect of the species on ecosystem integrity by affecting its biotic properties has been assessed as medium.

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 diet of sacred ibises includes small amounts of seeds, e.g. cereal grains (Clergeau and Yésou 2006, Marion 2013 – P), and in Florida sabal palm fruits (Herring and Gawlik 2008 – P). Therefore, there are some concerns about the risk of damage in crops caused by ibises (Robert et al. 2013 – P). Some researchers also suggested that foraging sacred ibises may damage winter wheat seedlings (Blair et al. 2000 – P). However, the sacred ibis prefers animal food, and its significant negative impact on cultivated plants has not been proven anywhere, even in areas where its population spread on a wide scale.

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: The sacred ibis is not a plant species.

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 sacred ibis is not a plant species.

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: The effect of the species on cultivated plant targets by affecting the cultivation system's integrity has not been proven and is very unlikely.

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 has been no evidence of the transmission of pathogens or parasites that are harmful to cultivated plants by the sacred ibis, and this risk is very low.

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
X	very low
	low
	medium
	high
	very high

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

acomm24. Comments:

So far, no cases of predation of sacred ibises on companion animals or production animals have been reported, although the species often forages in farmyards or free-range poultry farms (Clergeau and Yésou 2006 – P). Because the diet of this species also includes fish and molluscs, it has been suggested that it may potentially contribute to losses in fisheries (Clergeau et al. 2010 – P). The probability of predation on production animals or companion animals in Poland is low, and the impact of the species on the health of single animals or animal production is low.

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	high **X**	level of confidence

acomm25. Comments:

To date, no negative effect of the species on individual animal health or animal production by having properties that are hazardous upon direct contact has been reported for this species.

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 **X**	high	level of confidence

acomm26. Comments:

The sacred ibis is known to host pathogens responsible for the most serious animal diseases, listed by the World Organization for Animal Health (OIE): highly pathogenic avian

influenza virus A H5N8 (OIE 2017 - I), causing high mortality among production birds; bacteria *Chlamydia ibidis* and *Chlamydia psittaci* (Vorimore et al. 2013 – P), causing chlamydiosis in production birds, which can lead to serious diseases and even death; *Salmonella* spp. (Bastian et al. 2010 – P), causing salmonellosis in various groups of production animals, and in birds also fowl typhoid and pullorum disease; infections with some *Salmonella* serovars may be incurable and lead to death. Moreover, mortality of ibises in southern Africa caused by infection with the bacterium *Pasteurella multocida* (Crawford 1992 – P; pathogen not listed by OIE) was reported; the pathogen causes dangerous avian cholera, also in poultry species. It is believed that sacred ibises can potentially pose a high risk by transmitting various diseases and parasites to production animals, because of their foraging strategy (often in large flocks), the diversity of visited places, including those that promote the development and transmission of parasites and pathogens (landfills and rubbish bins, sewage works, silos, slurry pits), and feeding on free-range poultry farms and pastures. However, the transmission of pathogens and parasites between the sacred ibis and production animals has not yet been confirmed, and the prevalence and intensity of detected infections was low (Bastian et al. 2010, Wright 2011, Robert et al. 2013 – P). Therefore, there is no evidence that the sacred ibis poses a greater risk in this respect than native species (cf. Marion 2013, Robert et al. 2013 – P).

A4d | Impact on the human domain

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

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

X	inapplicable
	very low
	low
	medium
	high
	vert high

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

acomm27. Comments:

The sacred ibis is not a parasitic species.

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:

To date, no negative effect of the species on human health by having properties that are hazardous upon direct contact has been reported for this species.

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

	inapplicable
	very low
	low
X	medium
	high
	very high

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

acomm29. Comments:

The sacred ibis is known to host pathogens that may be transmitted to humans and cause serious diseases: highly pathogenic avian influenza virus A H5N8 (OIE 2017 - I), causing high morbidity and mortality among poultry, and potentially deadly to humans, but so far no cases of human infection have been reported (WHO 2016 – I); bacteria *Chlamydia ibidis* and *Chlamydia psittaci* (Vorimore et al. 2013 – P), responsible for avian chlamydiosis, which may be transmitted to humans and cause serious symptoms, e.g. acute pneumonia; bacteria *Salmonella* spp. (Bastian et al. 2010 – P), some strains can cause salmonellosis and typhoid fever in humans. All these diseases are regarded as completely curable. It is believed that sacred ibises can potentially pose a risk by transmitting various zoonotic diseases and parasites, because of their foraging strategy (often in large flocks), the diversity of visited places, including those that promote the development and transmission of parasites and pathogens (landfills and rubbish bins, sewage works, silos, slurry pits), foraging in farmyards, pastures, free-range poultry farms, and also the possibility of contact with many wild birds in nesting, foraging and roost sites (Bastian et al. 2010, Wright 2011, Robert et al. 2013 – P). However, the transmission of pathogens and parasites between the sacred ibis and humans has not yet been confirmed, and the prevalence and intensity of infections detected in sacred ibises was low (Bastian et al. 2010, Wright 2011, Robert et al. 2013 – P). Therefore, there is no evidence that the sacred ibis poses a greater risk in this respect than native species (cf. Marion 2013, Robert et al. 2013 – P).

A4e | Impact on other domains

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

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

	very low
X	low
	medium
	high
	very high

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

acomm30. Comments:

In the native range (e.g. in Kenya) there are reports on collisions of sacred ibises with airplanes, because these birds eagerly forage on grassy, mown airports (Owino et al. 2004 – P). Such collisions were also reported from Australia for a closely related Australian white ibis *Threskiornis molucca* (Martin et al. 2007 – P). In France, in attractive tourist areas, the destruction of trees by droppings in the colonies was suspected, ibisy przyczyniały się także do zniszczeń w salinach (niszczenie struktury zbiorników, obsypywanie grobli i zanieczyszczanie solanki; Robert et al. 2013 – P). The probability of the negative impact of sacred ibises on infrastructure in Poland was assessed as low, and the effect as medium.

A5a | Impact on ecosystem services

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

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

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

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

acomm31. Comments:

The diet of sacred ibises is known to include cereal grains (Clergeau and Yésou 2006, Marion 2013 – P), and in Florida sabal palm fruits (Herring and Gawlik 2008 – P), so potentially the species can cause losses in crops, but this has not been reported to date. Because the diet of this species also includes fish and molluscs, it has been suggested that it may potentially contribute to losses in fisheries (Clergeau et al. 2010 – P). The sacred ibis is known to host pathogens, such as avian influenza virus A H5N8, bacteria *Chlamydia* spp., *Salmonella* spp., *Pasteurella multocida*, which can cause mortality or serious diseases in production animals. However, the transmission of pathogens has not been reported so far. In France, ibisy negatywnie wpływały na produkcję soli w salinach (niszczenie struktury zbiorników, obsypywanie grobli i zanieczyszczanie solanki; Robert et al. 2013 – P).

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 effect on regulation services has been assessed as moderately negative. The species may have a negative effect on the control of dangerous animal and human diseases (including avian influenza virus A H5N8, bacteria *Chlamydia* spp., *Salmonella* spp. and *Pasteurella multocida*), and a negative effect on the control of pollution through the contamination or eutrophication of water and soil with droppings. Its impact on biological regulation through predation can be negative, e.g. when it causes a decline in the invertebrate fauna in ecosystems, but also positive, when it eats crop pests or invasive species; for example, studies in France demonstrated that the diet of the sacred ibis contains a significant proportion of invasive red swamp crayfish *Procambarus clarkii* (Marion 2013 - P).

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

	significantly negative
	moderately negative
X	neutral

	moderately positive
	significantly positive

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

acomm33. Comments:

Breeding of this species in zoos and other animal collections can serve aesthetic, recreational and educational purposes. As an aesthetically pleasing exotic species in Poland, the sacred ibis when introduced can be a great attraction for bird watchers and enthusiasts of nature. However, if the species spreads on a significant scale in Poland, the attitude of the public to this species will most likely change to negative, and the sacred ibis might be perceived as a pest, as is the synurbic Australian white ibis *Threskiornis molucca* in Australia (Martin et al. 2007 – P).

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

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

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

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

	decrease significantly
	decrease moderately
X	not change
	increase moderately
	increase significantly

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

acomm34. Comments:

The majority of introductions of the sacred ibis in Europe resulted from the release of birds from zoological gardens and other places of captivity, and therefore the expected climate change (warming) is unlikely to influence the capacity of the species to overcome geographical barriers. In addition, the species is highly adaptable to various climatic and habitat conditions (Clergeau and Yésou 2006 – P, CABI 2018 – B), as evidenced by its expansion and establishment in the northern part of Western Europe.

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 **X**	high	level of confidence

acomm35.	Comments: Climate warming could promote the establishment of the species in Poland, for example, because of milder conditions for overwintering. However, the climate does not seem to be decisive for the breeding success of the species, because, for example, in the moderate climate of France, ibises achieved higher success than in the tropics (Clergeau and Yésou 2006 – P).

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: Climate warming could create milder conditions for overwintering, and hence faster population growth and a higher rate of dispersal.

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 **X**	high	level of confidence

acomm37.	Comments: If climate change increases the probability of the species' dispersal (cf. section a36), the negative effect of the species on the natural environment (described in sections a13-a18) may also increase.

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 **X**	high	level of confidence

acomm38.	Comments: So far, the impact of the species on cultivated plants has not been proven, and it can be assumed that climate warming will not change this either.

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 **X**	high	level of confidence

acomm39. Comments:

If climate change increases the probability of the species' dispersal (cf. section a36), the negative impact of the species on animal production (described in sections a24-a26) may also increase.

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:

If climate change increases the probability of the species' dispersal (cf. section a36), the negative impact of the species on the human domain (described in sections a28-a29) may also increase.

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:

If climate change increases the probability of the sacred ibis' dispersal (cf. section a36), the negative impact of the species on other domains (described in sections a30) may also increase.

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.17	0.83
Establishment (questions: a09-a10)	0.50	0.50
Spread (questions: a11-a12)	0.75	0.75
Environmental impact (questions: a13-a18)	0.42	0.67
Cultivated plants impact (questions: a19-a23)	0.00	1.00
Domesticated animals impact (questions: a24-a26)	0.33	0.83
Human impact (questions: a27-a29)	0.25	0.75
Other impact (questions: a30)	0.25	1.00
Invasion (questions: a06-a12)	0.47	0.69
Impact (questions: a13-a30)	0.42	0.85
Overall risk score	0.20	
Category of invasiveness	potentially invasive alien species	

A6 | Comments

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

acomm42. Comments:
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