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Risk analysis of the Sacred Ibis, *Threskiornis aethiopicus* (Latham, 1790)

Risk analysis report of non-native organisms in Belgium

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Adopted in date of : 11 March 2013

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Contents

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Etienne Branquart (Cellule Espèces Invasives, Service Public de Wallonie) developed the risk analysis template that was used for this exercise.

The general process of drafting, reviewing and approval of the risk analysis for selected invasive alien species in Belgium was attended by a steering committee, chaired by the Federal Public Service Health, Food chain safety and Environment. RBINS/KBIN was contracted by the Federal Public Service Health, Food chain safety and Environment to perform PRA's for a batch of species. ULg was contracted by Service Public de Wallonie to perform PRA's for a selection of species. INBO and DEMNA performed risk analysis for a number of species as in-kind contribution.

Steering committee members were:

Tim Adriaens	Research Institute for Nature and Forest (INBO)
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Hugo Verreycken	Research Institute for Nature and Forest (INBO)

Rationale and scope of the Belgian risk analysis scheme

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species. It strongly promotes the use of robust and good quality risk assessment to help underpin this approach (COP 6 Decision VI/23). More specifically, when considering trade restrictions for reducing the risk of introduction and spread of a non-native organisms, full and comprehensive risk assessment is required to demonstrate that the proposed measures are adequate and efficient to reduce the risk and that they do not create any disguised barriers to trade. This should be seen in the context of WTO and free trade as a principle in the EU (Baker et al. 2008, Shine et al. 2010, Shrader et al. 2010).

This risk analysis has the specific aim of evaluating whether or not to install trade restrictions for a selection of absent or emerging invasive alien species that may threaten biodiversity in Belgium as a preventive risk management option. It is conducted at the scale of Belgium but results and conclusions could also be relevant for neighbouring areas with similar eco-climatic conditions (e.g. areas included within the Atlantic and the continental biogeographic regions in Europe).

The risk analysis tool that was used here follows a simplified scheme elaborated on the basis of the recommendations provided by the international standard for pest risk analysis for organisms of quarantine concern[1] *produced by the secretariat of the International Plant Protection Convention (FAO 2004). This logical scheme adopted in the plant health domain separates the assessment of entry, establishment, spread and impacts. As proposed in the GB non-native species risk assessment scheme, this IPPC standard can be adapted to assess the risk of intentional introductions of non-native species regardless the taxon that may or not be considered as detrimental (Andersen 2004, Baker et al. 2005, Baker et al. 2008, Schrader et al. 2010).*

The risk analysis follows a process defined by three stages : (1) the initiation process which involves identifying the organism and its introduction pathways that should be considered for risk analysis in relation to Belgium, (2) the risk assessment stage which includes the categorization of emerging non-native species to determine whether the criteria for a quarantine organism are satisfied and an evaluation of the probability of organism entry, establishment, spread, and of their potential environmental, economic and social consequences and (3) the risk management stage which involves identifying management options for reducing the risks identified at stage 2 to an acceptable level. These are evaluated for efficacy, feasibility and impact in order to select the most appropriate. The risk management section in the current risk analysis should however not been regarded as a full-option management plan, which would require an extra feasibility study including legal, technical and financial considerations. Such thorough study is out of the scope of the produced documents, in which the management is largely limited to identifying needed actions separate from trade restrictions and, where possible, to comment on cost-benefit information if easily available in the literature.

This risk analysis is an advisory document and should be used to help support Belgian decision making. It does not in itself determine government policy, nor does it have any legal status. Neither should it reflect stakeholder consensus. Although the document at hand is of public nature, it is

1 A weed or a pest organism not yet present in the area under assessment, or present but not widely distributed, that is likely to cause economic damages and is proposed for official regulation and control (FAO 2010).

important to realise that this risk assessments exercise is carried out by (an) independent expert(s) who produces knowledge-based risk assignments sensu Aven (2011). It was completed using a uniform template to ensure that the full range of issues recognised in international standards was addressed.

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted (after Baker et al. 2008):

2 *Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based;*

3 *The risk assessment deals with potential negative (ecological, economic, social) impacts. It is not meant to consider positive impacts associated with the introduction or presence of a species, nor is the purpose of this assessment to perform a cost-benefit analysis in that respect. The latter elements though would be elements of consideration for any policy decision;*

4 *Completed risk assessments are not final and absolute. New scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.*

Threskiornis aethiopicus (Photo : Johan Wessels, Wikimedia Commons).

Executive summary

PROBABILITY OF ESTABLISHMENT AND SPREAD (EXPOSURE)

- Entry in Belgium

The first Sacred Ibis in Belgium was recorded in 1989. At the present time and in the future it is highly likely that individuals will enter Belgium through any of the two following pathways: free flying populations from zoological parks or escapes from aviaries and dispersal from neighboring countries.

- Establishment capacity

Highly mobile, omnivorous and with a high capacity of adaptation to different habitats, *T. aethiopicus* has a strong propensity towards invasiveness. Belgium is located on the northern edge of the species geographic range and without local predators or any other control agents, the probability of establishment is rather high in most suitable habitats (including sites that are threatened or under particular conservation status, such as Ramsar sites and endangered areas).

- Dispersion capacity

With the characteristic of being an invasive species in the non-native range and, in some specific situations considered as a pest species in its native range, the Sacred Ibis benefits from human activities and human-influenced environments. Appreciated in zoos and private collections, the species was imported voluntarily and widely traded thanks to its high breeding success and adaptability. Many zoo individuals were given the possibility to fly freely and in some case escaped and formed feral populations. Once in the wild, individuals can disperse at considerable distances (up to several hundred kilometres) and establish in suitable habitats.

EFFECT OF ESTABLISHMENT

- Environmental impacts

Competition with other ciconiiformes and spoonbill for nesting space at colonies has been mentioned but is believed to have only limited effect on native species (at least at early stages of invasion). In case of important invasion, the strongest negative effect of *T. aethiopicus* in its non-native range is its tendency towards predation of eggs and nestlings of other colony birds (terns in particular) as well as of some amphibians.

RISK MANAGEMENT

Free moving *T. aethiopicus* from established populations in neighbouring countries (France and the Netherlands) can be considered as the main pathway of entry into Belgium. The other probability of entry in Belgium is from birds escaping from zoos (currently three in Belgium) and private collections.

The most effective action to prevent population establishment is to drastically restrict any importation and trade of this species. Legislation should be amended in order to set strict rules about captivity conditions for birds already in the area (e.g. obligation to keep birds with their wings

pinioned in secure cages, registered) and to strictly forbid release of these non-native birds into the wild (for recreational purpose). Preventive actions have been proven to be the most cost effective for this species.

In case of establishment into the wild, the most adapted population control practice is egg sterilisation and culling of flying birds (preferably away from the colony or on feeding grounds).

Résumé

PROBABILITE D'ETABLISSEMENT ET DE DISSEMINATION (EXPOSITION)

- Introduction en Belgique

Le premier Ibis sacré a été enregistré en Belgique en 1989. Actuellement et à l'avenir, il est fort probable que d'autres individus entreront en Belgique par l'une des deux voies suivantes: soit à partir de populations mises en liberté dans des parcs zoologiques ou d'échappés de volières, soit à partir d'oiseaux se dispersant depuis des populations établies dans les pays voisins.

- Capacité d'établissement

Très mobile, omnivore et présentant une grande capacité d'adaptation à différents habitats, *T. aethiopicus* montre une forte propension à l'envahissement. La Belgique est située sur la frange nord de la zone géographique de l'espèce et sans prédateurs locaux ou tout autre agent de contrôle, la probabilité d'établissement de cette espèce est relativement élevée dans les habitats les plus adaptés (y compris des sites menacés ou bénéficiant d'un statut de conservation particulier, notamment les sites Ramsar et les zones menacées).

- Capacité de dispersion

Cette espèce exotique envahissante est considérée comme nuisible dans certaines situations spécifiques, et ce même dans son aire de répartition d'origine. L'Ibis sacré profite des activités humaines et des environnements même très anthropisés. Appréciée dans les zoos et par les particuliers, l'espèce a été importée délibérément et largement commercialisée en raison du succès de sa reproduction et de son adaptabilité. De nombreux individus de zoos ont eu la possibilité de voler librement et dans certains cas se sont échappés et ont formé des populations férales. Lorsqu'ils sont relâchés dans la nature, ces individus peuvent se disperser sur de longues distances (jusqu'à plusieurs centaines de kilomètres) et s'établir dans des habitats adaptés.

EFFET DE L'ETABLISSEMENT

- Impacts environnementaux

La compétition avec d'autres ciconiiformes et les spatules pour l'espace de nidification dans les colonies a été mentionnée mais n'a probablement qu'un effet limité sur les espèces indigènes belges (au moins aux premiers stades de l'envahissement). En cas d'envahissement important, les effets négatifs les plus importants de *T. aethiopicus* dans son aire de répartition exotique sont sa tendance à la prédation sur les œufs et poussins d'autres espèces (surtout des sternes), la compétition pour le site de nidification avec d'autres oiseaux coloniaux et la prédation sur plusieurs espèces de batraciens.

GESTION DES RISQUES

Les oiseaux provenant de populations échappées de captivité et établies dans les pays voisins (France et Pays-Bas) constituent la principale voie d'introduction de *T. aethiopicus* en Belgique. L'établissement de populations férales à partir d'individus pouvant voler librement dans certains parcs zoologiques et chez des particuliers constitue la deuxième voie d'introduction dans la nature (trois zoos détiennent actuellement des Ibis sacrés en Belgique).

L’action la plus efficace en matière de prévention de l'établissement de cette espèce est de limiter de manière draconienne l'importation et le commerce de l'espèce. La législation devrait être modifiée et imposer des règles strictes au niveau des conditions de captivité des oiseaux déjà présents (p. ex. obligation de garder les oiseaux dans des cages sécurisées et de les enregistrer) ainsi qu’interdire formellement de mettre ces oiseaux en liberté dans la nature (à des fins récréatives). Les actions préventives ont montré qu’elles étaient les plus efficaces dans le cas de cette espèce.

En cas d’établissement dans la nature, la mesure de contrôle de l’espèce la plus appropriée consiste à stériliser les œufs et à éradiquer les oiseaux volants (de préférence hors de la colonie ou présents sur les aires d’alimentation).

Samenvatting

WAARSCHIJNLIJKHEID VAN VESTIGING EN VERSPREIDING (BLOOTSTELLING)

- Introductie in België

De eerste heilige ibis in België werd waargenomen in 1989. Zowel actueel als in de toekomst is de kans groot dat individuen via een van de twee volgende introductiepaden hun weg naar België zullen vinden: (1) ontsnappingen uit vrij levende populaties in dierenparken of vogelverblijven, of (2) verbreiding vanuit populaties in de buurlanden.

- Vestigingsvermogen

De heilige ibis is een zeer mobiele soort, is omnivoor en past zich goed aan uiteenlopende habitats aan. De soort heeft dan ook een sterke neiging tot invasiviteit. België bevindt zich op de noordgrens van haar verspreidingsgebied en zonder natuurlijke vijanden of andere controlerende organismen, is de kans vrij groot dat de soort zich in geschikte habitats vestigt, waaronder bedreigde habitats en gebieden met een beschermingsstatuut, zoals Ramsargebieden).

- Verspreidingsvermogen

De heilige ibis geldt als invasief en wordt ook binnen haar normale leefgebied in specifieke situaties beschouwd wordt als een plaagsoort. Ze profiteert van menselijke activiteit en van door de mens beïnvloede omgevingen. Dankzij haar hoge broedsucces en doordat ze zich zo gemakkelijk aanpast werd de heilige ibis in dierenparken en particuliere collecties erg naar waarde geschat. Ze werd dan ook herhaaldelijk opzettelijk ingevoerd en op grote schaal verhandeld. In dierenparken vliegen individuen vaak vrij rond; sommige daarvan ontsnapten en vormden verwilderde populaties. Eens in het wild, kunnen de vogels zich over aanzienlijke afstanden (tot verschillende honderden kilometer) verbreiden en zich vestigen in geschikte habitat.

EFFECTEN VAN DE VESTIGING

- Milieu-impact

Competitie met andere ooievaarachtigen en lepelaars voor nestruimte in kolonies werd als mogelijke milieu-impact aangehaald, maar dit heeft vermodelijk slechts een beperkt effect op inheemse soorten (tenminste in een vroeg stadium van de invasie). Bij grote invasies vormt het sterkste negatieve effect van *T. aethiopicus* binnen haar niet-inheemse verspreidingsgebied de neiging tot predatie van eieren en kuikens van andere kolonievogels (sternen in het bijzonder) en van sommige amfibieën.

RISICOBEHEER

Vrij bewegende heilige ibissen uit gevestigde populaties in buurlanden (Frankrijk en Nederland) kunnen worden beschouwd als het voornaamste introductiepad in België. Een andere mogelijke toegangsweg zijn vogels die uit dierenparken (momenteel drie in België) en particuliere collecties ontsnappen.

De meest doeltreffende manier om te voorkomen dat populaties zich vestigen, is het drastisch aan banden leggen van invoer van vogels en handel in de soort. Er dient een wijziging van de wetgeving te komen teneinde de regels aangaande de voorwaarden voor het gevangen houden van vogels die zich reeds in het gebied bevinden strenger te maken (vb. verplichting om de vogels geregistreerd en gekortwiekt in beveiligde kooien te houden) en om het uitzetten van deze niet-inheemse vogels in het wild (voor recreatieve doeleinden) ten stelligste te verbieden. Preventie is de goedkoopste oplossing voor deze soort gebleken.

Gevestigde populaties beheersen gebeurt best door het steriliseren van de eieren en door afschot van volwassen vogels (bij voorkeur in de buurt van de kolonie of op voederplaatsen).

STAGE 1: INITIATION

Precise the identity of the invasive organism (scientific name, synonyms and common names in Dutch, English, French and German), its taxonomic position and a short morphological description. Present its distribution and pathways of quarantine concern that should be considered for risk analysis in Belgium. A short morphological description can be added if relevant.

1.1 ORGANISM IDENTITY

Scientific name :	Threskiornis aethiopicus
Synonyms:	Tantalus aethiopicus Latham, 1790 Threskiornis aethiopica
Common names :	Sacred Ibis (Eng), Ibis sacré (Fr), Heilige Ibis (Nl) , Heiliger Ibis (Ge)
Taxonomic position:	Domain Eukaryota, Kingdom Metazoa, Phylum Chordata, Subphylum Vertebrata, Class Aves, Order Ciconiiformes, Family Threskiornithidae, Genus Threskiornis, Species Threskiornis aethiopicus

Notes on taxonomy: The Black-headed Ibis (*Threskiornis melanocephalus*) in south Asia and the Australian White Ibis (*Threskiornis molucca*) in Australia are considered by some authors as races of *T. aethiopicus*.

Generally three subspecies are distinguished in *T. aethiopicus*:

T. aethiopicus aethiopicus (Latham, 1790), in sub-Saharan Africa (the main area of distribution) and southern Iraq; formerly in Egypt. Introduced in Europe, USA, the United Arab Emirates and Taiwan.
T. aethiopicus bernieri (Bonaparte, 1855), in Madagascar
T. aethiopicus abbotti (Ridgway, 1893), on the island of Aldabra.

Threskiornis aethiopicus (Sibley and Monroe 1993) has been split into *T. aethiopicus* (including *T. a. abbotti*) and *T. bernieri* following Sibley and Monroe (1990) whose treatment has been adopted by the BirdLife Taxonomic Working Group on the basis of *bernieri's* smaller size, proportionately much smaller, slimmer bill, little or no black in the wing-tips, a bluish-white or white, not brown iris, paler, less well developed ornamental plumes, the apparent absence of a neck-sac and its restriction to estuarine and coastal areas.

1.2 SHORT DESCRIPTION

A large white bird with a length of 65-89 cm and a wingspan of 112-124 cm; the weight is about 1500g (Urban, 1974). The female adults are smaller, especially the bill. The plumage is white with primaries and secondaries tipped black. The bill is curved and thick. The head and the neck are bare and black. Immature birds have blackish-brown tertials and the head and neck are feathered (del Hoyo et al., 1992; Reeber, 2005).

It is mostly found in wet areas in meadows and inland wetlands to coastal areas. It is carnivorous with a tendency to omnivory. The diet is based on terrestrial and aquatic insects, fishes, batrachians, molluscs and crustaceans. It can also feed upon small mammals and bird eggs and on animal and vegetable refuse.

In its native range, the species starts to breed during or shortly after the rains, although in flooded areas it also breeds during the dry season, usually nesting in large mixed-species colonies of 50-2,000

pairs (del Hoyo *et al*. 1992). It is a very gregarious species, often flying more than 30 km away from the colony to feed (Brown *et al*. 1982, Hockey *et al*. 2005).

1.3 ORGANISM DISTRIBUTION

Native range

Native range of the Sacred Ibis covers most of central and southern Africa including the following countries (see figure 1): Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo, The Democratic Republic of the, Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Iran, Islamic Republic of, Iraq, Kenya, Lesotho, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, United Republic of, Togo, Uganda, Yemen, Zambia, Zimbabwe (BirdLife International 2012). The species is also present in south-eastern Iraq, and formerly in Egypt.

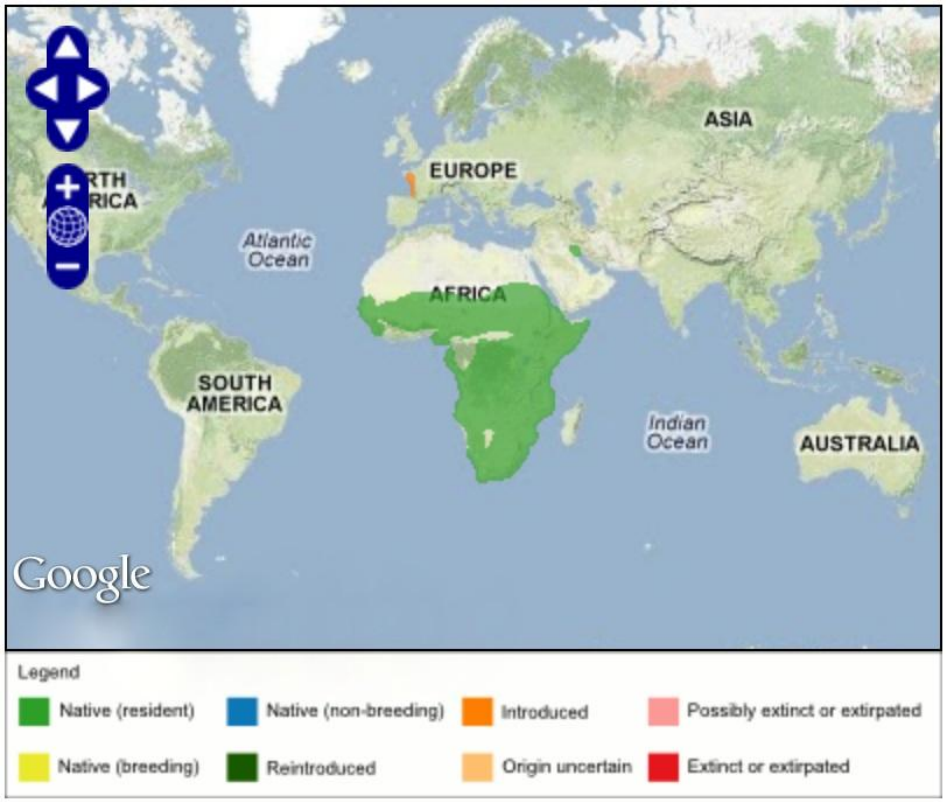

Fig. 1. Geographical distribution of *Threskiornis aethiopicus*.
Source: http://www.birdlife.org/datazone/speciesfactsheet.php?id=3794

This species is an intra-African migrant, making nomadic or partially migratory movements of several hundred kilometers to breed during the rains (Brown *et al*. 1982, del Hoyo *et al*. 1992). Populations north of the equator migrate northwards and those south of the equator migrate southwards (Brown *et al*. 1982, del Hoyo *et al*. 1992), both groups returning towards the equator at the end of the breeding season (Brown *et al*. 1982). Some populations (e.g. in southern Africa) may also be sedentary (Hockey *et al*. 2005).

Introduced range

Belgium: the species is not yet established as a breeding bird in Belgium, the maximum number of records in one year was 198 in 2011 (corresponding only to a maximum 15 -20 individuals). It can, however, be observed on most wetlands, fresh water streams of brackish areas of northern Belgium (with an extension along the Meuse, up to Amay, and one record near Manhay) (figure 2).

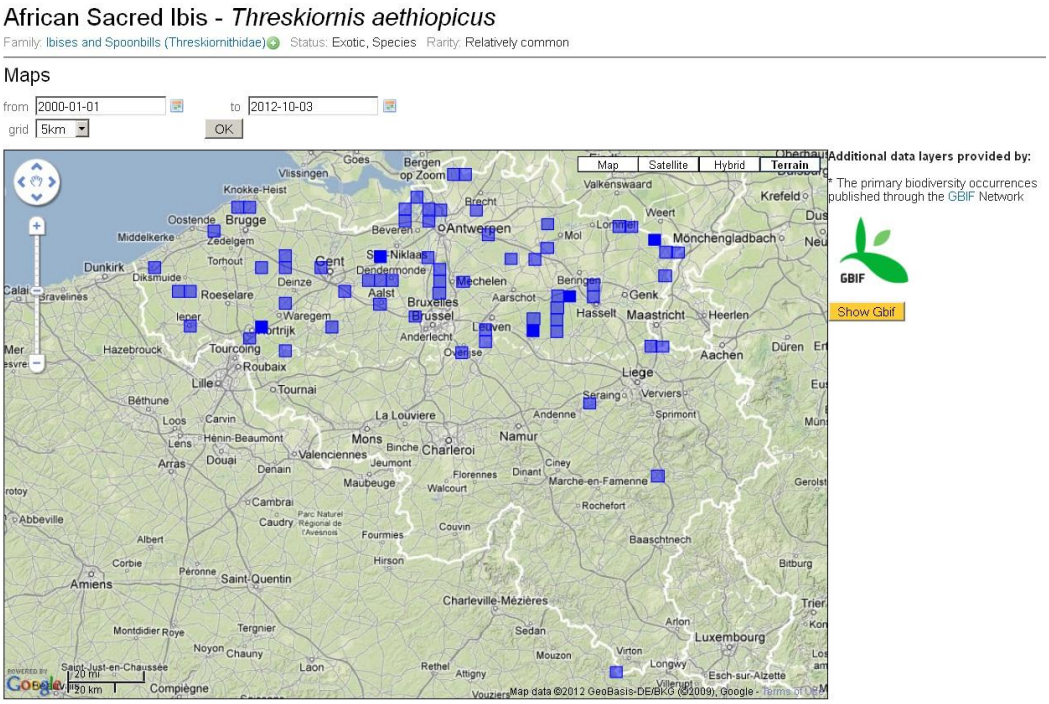

Fig. 2. Count and areas where Sacred Ibis have been observed in Belgium since year 2000. Source: http://observations.be

Rest of Europe:

All the introductions of *T. aethiopicus* are linked to escape from zoos. The history of the spread and breeding of the species is briefly presented here (for more details and other populations see Yésou and Clergeau (2005) and Clergeau and Yésou (2006)).

- France

In western France, after 20 birds were imported from Kenya, a breeding colony soon became established at Branféré zoological garden in southern Brittany. There were 150 pairs in the zoo in 1990. The young were left free to fly and rapidly moved beyond the zoo, mostly visiting the nearby wetlands but also wandering hundreds of kilometres away along the Atlantic coast. Breeding in the wild was first noted in 1993 at both the Golfe du Morbihan, 25 km from the introduction site, and the Lac de Grand-Lieu, 70 km away. Breeding has not occurred at Branféré zoo since 1997. Colonies later occurred at various sites along the French Atlantic seaboard: in Brière marshes (up to about 100 nests), in the Golfe du Morbihan and on a marine island nearby (up to about 100 nests), with a few more nests up to 350 km south of Branféré at Brouage marshes and near Arcachon. The largest colony was discovered in 2004 on an artificial island in the estuary of the Loire River, and in 2005 this site attracted at least 820 pairs. The French Atlantic population was a little over 1000 breeding pairs and about 3000 individuals in 2004-2005 (based on a roost census). There were about 1400 to 1800 pairs in 2007 with more than 5000 individuals. Culling was tested in 2007 and has been carried out at a large scale from 2008, 3000 birds were shot that year, leading to a remaining total of 2500

individuals in February 2009 and a breeding population of about 900 pairs that year. In 2010, culling and eggs sterilisation brought the numbers down to 670 pairs (Dubois, 2012), the large majority (95%) of it in Loire Atlantique and on Grand-Lieu lake in particular. P. Dubois (2012) indicates that 2393 eggs were sterilized in 2010 and 2424 in 2011. This method, coupled with culling of adults on feeding grounds close the colonies, seems very effective and the species has already disappeared from Languedoc-Roussillon as a breeding species. Indeed, egg sterilisation seems to be the best way to impeach young breeder's recruitment and allow a soft decline in the number of breeding pairs. The population was estimated in 2011 at around 1500 individuals (Dubois, 2012) (figure 3). French breeding and winter repartition of *T. aethiopicus* is illustrated on figure 4.

In Southern France, *T. aethiopicus* was acclimatized in 1982 within the "African Reserve" at Sigean. They were left free to fly by 1989 and a pair bred in 1991. Observations in natural surroundings became regular from 1995, and in 2000 the species bred in a colony of 8 nests in the wild at Etang de Bages. This colony held 75 pairs in 2004 and about 300 individuals in 2007. Population limitation began in 2007 and fewer than 30 birds remained in the wild in February 2009.

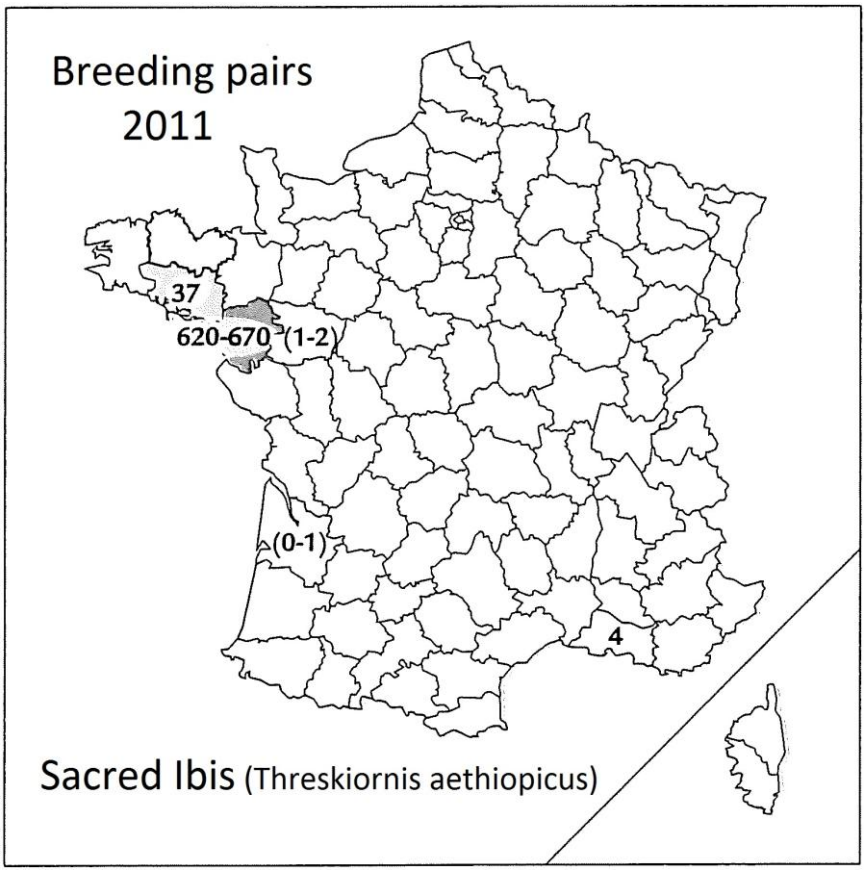

Fig. 3. Number of breeding pairs of Sacred Ibis by departments of France in 2011.
Source: Dubois 2012

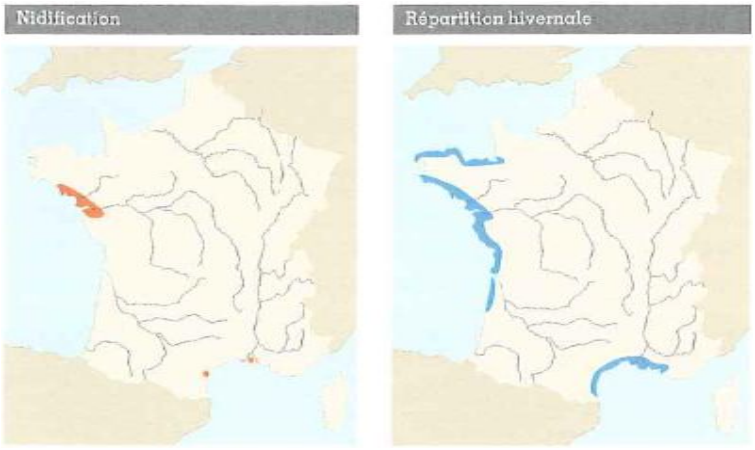

Fig. 4. Geographic repartition of Sacred Ibis in France during breeding period (on the left) and during non-breeding season (map on the right). Source: Dubois *et al*. 2008

- Netherlands

In the Netherlands escaped Sacred Ibises and (formerly) free flying Ibises from the zoological park Avifauna in Alphen a/d Rijn, Zuid-Holland resulted in breeding attempts in 2001 and the first successful breeding in 2002. Between 2001 and 2009, an average of 7,25 pairs (with a maximum of 15 breeding pairs in 2007) of Sacred Ibis were breeding in the Netherlands. The overall growth rate of the breeding population during the entire period 2001-2009 was 12.6% (Smits *et al.,* 2010). Figure 5 shows observation sites and number of individuals in The Netherlands since January 2000 and figure 6 illustrates the recent repartition of *T. aethiopicus* (after 2000) compared to previous periods.

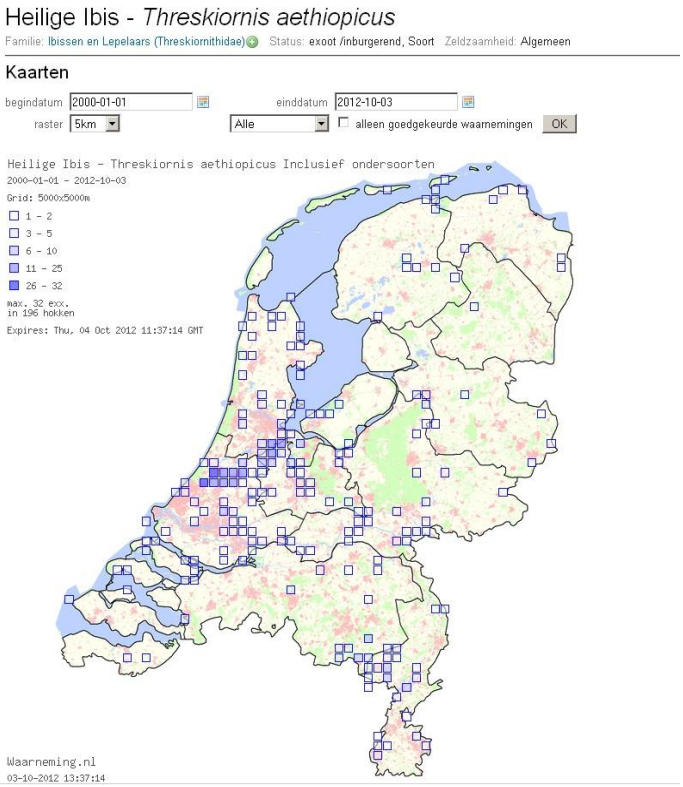

Fig. 5. Observation sites and number of individuals in The Netherlands since January 2000.
Note: these data may include some records of *Threskiornis melanocephalus*.
Source: http://waarneming.nl

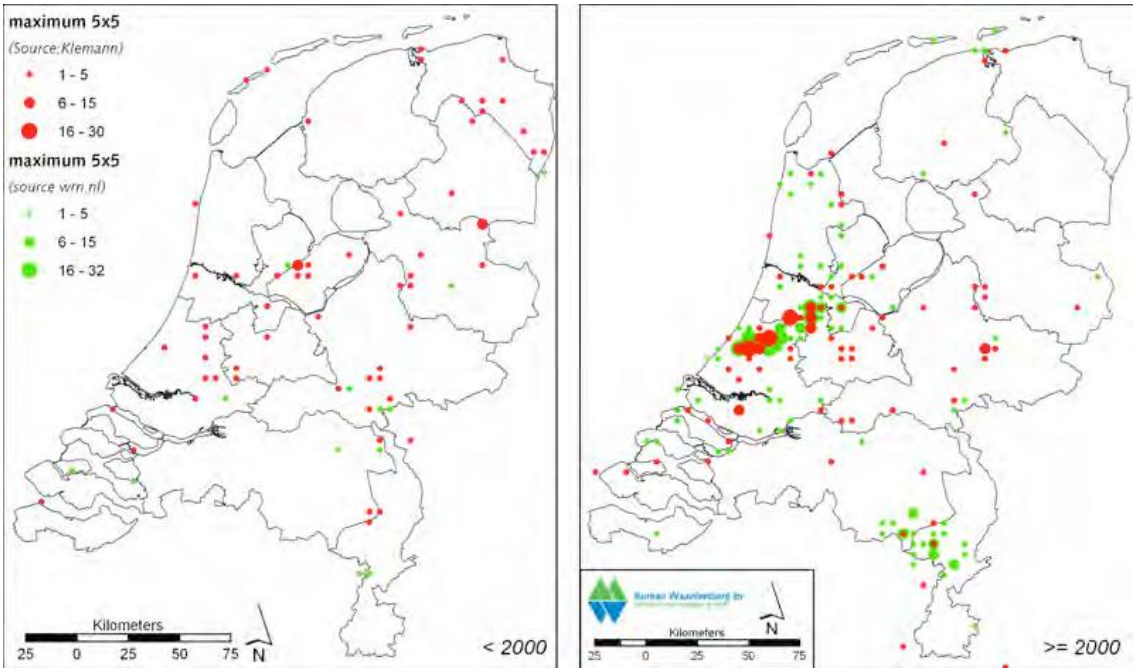

Fig. 6. The distribution of the Sacred Ibis in the Netherlands for the periods before 2000 (on the left) and after 2000 (on the right). Presented is the maximum number of birds sighted per 5x5 km. Red dots correspond to datafrom Klemann and green dots from waarneming.nl.
Source: Klemann and waarneming.nl in Smits *et al.* 2010

- Italy

In Italy, *T. aethiopicus* has bred in the upper Po valley (Piedmont) since 1989, having escaped from a zoo near Turin. There were 26 pairs and about 100 individuals in 2000. In 2003, breeding was observed at another site in the same area, with possibly up to 25-30 pairs, and a few more pairs were found at a third colony in 2004. In northeast Italy, near Veneto, individuals are present during the breeding season and attempt to breed. In central Italy, near Tuscany, breeding attempts have been recorded since 2000. Since 2004 there has been neither a co-ordinated count of the breeding sites nor an updated estimate of the population size (Smits *et al.,* 2010).

- Germany

Free flying populations of zoological parks are known. No breeding outside a park has yet been recorded. Twelve colour-ringed birds escaped from the Metelener Heide Bird Sanctuary (www.cr-birding.be) and are probably seen in eastern Netherlands (data from M. Klemann cited in Smits *et al.,* 2010).

- Spain

In Catalonia, Malaga and the Canary Islands free flying ibises bred or are still breeding. In Malaga birds are possibly breeding since 1997 and in the Canary Islands (Tenerife) a maximum of five pairs is breeding since 1997.

- Portugal

Since 1998 escaped/free-flying ibises from a zoological park in Coimbra are possibly breeding.

Escaped individuals are reported from many other European countries including UK, Ireland, Sweden and Poland (http://www.michelklemann.nl/ibis/index.htm).

Other continents:

- United States of America

Since 2005 Sacred Ibis breeds in the Florida Everglades (Herring & Gawlik 2008). Sacred ibises were present in this area since the mid 1990s with occasional breeding confirmed near the Miami Metro Zoo. At this time, local governments (e.g., Palm Beach County), Florida Fish and Wildlife Conservation Commission (FWC), and the United States Department of Agriculture Wildlife Services Office (USDA/APHIS/WS) have teamed up to attempt to eradicate invasive Sacred Ibises. Experts believe now that all Sacred Ibises living in the wild in south Florida have been removed, approximately 75 birds in total (Johnson & McGarrity 2009).

- United Arab Emirates

Since 1989 a small, introduced population occurs and breeding is regularly recorded in Sir Bani Yas Island (Yésou & Clergeau 2005).

- Taiwan

Since 1998 the species is establishing in Taiwan (website http://www.michelklemann.nl/ ibis/index.htm). In 2004 the species was reported to expand its range in Taiwan (Agoramoorthy & Hsu 2007).

Some vagrant individuals can be found in Azerbaijan, Kazakhstan, Kuwait, Oman, Saudi Arabia.

1.4 REASONS FOR PERFORMING RISK ANALYSIS

Specify also the reason(s) why a risk analysis is needed (the emergency of a new invasive organism in Belgium and neighboring areas, the reporting of higher damages caused by a non native organism in Belgium than in its area of origin, or request made to import a new non-native organism in the Belgium).

The risk of introduction is completely linked to zoos and captive collections. Sometimes individuals escape from captivity, but in general, the birds are allowed to fly freely and can move out of the zoo limits and form feral populations. The use of pinioning (surgically removing one pinion joint, the joint of a bird's wing farthest from the body, to prevent flight) or of large aviaries seems indispensable to prevent this.

Although the impacts of feral populations of ibis have not been analyzed in all introduced areas, studies in western and southern France illustrate the impact of this opportunistic bird (especially destruction of tern and heron eggs and young, and capture of amphibians). These impacts have also been observed in its native range (South Africa; Williams & Ward, 2006). The importance of the predatory impact in France have been largely discussed and sometimes challenged (at least not to be considered as significant at population level for native species; Marion, 2007), but was recently confirmed by an accumulation of observations (Clergeau *et al*., 2010).

Other impacts are observed, such as the destruction of vegetation at breeding sites. Indeed, the trampling of hundreds of ibises in marshes where they feed or on the soil of islands where they breed can affect the aquatic functioning or the development of vegetation. However, the more important effect, as observed in most of the large colonial breeders (e.g. Phalacroracidae, Ardeidae, Threskiornithidae) is the layer of droppings under colony sites, which can destroy trees, shrubs and grasses. After the breeding season, some islands show no vegetation for several months.

Another suspected impact is the spreading of diseases since ibises frequently visit rubbish dumps and slurry pits to catch insect larvae and can then move to pastures or poultry farms. But a recent study indicates that parasite load and pathogens in Sacred Ibis are relatively low and similar to the native avifauna (Bastian et al., 2010).

The closely related Australian white ibis (*Threskiornis molluca)*, which expanded its range into the urban centres of eastern Australia, is sometimes considered to be a pest species. This is because they pose a threat to aircraft safety, scavenge food at waste-management sites, cafes and parks, and compete with other native species for food and habitat (Martin *et al.* 2007). The same status of “pest species” can be attributed to *Threskiornis aethiopicus.* It feeds on corn seeds (Clergeau & Yésou 2006) and Sabal palm fruit (Herring & Gawlik 2008) to such a certain extend that in specific situations the species is sometimes considered as pest for agriculture within its native range.

STAGE 2 : RISK ASSESSMENT

2.1 PROBABILITY OF ESTABLISHMENT AND SPREAD (EXPOSURE)

Evidence should be available to support the conclusion that the non-native organism could enter, become established in the wild and spread in Belgium and neighbouring areas. An analysis of each associated pathways from its origin to its establishment in Belgium is required. Organisms intentionally imported maybe maintained in a number of intended sites for an indeterminate period. In this specific case, the risk may arise because of the probability to spread and establish in unintended habitats nearby intended introduction sites.

2.1.1 Present status in Belgium

Specify if the species already occurs in Belgium and if it makes self-sustaining populations in the wild (establishment). Give detail about species abundance and distribution within Belgium when establishment is confirmed together with the size of area suitable for further spread within Belgium.

The species is already present in Belgium but is not widely distributed or established yet. [2]
Estimations on the number of free flying Sacred Ibis currently present in our country range from 10 to 15 individuals. Taking into account double counting and long stays; the 2011 data of 198 records correspond to 10-15 individuals, maximum 20. This means only 8 to 10 birds with rather long period of presence recorded. It is possible that the total number of birds is even smaller, a bird present in one particular site for a couple of months can then move and stay in a second site. There are also 7 observations of isolated birds, often on the move. All of these but one were observed between 26 September and 14 October, the remaining one on 14 May. This could indicate a “migration” of birds issued from the populations of France or The Netherlands.

The actual size of the captive population is unknown. Besides the number of birds present in zoological parks, there is probably more specimen in non-official, private collections.

2.1.2 Present status in neighbouring countries

Mention here the status of the non-native organism in the neighbouring countries.

In this paragraph the non-native status of the species is described for several countries. Most information originates from Clergeau & Yésou (2006), Clergeau *et al.* (2010) and Smits *et al* (2010).

The sacred ibis *Threskiornis aethiopicus* escaped from wildlife centres in Brittany and Languedoc-Roussillon (Atlantic and Mediterranean coasts of France, respectively) during the 1980s-1990s has settled in natural habitats where it rapidly spread.

Besides the established populations in France, the species is also breeding in the wild in The Netherlands. It also occurs in several other countries outside its natural range.

[2] According to Clergeau & Yesou (2006) one breeding attempt has been observed in 2001. However, the fact that the reported breeding attempt occurred in September made it very unlikely and this is the reason why it was not taken into account by us.

Netherlands:

The current population in the Netherlands may vary around 30 individuals with the most recent record of 4-5 breeding pairs in 2009 (the highest record of breeding pairs being 15 in 2007). With the current growth rate of 12.6% the population is predicted to reach 60 pairs in 2025 and 1200 pairs in 2050 (Smits *et al.* 2010).

France:

According to the most recent literature available, serious measures of control or even eradication were put in place in 2010 and 2011, and the population of Sacred Ibis in France is now estimated at around 1500 individuals (Dubois, 2012).

Germany:

No breeding birds have been found in Germany so far. A free flying population is known from different zoos (without further estimates).

2.1.3 Introduction in Belgium

Specify what are the potential international introduction pathways mediated by human, the frequency of introduction and the number of individuals that are likely to be released in Europe and in Belgium. Consider potential for natural colonisation from neighbouring areas where the species is established and compare with the risk of introduction by the human-mediated pathways. In case of plant or animal species kept in captivity, assess risk for organism escape to the wild (unintended habitats).

There are two potential pathways (with comparable importance) along which sacred ibises can enter the country:

1. Free flying populations from zoological parks or escapes from private aviaries
2. Dispersal from feral populations in neighboring countries.

In Belgium, Sacred Ibis are currently present in both zoological parks and private collections, the only known estimates for Belgium is 15 individuals in captivity (in three zoos: Pairi Daiza, Plankendael and Olmense Zoo), it is probably an underestimate of the real number. In comparison, captive numbers in other countries in Europe and the Middle East are: Germany (55), France (202), The Netherlands (64+), Europe and Middle East (817). This might lead to future escapes that could contribute to colonization or support of wild populations.

If the population growth rate of 12,5 % observed in The Netherlands between 2000 and 2009 remains the same, the number of breeding birds could reach 60 pairs in the near future (up to the year 2025). After 2025, with a continuing growth rate, the population might increase to 1200 pairs in 2050 (Smits *et al*., 2010). Eventually, almost every wetland, including the Wadden islands can then be colonized. At such a state of invasion, given the widespread availability of seemingly suitable wetlands habitats, it is likely that more and more frequently, dispersing individuals from the Netherlands will enter Belgium. This should drastically increase the importance of this pathway of invasion.

Chances of colonization by French expanding populations are currently declining and is now relatively low considering the fact that the eradication program continues in this country. On the other hand,

there are no management actions undertaken in Italy or Germany which might lead to population growth and subsequent invasion.

Risk of organism escaping into the wild and constituting feral populations from zoological parks, was summarized by Clergeau and Yésou (2006). From this study it appears that in 100% of cases, at least a portion of bird that were allowed to fly freely inside the zoological park ended up as successful breeders outside the park boundary. This has been verified in at least in France, Spain, Portugal, Italy, the Netherlands. It is also reported that about in 50% of cases, birds that were not allowed to fly freely did find their way outside the park boundaries. This highlights the strong potential threat that any captive stock may be considered as potential source of further invasion.

ENTRY IN BELGIUM

The first Sacred Ibis in Belgium was recorded in 1989. At present and in the future it is highly likely that individuals will enter Belgium through any of the two pathways: free flying populations from zoological parks or escapes from aviaries and dispersal from feral birds established in neighbouring countries.

2.1.4 Establishment capacity and endangered area

Provide a short description of life-history and reproduction traits of the organism that should be compared with those of their closest native relatives (A). Specify which are the optimal and limiting climatic (B), habitat (C) and food (D) requirements for organism survival, growth and reproduction both in its native and introduced ranges. When present in Belgium, specify agents (predators, parasites, diseases, etc.) that are likely to control population development (E). For species absent from Belgium, identify the probability for future establishment (F) and the area most suitable for species establishment (endangered area) (G) depending if climatic, habitat and food conditions found in Belgium are considered as optimal, suboptimal or inadequate for the establishment of a reproductively viable population. The endangered area may be the whole country or part of it where ecological factors favour the establishment of the organism (consider the spatial distribution of preferred habitats). For non-native species already established, mention if they are well adapted to the eco-climatic conditions found in Belgium (F), where they easily form self-sustaining populations, and which areas in Belgium are still available for future colonisation (G).

A/ Life-cycle and reproduction

In the native range, breeding usually starts during early spring (during or just after the rainy season in the species native range). Populations return to the same crowded colonies year after year, and pairs form quickly. Once a pair has chosen a site, usually in the branches of a thorny tree, the female builds the nest from sticks and grass that the male collects. She lays 2-5 eggs. Both parents incubate the eggs and also share the feeding duties once the eggs have hatched. The chicks thrust their heads into the adults' open bills in order to stimulate adults to regurgitate food. The survival rate for sacred ibis chicks is low, and it is very rare that more than one chick leaves the nest alive. Those that survive continue to be fed by their parents until they are fully fledged (Brown *et al*. 1982). In France, the average clutch size (2.41 +- 0.68 eggs per nest, n = 58) and the productivity (1.46 young fledged per pair, n=486) were higher than most values from the African natural range of the species. Yésou et al. (2006) suggest that both very low predation rate and rich food resources, including rubbish dumps, helped higher breeding success.

B/ Climatic requirements[3]

Native range of the species is tropical and subtropical characterized by a monsoon climate. However, the fact that feral populations of Sacred Ibis have begun to settle in the North of Europe indicates a large tolerance to various latitudes and temperatures. Currently non-native geographic range of the Sacred Ibis seems restricted to warm or Atlantic temperate regions of the globe.

But the species shows niche expansion. This makes it difficult to predict where the species could occur in the future (e.g. using species distribution models). This is an extra source of uncertainty which could be taken into account. Not all suitable available climates in Europe have already been colonized. It is thus likely that without management, the species will spread further across Europe (Diedriek Strubbe com pers.).

C/ Habitat preferences[4]

T. aethiopicus shows a large tolerance to various environments but the presence of water appears essential. The species is adapted to fairly wide range of habitats, often close to the sea coasts in Europe but also along lakes and rivers and in cultivated areas.

Clergeau & Yésou (2006) indicate that the various feeding habitats of non-native sacred ibises (such as in western France) are of three main types:

1. meadows, usually but not only wet meadows, with or without cattle; groups of up to ca. 100 ibises could be recorded, occasionally forming mixed foraging groups with other birds species, particularly little egret, curlew (*Numenius arquata)* or herring gull (*Larus argentatus)*.

2. rubbish dumps, exploited all year round by ibises, together with various birds species and more frequently *Herring gull*; up to 600 sacred ibises have occurred together at one dump.

3. marshes and reedbeds, particularly used in spring and summer, regularly visited by groups of up to over 100 ibises accompanying various wading species including little egret, cattle egret, grey heron (*Ardea cinerea)* and also dabbling ducks (Anatidae) and coot (*Fulica atra)*.

Breeding colonies of sacred ibis have occurred in a variety of habitats: e.g. in western France on Cypress trees on islets in Golfe du Morbihan; on floating stands of Willow trees at Lac de Grand-Lieu; on Willow trees isolated amidst very large reedbeds in Briére; both on stranded trees and directly on the ground at an artificial sandy island in the Loire estuary. A colony also occurred on Thuya trees in a large private garden in a suburban area. The species thus shows an adaptive capability to different landscapes, provided that there is an island-like appearance. At Grand-Lieu, Reeber (2005) reported that ibises regularly form small monospecific groups within colonies of other tree-breeding colonial species, mostly little egrets (*Egretta garzetta)*, cormorants (*Phalacrocorax carbo*) and spoonbills

[3] Organism's capacity to establish a self-sustaining population under Atlantic temperate conditions (Cfb Köppen-Geiger climate type) should be considered, with a focus on its potential to survive cold periods during the wintertime (e.g. plant hardiness) and to reproduce taking into account the limited amount of heat available during the summertime.

[4] Including host plant, soil conditions and other abiotic factors where appropriate.

(*Platalea leucorodia*). They sometimes built large communal platforms holding up to 30 nests. Such aggregates held up to ca. 250 nests at the main breeding site in the Loire estuary (Clergeau & Yésou, 2006).

In Belgium, potential future establishment sites can be predicted by the current multi-specific colonies of tree breeding cormorants, herons and spoonbills. These sites are relatively limited in number (see figure 7).

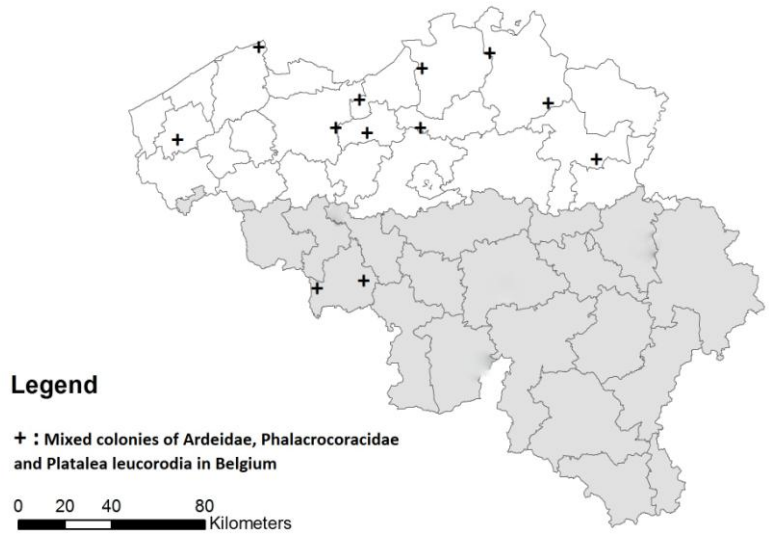

Figure 7: Localisation of multi-specific tree breeding colonies potentially suitable for *T. aethiopicus* establishment.

In non-native countries such as France, sacred ibises spend their winter nights in groups at various roost sites, especially on Cypress and Pine trees. In a minority of cases, roost site and breeding site were the same. Roosts could be either mono-specific (up to 700 ibises at one place) or multi-specific in association with either little egrets (*Egretta garzetta)* or cattle egrets (*Bubulcus ibis)*. Most roost sites were in natural environments, but one major mixed roost occurred close to the illuminated car park of a megastore, and another roost was in a large private garden in a suburban area.

It is important to note that in a non-native situation, the species could shows a ecological niche expansion (D. Strubbe pers.comm.). This makes it difficult to predict where the species could occur in the future (e.g. using species distribution models). This is an extra source of uncertainty which should be taken into account for any risk analysis regarding *T. aethiopicus*. Moreover not all suitable available climates in Europe have already been colonized. It is thus likely that without management, the species will spread further across Europe (D. Strubbe pers.comm.).

D/ Food habits[5]

T. aethiopicus feeds mainly on invertebrates, including insects (particularly locusts and grasshoppers), spiders, annelids, crustaceans, and molluscs. Also frogs, reptiles, fish, young birds and eggs, carrion and offal. Feeds during day mainly in flocks, mostly by wading in shallow wet areas and occasionally on dry land close to water (Brown *et al*. 1982; Snow & Perrins, 1998). Because its diet includes also the seeds of corn (Clergeau & Yésou 2006) and Sabal palm fruit (Herring & Gawlik 2008), the species is sometimes considered as pest species for agriculture in specific situations within native range.

Some individuals can specialize at least temporarily as predators on seabird colonies and feeding on rubbish dumps is general (Clergeau *et al.,* 2005, Clergeau *et al*. 2010). Moreover, a study conducted in Florida on the diet of Sacred Ibis highlights an exploitative relationship with humans and its generalist foraging strategy. Out of 22 specimens taken into consideration in this study, 13 were identified as having consumed anthropogenic food items and 9 as having consumed only natural food items. The food item categories that define an anthropogenic diet (e.g., cheese, meat, paper pulp, pellet meal) comprised 58% of the cumulative gut-content biomass for all Sacred Ibises. The large number of birds with anthropogenic food in their diet confirmed that this species is capable of exploiting human landscapes to become established. Some birds consumed primarily anthropogenic food whereas others used it only as a supplement to natural food items. It is not clear whether this species prefers anthropogenic food or whether it simply serves as a buffer when natural food items are scarce (Calle & Gawlick 2011).

E/ Control agents

There is no information on predation, parasites or diseases which may affect the Sacred Ibis in north-western Europe. In its native range the most important predator is the African Fish-Eagle, *Haliaeetus vocifer*, mainly in Kenya (Parson 1977 in Smits *et al*., 2010); in India the closely related Black-headed Ibis are heavily predated by crowns (for eggs and nestlings) and birds of prey (del Hoyo *et al.*, 1992).

As any birds, Sacred ibis can suffer from avian diseases such as avian cholera. In 1991 a large scale mortality of Cape cormorants (16% of the breeding population) from avian cholera was reported in western South Africa (Crawford *et al.* 1992). In addition, small numbers of other species, including sacred ibis, were killed. And also like all birds, sacred ibises can carry a variety of viruses and bacteria that can cause diseases, such as the Australian white ibis, which serves as a host to several zoonotic and livestock pathogens (Epstein *et al.* 2007). The actual prevalence of pathogens and parasites in the non-native populations of sacred ibis is unknown.

Relatively high levels of pesticide residuals have been found in sacred ibis eggs in South Africa, this is probably due to its opportunistic diet (scavenging) and the ability to live in close proximity of human developments (Bouwman *et al.* 2008). However, as the sample size of this study was small the authors stated that it should be used with caution.

[5] For animal species only.

The growth rate of the established population in the Netherlands is high and depends partly on winter-feeding provided by humans. It could be lower under more natural conditions. A similar situation occurred in western France where, over a breeding colony of 1100 pairs, the number of eggs laid per nest was marginally higher than the average number observed in a African colonies (2,4 eggs in France versus 2,2-2,3 in Africa). Subsequently, the total recruitment in the French colony reached a similar level as those observed in the best African colonies, where usually less than one nestling per nest reaches the fledgling stage (Brown *et al.,* 1982). The relatively high reproductive success of the French colony can probably be explained by the very low predation rate and a high availability of food at a nearby dump regularly visited by ibises. Important feeding on dump is indeed proven by the high frequency of domestic rubbish found in regurgitates at the colony (Yésou *et al*., 2006).

F/ Establishment capacity in Belgium

The species was able to establish a free breeding population in the Netherlands and in western France. The growth rate of the newly established population in the Netherlands is similar, if not even higher, than the French one. There is no reason to doubt that the species can also establish itself in Low and Middle Belgium, a geographic region characterized by habitats and conditions similar to what is found in neighbouring countries where the species successfully established itself.

G/ Endangered areas in Belgium

Many areas of potential attractiveness for the Sacred Ibis in Belgium are marine, brackish or freshwater wetlands. These areas are very often protected areas (Natura 2000-sites). On the long term all such areas can potentially be colonized by Sacred Ibis (see figure 7). The areas that are more likely to be colonized in the near future are the coastal wetlands ranging from De Panne to “Het Zwin” and along the Ijzer , the area around Gavermeer (close to Kortrijk), around Ghent, around Molsbroek (east of Lokeren), along the Schelde in particular wetlands between Antwerp and Oude Doel, around Kalmthout, around Harchies, along the Dyle river (form Pecrot to Leuven), at sedimentation pools of Tienen, Schullens Meer (south-east of Diest), most of wetlands between Hasselt and Heusden-Zolder, most wetlands along the Maas (north of Visé and between Maaseik and the border with The Netherlands). It is possible that due to the high dispersal capacity of the species, individuals will disperse further away from these areas (where birds have already been recorded).

Establishment capacity in the Belgian geographic districts:

Maritime, Flandrian, Brabant, Kempen and Meuse districts are considered as optimal for the species establishment due to their proximity to the coast or abundant brackish or freshwater wetlands, presence of colonies of closely related species and easy/close access to food (in natural habitats, cultivated areas or dumps). On the other hand the Ardennes and Lorraine probably do not provide enough or large enough areas of suitable habitat. Wetlands areas (essential to the species) may be present but are rather small, isolated and far away from each other. The accessibility to food may not be as optimal as in coastal and vast wetland areas.

Districts in Belgium	**Environmental conditions for species establishment**[6]
Maritime	Optimal
Flandrian	Optimal
Brabant	Optimal
Kempen	Optimal
Meuse	Optimal
Ardenne	Suboptimal
Lorraine	Suboptimal

ESTABLISHMENT CAPACITY AND ENDANGERED AREAS IN BELGIUM
Highly mobile, omnivorous and with a high capacity of adaptation to different habitats, *T. aethiopicus* has a strong propensitytowards invasiveness. Belgium is located on the northern edge of the species optimal geographic range and without local predators or any other control agents, the probability of establishment is rather high in most suitable habitats (including sites that are threatened or under particular conservation status, such as Ramsar sites and endangered areas).

2.1.5 Dispersion capacity

Specify what is the rate of dispersal once the species is released or disperses into a new area. When available, data on mean expansion rate in introduced territories can be specified. For natural dispersion, provide information about frequency and range of long-distance movements (i.e. species capacity to colonise remote areas) and potential barriers for spread, both in native and in introduced areas, and specify if the species is considered as rather sedentary or mobile. For human-assisted dispersion, specify the likelihood and the frequency of intentional and accidental movements, considering especially the transport to areas from which the species may easily colonise unintended habitats with a high conservation value.

A/ Natural spread

Being abundant in its broad native range, the species is also highly adaptable to different environments and highly mobile. Invasive in other countries, *T. aethiopicus* takes advantages of human activities and environments (considered as a human commensal) and is capable of securing and ingesting a wide range of food. Gregarious, it can cover several kilometers (sometimes dozens)

[6] For each district, choose one of the following options : optimal, suboptimal or inadequate.

from colonies to feeding grounds (Brown *et al*. 1982, Hockey *et al*. 2005) and/or new reproduction sites. The species has a high reproductive potential and a relatively long lifespan (up to 20 years).

In France, new colonies of Sacred Ibis have established up to 70 km away from the original site. Furthermore, dispersal of up to several hundreds of km is recorded (Smits et al. 2010). Such a high dispersal capability suggests for example that birds from the Bages-Siegean population in southern France might wander to wetlands of the Mediterranean coasts of Spain.

B/ Human assistance

As a first step, birds were transported from native areas where they were captured, such as Kenya, to numerous zoos, especially during the 1970s.

As a second step, the high breeding success in captivity permits numerous exchanges of individuals between zoos.

As a third step, in several cases the birds were allowed to fly freely within the zoo and then settle nearby, for example in Brittany and southern France, in The Netherlands, in Florida (USA) or Catalonia (Spain), or spread into other regions up to hundreds kilometres away from the original site such as western France (Clergeau and Yésou, 2006).

DISPERSAL CAPACITY

With the characteristic of being an invasive species in non-native range and, in some specific situations considered as a pest species in its native range, the Sacred Ibis benefits from human activities and environments. Appreciated in zoos and private collections, it was imported voluntarily and widely traded thanks to its high breeding success and adaptability. Finally many zoo individuals were given the possibility to fly freely and in some case escape and form feral populations. Once in the wild, individuals can disperse at considerable distances (up to several hundred kilometres) and establish at suitable habitat.

2.2 EFFECTS OF ESTABLISHMENT

Consider the potential of the non-native organism to cause direct and indirect environmental, economic and social damages as a result of establishment. Information should be obtained from areas where the pest occurs naturally or has been introduced, preferably within Belgium and neighbouring areas or in other areas with similar eco-climatic conditions. Compare this information with the situation in the risk analysis area. Invasion histories concerning comparable organisms can usefully be considered. The magnitude of those effects should be also compared with those caused by their closest native relatives.

2.2.1 Environmental impacts

Specify if competition, predation (or herbivory), pathogen pollution and genetic effects is likely to cause a strong, widespread and persistent decline of the populations of native species and if those mechanisms are likely to affect common or threatened species. Document also the effects (intensity, frequency and persistency) the non-native species may have on habitat peculiarities and ecosystem functions, including physical modification of the habitat, change to nutrient cycling and availability, alteration of natural successions and disruption of trophic and mutualistic interactions. Specify what kind of ecosystems are especially at risk.

A/ Competition

As their breeding numbers have increased in France, Sacred Ibis have been observed competing for nest sites with Cattle Egrets, *Bulbucus ibis**, and Little Egrets, *Egretta garzetta**, and have forced pairs of both species to leave their colonies (Kayser *et al.* 2005). In The Netherlands, Smits *et al*. (2010) mention the risk of competition for nest sites with the Spoonbill, *Platalea leucorodia*, and heron species. Although the cases outlined above are not believed to have had serious impact on the populations of native species (Marion, 2007 ; Strubbe *et al*. 2012), nature conservation societies are concerned that such competition behavior may increase (Yésou & Clergeau, 2005; Clergeau *et al*., 2010).

B/ Predation/herbivory

It has been reported that Sacred ibis individuals can specialize as predators on seabird colonies, including Cape Penguin, *Spheniscus demersus*, Hartlaub's Gull, *Larus hartlaubii*, Swift Tern, *Sterna bergii* and cormorants, *Phalacrocorax spp*. in South Africa (Clergeau *et al*., 2010). Williams & Ward (2006) have found that such predation (up to 65%) in a colony of Cape Cormorants, *Phalacrocorax capensis*, also in South Africa can have a greater impact than predation by Kelp Gulls, *Larus dominicanus*.

In western France, predation has been observed in a Sandwich Tern colony, *Sterna sandvicensis**, with ibises flushing the terns off their nests and taking their eggs. Also, colonies of some tens of incubating Black Terns, *Chlidonias niger**, and Whiskered Terns, *Chlidonias hybrida*, have been destroyed by Sacred Ibises in France on at least three occasions (Yésou & Clergeau 2005). Predation has also been reported in western France on Common Tern, *Sterna hirundo**, Mallard, *Anas platyrhynchos**, Garganey, *Anas querquedula**, Blackwinged Stilts, *Himantopus himantopus*,* Black Terns and Lapwings, *Vanellus vanellus** (Vaslin, 2005; Clergeau *et al*., 2010). In southern France, Sacred Ibises have been observed predating the nests of Cattle Egrets *Bubulcus ibis**.

Cases of predation by Sacred Ibis leading to local extinctions of other native species is rather unlikely (except perhaps for terns in particular situations). Therefore, Sacred Ibis should not be considered as a threat for Belgian populations of birds even if, in an extreme case of invasion, high densities of

Ibises could jeopardize reproduction of some rare bird and conservation value of some Natura 2000 species locally.

On top of predatory behavior on birds, there is also concern that the observed predation by Sacred Ibises on newts may have detrimental effects on discrete populations of these amphibians.

C/ Genetic effects and hybridization

There is one case of hybridisation with African Spoonbill, *Platalea alba*, reported in Italy (outside the natural range of the two parents species) (Volponi & Emiliani, 2008) but no genetic effects or other hybridization cases of Sacred ibis with other species have been documented so far. The risk of impact by hybridisation seems very low.

D/ Pathogen pollution

There is no literature reporting evidences of pathogen dissemination or transport in European countries by the Sacred ibis. However, since the species often feeds on rubbish dumps and possibly polluted sewage lagoons, it can be a fair assumption that individuals may carry bacteria or diseases from feeding grounds to the nesting colony or roosting areas. Bastian *et al*. (2010) report that, besides the fact that Sacred Ibis is often found on poultry or duck farms (feeding in dirt polluted by faeces) or in dumps (with numerous comings and goings to the colonies or roosting site), no portage of parasites nor pathogen agents have been recorded to a level that may rise concerns. Sacred Ibis may display a feeding behaviour that may enhance propagation of pathogen (particularly if the number of birds is important) but at this point of investigation, the species has not been found more subject to enhance pathogen pollution than any other native species.

E/ Effects on ecosystem functions

At the current (early) stage of colonization in Belgium, there is no evidence that Sacred Ibis could have significant negative effects on the ecosystem functions and services. If invasive populations become important, impacts such as the destruction of vegetation at breeding sites could become problematic locally. Indeed, the trampling of hundreds of ibises in marshes where they feed or on the soil where they breed could affect the aquatic functioning or the development of vegetation (on a limited time and space scale). The most important effect, observed in large Sacred Ibis colonies as well as most of the large colonial native breeders (e.g. Phalacroracidae, Ardeidae, Threskiornithidae) is the layer of droppings under colony sites, which can destroy trees, shrubs and grasses. After the breeding season, some islands show no vegetation for several months.

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ENVIRONMENTAL IMPACTS
Competition with other ciconiiformes for nesting space at colonies has been mentioned but should only have limited effect on native species (at least at early stage of invasion). In case of important invasion, the strongest negative effect of *T. aethiopicus* in its non-native range is its tendency towards predation of eggs and nestlings of other waterbirds (terns in particular) as well as of some amphibians.

2.2.2 Other impacts

A/ Economic impacts

Economic impact of *T. aethiopicus* is not documented anywhere. Suspicions of tourism impact could exist in a case where pine woodland has been destroyed by droppings under nest colonies (Island of Morbihan, France). Destruction of the structure of salt pans has been observed in Brittany, necessiting an increase in saltpans repair work (Clergeau et al., 2005). Besides these negative aspects it is obvious hat *T. aethiopicus* was introduced to zoos (with its good acceptance of captivity and good breeding success there) for recreational reasons. This may then be considered as a commercial asset in regards with the attractiveness of the zoo towards the public.

B/ Social impacts

As shown in *T. molucca* (Epstein *et al*., 2007), *T. aethiopicus* is suspected of spreading disease since it frequently forages in rubbish dumps and slurry pits. Studies of different pathogens are in progress at the Veterinary School of Nantes, France.

STAGE 3 : RISK MANAGEMENT

The decision to be made in the risk management process will be based on the information collected during the two preceding stages, e.g. reason for initiating the process, estimation of probability of introduction and evaluation of potential consequences of introduction in Belgium. If the risk is found to be unacceptable, then possible preventive and control actions should be identified to mitigate the impact of the non-native organism and reduce the risk below an acceptable level. Specify the efficiency of potential measures for risk reduction.

3.1 RELATIVE IMPORTANCE OF PATHWAYS FOR INVASIVE SPECIES ENTRY IN BELGIUM

The relative importance of intentional and unintentional introduction pathways mediated by human activities should be compared with the natural spread of the organism. Make use e.g. of information used to answer to question 2.1.3.

In the near future, natural spread into Belgium of Sacred Ibis from its African native range is very unlikely. However immigration in Belgium of free moving animals coming from established populations in neighbouring countries (France and the Netherlands) has already been observed. This will probably continue and constitute one of the two major pathways for entry. The other probability of entry is from birds (often free flying) escaping from zoos (currently three in Belgium) and private collections in Belgium.

3.2 PREVENTIVE ACTIONS

Which preventive measures have been identified to reduce the risk of introduction of the organism? Do they reduce the risk to an acceptable level and are they considered as cost-effective? Specify if the proposed measures have undesirable social or environmental consequences. Consider especially (i) the restrictions on importation and trade and (ii) the use of specific holding conditions and effect of prohibition of organism introduction into the wild.

(i) Prohibition of organism importation, trade and holding

The government should be asked to introduce legislation to control and drastically restrict importation, trade and set strict rules about captivity conditions. Also, release of any non-native species (for hunting or recreational purpose) into the wild should be strictly prohibited. If any feral population start to breed, immediate action (eradication) should be undertaken to prevent establishment (at a national level and, more efficiently at a European and international levels)– just as the European Strategy on IAS prescribes.

Moreover, Banks *et al.* (2008) propose that existing legislation of indigenous waterfowl species conservation could be amended in order to improve and facilitate the eradication efficiency of target non-native species.

(ii) Use of specific holding conditions and effect of prohibition of organism introduction into the wild

The only method used to prevent introduction is keeping the birds in secure aviaries and/or with their wings clipped. Some zoos have chosen to stop presentation of free birds, but others have not.

Legislation forbidding introduction in the wild of potential invasive species such as the Sacred Ibis is the most cost effective and most ecologically responsible way to avoid negative consequences of non-native species establishment in our country. By focusing on regulations concerning existing private avian collections and strengthening aviaries and improving cage surveillance, significant progress will be made to avoid risks of escape and subsequent costly programs of eradication or control. In this context, reinforcement and strong legislation implementation are considered as essential steps towards prevention (Banks *et al.,* 2008).

3.3 CONTROL AND ERADICATION ACTIONS

Which management measures have been identified to reduce the risk of introduction of the organism? Do they reduce the risk to an acceptable level and are they considered as cost-effective? Specify if the proposed measures have undesirable social or environmental consequences. Consider especially the following questions.

(i) Can the species be easily detected at early stages of invasion (early detection)?

Yes, the species is very conspicuous. Besides, our nation counts a large number of keen (professional or amateur) birdwatchers and potential settlement sites of Sacred Ibis are regularly checked. Communication among birdwatchers and wide data transmission is also very effective and a good way of confirming detection and early stages of invasion.

(ii) Are they some best practices available for organism local eradication?

Prevention is certainly the most cost-effective practices to limit the risks of introduction, but in the case of this colonial breeding birds it seems feasible to eradicate the population after establishment. The best way to limit the population is by a combination of eggs sterilisation and culling of flying birds on feeding grounds close to the colonies. Those eradication practices are in use in France and seems to be very effective (reduction of the breeding population from 5000 individuals in 2006 (Yésou in Dubois 2007) to 1500 individuals in 2011 (Dubois, 2012)).

(iii) Do eradication and control actions cause undesirable consequences on non-target species and on ecosystem services ?

When birds are destroyed (egg sterilization, culling, etc.) in or close to mixed colonies, it may have an impact on other breeding species (e.g. disturbance by shooting, presence of hunter close to the colonies, disturbance caused by means of transportation such as boat, 4WD vehicle). There are however no report of undesirable consequences of Sacred Ibis eradication on non-target species nor ecosystem services in France.

(iv) Could the species be effectively eradicated at early stage of invasion?

The species being highly conspicuous and relatively easy to cull, early stage of invasion has to be considered as the most effective stage to limit the invasion or to eradicate the species.

However, decisions about eradication of *T. aethiopicus* can be particularly difficult to reach. It is a large, easily recognizable, white, and nice-looking species, and it benefits from a relatively positive appreciation from the general public, tourists and some naturalists (Clergeau *et al*., 2005). The duration of its presence in Western France (over 20 years) has favored this and lack of consensus meant that it took several years to finally decide to eradicate the species.

(v) If widely widespread, can the species be easily contained in a given area or limited under an acceptable population level?

In France eradication programs have been conducted by the ONCFS (Office National de la Chasse et de la Faune Sauvage), mandated by the French government (Clergeau *et al*., 2010; Dubois, 2012). Nature wardens shoot birds with guns in some mono-specific colonies or on rubbish dumps. Eradication has nearly been achieved on the French Mediterranean coast (only 13 individuals remaining in spring 2009) and is in progress in western France (about half of the population was culled in 2008 + 2011).

In Spain, the authorities rapidly gave authorization to shoot the ten (tagged) ibises that arrived in Coto Doñana (Andalucia) from France.

RISK MANAGEMENT SUMMARY

Free moving *T. aethiopicus* from established populations in neighbouring countries (France and the Netherlands) can be considered as the main pathway of entry into Belgium. The other probability of entry is from birds (often free flying) escaping from zoos (currently three in Belgium) and private collections in Belgium.

The most effective action to prevent population establishment is to drastically restrict any importation and trade of this species. Legislation should be amended in order to set strict rules about captivity conditions (e.g. obligation to keep birds with their wings clipped in secure cages) and strictly forbid release of these non-native birds into the wild (for recreational purpose). Preventive actions have been proven to be the most adapted and cost effective for this species.

In case of detection of specimen establishment into the wild, the most adapted eradication practice is egg sterilisation and culling of flying birds (preferably away from the colony) or on feeding grounds.

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