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Developed by :
René-Marie Lafontaine
Henri Robert
Thibaut Delsinne
Tim Adriaens
Koen Devos
Roseline C. Beudels-Jamar

Risk analysis of the Ruddy Duck, *Oxyura jamaicensis* (Gmelin, 1789)

Risk analysis report of non-native organisms in Belgium

Adopted in date of : 11 March 2013

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René-Marie Lafontaine[1] – Henri Robert[1] – Thibaut Delsinne[1] – Tim Adriaens[2] - Koen Devos[2] - Roseline C. Beudels-Jamar[1]

1 : Royal Belgian Institute of Natural Sciences ; OD Natural Environment ; Conservation Biology Team ; Rue Vautier 29, 1000 Brussels ; http://www.sciencesnaturelles.be

2 : Instituut voor Natuur- en Bosonderzoek ; Kliniekstraat 25, 1070 Brussels ; http://www.inbo.be

Reviewed by : Jean-Yves Paquet (Aves-Natagora)
Diederick Strubbe (University of Antwerp)

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Commissioned by: Federal Public Service Health, Food chain safety and Environment

Contact person: Rene-Marie.Lafontaine@naturalsciences.be

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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)
Olivier Beck	Brussels Environment (BIM)
Roseline Beudels-Jamar	Royal Belgian Institute of Natural Sciences (RBINS/KBIN)
Etienne Branquart	Département de l'Etude du Milieu Naturel et Agricole (DEMNA)
Jim Casaer	Research Institute for Nature and Forest (INBO)
Thibaut Delsinne	Royal Belgian Institute of Natural Sciences (RBINS/KBIN)
Maud Istasse (chair)	Federal Public Service Health, Food chain safety and Environment
René-Marie Lafontaine	Royal Belgian Institute of Natural Sciences (RBINS/KBIN)
Alice Lejeune	Federal Public Service Health, Food chain safety and Environment
Céline Prévot	Département de l'Etude du Milieu Naturel et Agricole (DEMNA)
Henri Robert	Royal Belgian Institute of Natural Sciences (RBINS/KBIN)
Vinciane Schockert	Université de Liège (ULg)
Sonia Vanderhoeven	Belgian Biodiversity Platform (BBPF)
Hans Van Gossum	Agency for Nature and Forest (ANB)
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 important to realise that this risk assessments exercise is carried out by (an) independent expert(s)

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).

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):

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

Oxyura jamaicensis (male) in a garden in London. Photo : Annesov (wikimedia commons).

Executive summary

PROBABILITY OF ESTABLISHMENT AND SPREAD (EXPOSURE)

- Entry in Belgium

The species first entered Belgium in 1979 by natural colonization from the UK introduced population and subsequently from established populations in neighbouring countries. The species was not introduced in Belgium although it is very likely that there have also been local escapes from private waterfowl collections.

- Establishment capacity

The Ruddy Duck is likely to maintain a self-sustaining population in Belgium (as well as in neighbouring areas) because appropriate climatic conditions and habitats are encountered. Endangered areas may be suitable for population establishment although with local minor negative effects to be expected in Belgium itself. Nevertheless the species can expand from Belgium to other regions.

- Dispersion capacity

Ruddy Duck can easily disperse and establish itself over large distances (several thousand kilometres is possible). Most countries in Europe, North Africa and Western Asia may be suitable for *O. jamaicensis* invasion and establishment.

EFFECT OF ESTABLISHMENT

- Environmental impacts

Hybridization with the vulnerable White-headed Duck (*Oxyura leucocephala)* is the most important if not the only environmental impact to be expected in Europe. Ruddy Duck is dominant over this species in the wild and introgressive hybridization may lead to *O. Leucocephala* extinction. Negative effects on other aquatic birds through competition for food and nest sites or on ecosystem functions are considered negligible at the present stage of invasion and are not expected to be serious even in case of a strong population increase.

RISK MANAGEMENT

Management decisions to eradicate Ruddy Duck from Western Palearctic have been taken to ensure conservation of the White-headed Duck. The control programme reduced the UK population by over 98 % by 2012, and the arrival of Ruddy Duck in Spain decreased from 21 birds in 2003 to two sightings in the two years period 2010–2011. These successes demonstrate that successful control is feasible given early detection followed by a rapid response plan or a targeted eradication. With UK numbers drastically reduced, Belgium and The Netherlands are now important remnant populations on the European mainland that should urgently be removed. This also shows that, in order to

guarantee the conservation of an endangered native species, action may be required in countries outside its distribution range.

Official and non-official private collections in Belgium may represent an estimate of 400 to 700 captive individuals. Since the probability of birds escaping into the wild is never zero, birds in captivity are to be considered as a potential pathway of entry into the wild.

The revised EU Action Plan established the long-term objective to phase out all Ruddy Duck captive populations by 2020 by monitoring of the captive population and prevention of breeding through sterilization campaign. The only efficient method to prevent accidental introduction is to keep the birds in secure aviaries, sterilized and with their wings pinioned.

Résumé

PROBABILITE D'ETABLISSEMENT ET DE DISSEMINATION (EXPOSITION)

- Introduction en Belgique

L'espèce a été découverte dans la nature en Belgique pour la première fois en 1979 par colonisation naturelle à partir de la population introduite au Royaume-Uni et ensuite à partir des populations établies dans les pays voisins. Cette espèce n'a pas été introduite en Belgique même s'il est fort probable que certains individus se soient échappés de chez des particuliers qui possèdent des oiseaux aquatiques.

- Capacité d'établissement

Etant donné les conditions favorables tant climatiques que d'habitat en Belgique (et dans les zones voisines), l'Erismature rousse pourrait très probablement former une population durable. De nombreuses zones sensibles ou menacées (par exemple le réseau Natura 2000) peuvent convenir à l'établissement de l'espèce malgré des effets locaux négatifs mineurs à attendre en Belgique. Quoi qu'il en soit, l'espèce peut s'étendre de la Belgique à d'autres régions.

- Capacité de dispersion

L'Erismature rousse se disperse facilement et s'établit sur de grandes distances (plusieurs milliers de kilomètres éventuellement). La plupart des pays d'Europe, d'Afrique du Nord et d'Asie occidentale offrent des conditions propices à l'envahissement et à l'établissement de *O. jamaicensis*.

EFFET DE L'ETABLISSEMENT

- Impacts environnementaux

L'hybridation avec l'Erismature à tête blanche (*Oxyura leucocephala)* est l'impact environnemental le plus important sinon le seul auquel il faut s'attendre en Europe. Dans la nature, l'Erismature rousse est le compétiteur dominant et l'introgression peut mener à l'extinction de *O. Leucocephala.* Les effets négatifs sur d'autres oiseaux aquatiques par le biais de la compétition pour la nourriture et les sites de nidification ou sur les fonctions écosystémiques sont considérés négligeables au stade actuel de l'envahissement et on ne s'attend pas à ce qu'ils deviennent graves même en cas de forte augmentation de la population.

GESTION DES RISQUES

Des décisions de gestion visant l'éradication de l'Erismature rousse du Paléarctique occidental ont été prises pour s'assurer de la conservation de l'Erismature à tête blanche. Le programme de contrôle a permis de réduire la population du Royaume-Uni de plus de 98% en 2012 et l'arrivée de l'Erismature rousse en Espagne a diminué de 21 oiseaux en 2003 à deux observations sur la période de deux ans de 2010-2011. Ces réussites montrent qu'un contrôle efficace est possible à condition d'une détection précoce suivie d'un plan de réponse rapide ou d'une éradication ciblée. Le nombre d'individus ayant été drastiquement réduit au R-U, la Belgique et les Pays-Bas constituent désormais

les populations résiduelles sur le continent européen et devraient être urgemment éradiquées. Cela montre également que pour préserver la conservation des espèces indigènes menacées, il faut parfois agir dans des pays situés en dehors de leurs aires de distribution.

On estime que les collections privées officielles et non officielles belges comptent environ 400 à 700 individus captifs. Etant donné que la probabilité que des canards s'échappent dans la nature n'est jamais nulle, les oiseaux en captivité doivent être considérés comme une voie d'introduction potentielle de l'espèce.

Le Plan d'action UE révisé a fixé pour objectif à long terme l'éradication de toutes les populations d'Erismature rousse captives pour 2020 par la surveillance des populations captives et la prévention de la reproduction par le biais de campagnes de stérilisation. La seule méthode efficace pour empêcher l'introduction accidentelle est de garder les oiseaux dans des parcs ornithologiques sécurisés, de les stériliser et de les éjointer.

Samenvatting

WAARSCHIJNLIJKHEID VAN VESTIGING EN VERSPREIDING (BLOOTSTELLING)

- Introductie in België

De soort deed in 1979 voor het eerst haar intrede in België door natuurlijke kolonisatie vanuit de in het Verenigd Koninkrijk geïntroduceerde populatie en vervolgens van andere in buurlanden gevestigde populaties. De soort werd niet opzettelijk geïntroduceerd in België, hoewel het erg waarschijnlijk is dat er zich plaatselijk ontsnappingen uit particuliere watervogelcollecties voordeden.

- Vestigingsvermogen

Door de gunstige klimaatomstandigheden en het voorhanden zijn van geschikte habitats zal de rosse stekelstaart er in België (en in de omgevende gebieden) wellicht in slagen zijn populatie te handhaven. Bedreigde gebieden lenen zich voor de vestiging van de populatie, maar voor België zelf worden slechts weinig milieueffecten van vestiging van de soortverwacht. Niettemin kan de soort zich vanuit België naar andere regio's verspreiden.

- Verspreidingsvermogen

De rosse stekelstaart verbreidt en vestigt zich gemakkelijk over grote afstanden (meerdere duizenden kilometers zijn niet onrealistisch). De meeste landen in Europa, Noord-Afrika en West-Azië zijn geschikt voor een invasie door en vestiging van de soort.

EFFECTEN VAN DE VESTIGING

- Milieu-impact

Hybridisatie met de kwetsbare witkopeend (*Oxyura leucocephala)* is het voornaamste, zo niet het enige milieueffect dat in Europa kan worden verwacht. De rosse stekelstaart domineert deze soort in het wild en introgressieve hybridisatie zou tot uitsterving van de *O. Leucocephala* kunnen leiden. De negatieve gevolgen voor andere watervogels door competitie voor voedsel of nestplaatsen of een impact op andere ecosysteemfuncties worden in de huidige staat van invasie als verwaarloosbaar beschouwd en zouden bij een sterke toename van de populatie vermoedelijk evenmin ernstig zijn.

RISICOBEHEER

Voor het behoud van de witkopeend werd beslist om de rosse stekelstaart in het West-Palearctisch gebied uit te roeien. Een bestrijdingsprogramma deed de populatie in de UK dalen met meer dan

98% in 2012; de populatie rosse stekelstaart in Spanje daalde van 21 vogels in 2003 naar slechts twee waarnemingen in de periode 2010–2011. Deze successen bewijzen dat controle (en mogelijks uitroeiing) haalbaar is mits de dieren vroegtijdig worden gedetecteerd en de nodige snelle respons of gerichte actie voorzien is. Na de drastische vermindering van het aantal vogels in de UK, is het nu aan België, Nederland en Frankrijk om hun resterende populaties op het Europese vasteland te verwijderen. Dit toont eveneens aan dat, om het behoud van een bedreigde inheemse soort te verzekeren, actie in landen buiten het verspreidingsgebied nodig kan zijn.

Geraamd wordt dat het aantal in gevangenschap levende individuen in officiële en niet-officiële particuliere collecties tussen de 400 en de 700 ligt. Omdat de kans dat in gevangenschap levende vogels ontsnappen nooit onbestaande is, dienen deze te worden beschouwd als een potentieel introductiepad voor introductie in het wild.

Het herziene EU Actieplan voerde de doelstelling in om op lange termijn alle in gevangenschap levende populaties van rosse stekelstaart tegen 2020 uit te faseren. Dit kan gebeuren door monitoring van de in gevangenschap levende populatie en kweekpreventie door het uitvoeren van sterilisatiecampagnes. De enige efficiënte methode om onopzettelijke introductie te voorkomen, is de vogels in goed beveiligde vogelverblijven te houden, ze te steriliseren en te leewieken.

STAGE 1: INITIATION

1.1 ORGANISM IDENTITY

Scientific name : *Oxyura jamaicensis* (Gmelin, 1789)

Synonyms: *Anas jamaicensis* Gmelin, 1789

***Remark**: Oxyura jamaicensis* and *O. ferruginea* (Sibley and Monroe 1990) have been lumped into *O. jamaicensis* following SACC (2005).

Common names : Ruddy Duck (Eng), Erismature rousse (Fr), Rosse Stekelstaart (Nl), Schwarzkopf-Ruderente (Ge), malvasía cabeciblanca (Sp).

Taxonomic position: Aves » Chordata » Aves » Anseriformes » Anatidae » Oxyura jamaicensis

1.2 SHORT DESCRIPTION

Oxyura jamaicensis (Ruddy Duck) is a small diving duck with a long tail, often held erect. On average the females weigh 550g and males around 600g. During the breeding season males can be distinguished from other ducks by a white cheek patch, chestnut red body plumage, and blue bill. Females are distinguished by their body structure and off-white cheek split by a horizontal brown stripe. Both sexes can be distinguished from the White-headed Duck *Oxyura leucocephala* by their smaller size, shorter tail, thinner cheek stripe and concave bill profile.

1.3 ORGANISM DISTRIBUTION

Native range

O. jamaicensis is native to North and Central America including Antigua and Barbuda, Barbados, Bahamas, Cuba, Dominican Republic, Grenada, Guadeloupe, Guatemala, Honduras, Haiti, Jamaica, Saint Kitts and Nevis, Cayman Islands, Saint Lucia, Mexico, Nicaragua, Puerto Rico, El Salvador, Turks and Caicos Islands, Saint Vincent and the Grenadines, Virgin Islands (British), Virgin Islands (U.S.) (InfoNatura, 2004). The world population is estimated at 520.000-600.000 mature individuals (BirdLife International 2013). Although the overall population trend is decreasing the species is considered least concern (Wetlands International 2006).

Figure 1. Distribution map of *Oxyura jamaicensis jamaicensis* by Cornell lab of Ornithology

Introduced range

Belgium:	First observed in 1979, the species is now recorded on a regular basis. First isolated breeding occurred in 1991 (Jacob 2010). Latest estimated population: around 15 individuals.
Rest of Europe:	Recorded in 21 Western Palearctic countries (see figure 2) from Belgium east across to Turkey, south to Spain, Portugal, Italy and Morocco and north to Norway; Iceland. The UK had the largest population with almost 6,000 wintering individuals (in January 2000) before culling, followed by France with at least 50 breeding pairs. Meanwhile, by April 2012, UK number have been brought down to about 60 birds within a Life-funded eradication programme run since 2005 (pers. comm. Iain Henderson). Other countries currently have very low numbers (Cranswick and Hall 2010).
Other continents:	Observations of the species are reported from North Africa (Algeria, Morocco and Tunisia).

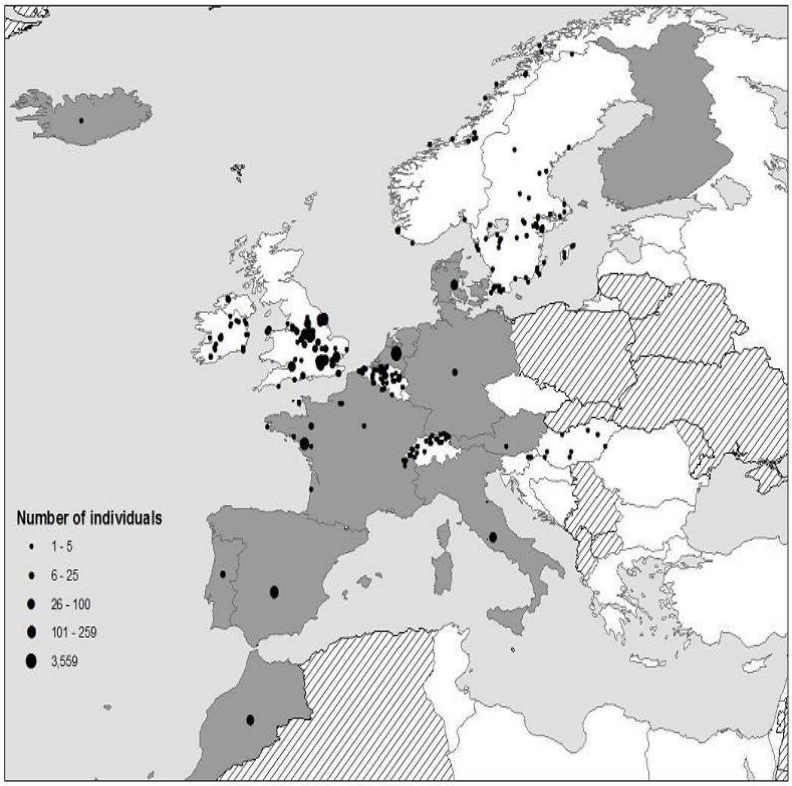

Figure 2. Distribution of Ruddy Duck records in Europe, 1996 to 2009 (Cranswick and Hall 2010). **Dots** indicate the location of all observations during the period. **Countries shaded grey** are those where Ruddy Ducks were present, but coordinates were not provided for observations. **Hatched countries** indicate those for which no data were received. Location information were provided for some observations in France, while single dots placed centrally in Austria, Denmark, Germany, Iceland, Italy, Morocco, the Netherlands and Spain signify the total numbers of birds. Locations in the UK are plotted only for observations in winter 2009/10.

1.4 REASONS FOR PERFORMING RISK ANALYSIS

In Europe, *Oxyura jamaicensis* (Ruddy Duck) threatens the globally endangered White-Headed Duck (see *Oxyura leucocephala* in IUCN Red List of Threatened Species) with extinction through introgressive hybridization and competition (Munoz-Fuentes et al. 2007; Rhymer & Simberloff, 1996; Kumschick & Nentwig, 2010; Muñoz-Fuentes et al., 2013). It is known that 'Ruddy Duck x White-headed Duck' hybrids are fertile to the second generation in captivity, which poses an increased threat to the survival of the White-headed Duck. Given that White-headed Duck in Spain is now protected from hunting and habitat loss, introgression with the Ruddy Duck may be the greatest long-term threat to the White-headed Duck (Henderson, 2010).

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.

Probability of spread and establishment of Ruddy Duck in most of the European countries is high. Probably benefitting from adequate climatic conditions and the availability of suitable habitats, introduced populations of Ruddy Ducks grew rapidly in the UK until the early 2000s (Henderson 2010). The species is also highly mobile and this was reflected by increases in several neighboring countries, notably France, Belgium and the Netherlands. There were also increased numbers of records in Northern, Eastern and Southern Europe and even Northern Africa. The absence of data for many countries in Eastern Europe precludes a clear picture of the true extent of the range, but it must be concluded that the range of wandering Ruddy Ducks expanded to cover a large part of Europe by the mid-2000s.

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.

Nowadays, the species regularly occurs in Belgium. Figure3 shows sites of observations recorded from January 2000 to November 2012. Since 1979, it was seen every year and his population is most recently estimated at ca 15 individuals. The first unsuccessful breeding attempt was recorded at Ploegsteert in 1991. More recently, the species started breeding with some regularity (table 1). The state of Ruddy Duck as a breeding bird in Flanders is extensively described in Spanoghe et al. (2010). In line with a growing population in The Netherlands on the Markiezaatsmeer (9 pairs in 2005) (Bergen op Zoom, Noord-Brabant), a first observations of summering birds was done in 2004 in the nature reserve Kalmthoutse Heide. In 2005 (1 pair), 2006 (3 pairs) and 2007 (1 pair) territorial couples were observed and breeding was suspected. However, breeding was believed to be unsuccessful here (Spanoghe *et al*. 2010, Adriaens *et al*. 2011).

year	Number of loactions	Breeding pairs	Successful breeding pairs	Number of fled young	Location
2005	1	1	0	0	Kalmthoutse Heide
2006	3	3	0	0	Kalmthoutse Heide
2007	1	1	0	0	Kalmthoutse Heide
2008	3	3	2	min 6	Groot Rietveld, De Haasop
2009	2	3	3	13	Groot Rietveld, Bospolder
2010	1	1	1	3	Blokkersdijk

Table 1. : breeding occurrences of Ruddy Duck in Belgium since 2005

In 2008 and 2009, 3 to 5 breeding pairs were present in the harbour area near Antwerp. In 2009, 5 adults and 5 pulli were culled by Flemish administration (Agency for Nature and Forest) in Antwerp harbour area (site Groot Rietveld; T. Adriaens pers. com. 2012). In 2011, only 8 individuals were seen (including a brood of four ducklings) and a pilot project started in January 2012 with the aim of complete eradication of the species in the wild.

The number of captive individuals in Belgium (mostly Flanders) was estimated at 200-500 in official collections (Beck *et al.* 2002) and additional 200 specimens should be taken into consideration in non-official collections (Owen *et al.* 2006).

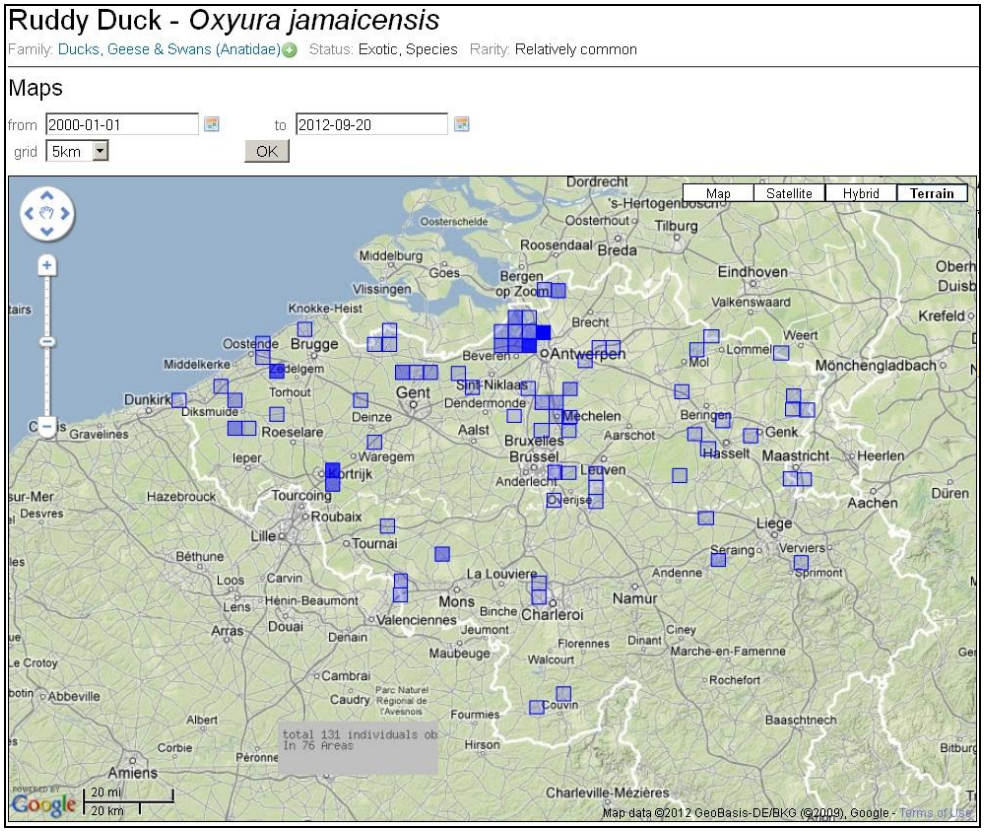

Figure 3. Distribution of Ruddy Duck records in Belgium, 2000 to 2012.
Source: http://observations.be consulted December 2012

2.1.2 Present status in neighbouring countries

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

At the end of 2010, non-native Ruddy Ducks were present in significant numbers in four countries (Table 1). Although it also occurs in a large number of other countries, numbers there are likely to be small (ten or fewer birds). Consequently, it is likely that the total population in the Western Palaearctic in 2010 was between 550 and 700 birds and in 2012 between 230-250 birds. The numbers of Ruddy Ducks on mainland Continental Europe now exceed those in the UK (Cranswick & Hall 2010).

Country	Individuals in 2010*	Individuals in 2012
Belgium	15	10-15
France	220	125-130
The Netherlands	60	35-45
UK	250	60

Table 2. Estimates of Ruddy Duck numbers in key countries, 2010 and 2012.

* *Estimates are from presentations to the third workshop for the EU Life-Nature project 'Eradication of Ruddy Ducks in the UK to protect the White-headed Duck', Madrid, November 2010. Numbers for 2012 are approximate and coming from various sources (Boele et al, 2012; ONCFS 2012; WWT/FERA counts 2012).*

Between 1996 and 2009, Ruddy Ducks occurred annually or near annually (that is, with records in ten to 14 years) in nine countries (France, Netherlands, Spain, Belgium, Ireland, Morocco, Sweden, Switzerland and UK). Three further countries (Denmark, Italy and Norway) reported Ruddy Ducks in over half the years during this period, and all 11 have observations for up to and including 2008 or 2009. Ruddy Ducks have occurred infrequently in seven further countries (Austria, Finland, Hungary, Iceland, Jersey, Portugal and Slovenia), where records have been of between one and three individuals.

- **In the Netherlands:**

In the Netherlands a restructuring of the nature conservation authorities has long delayed any action being taken, but numbers remain low and it seems likely that eradication can proceed quite quickly. Eradication of Ruddy Duck was considered a priority in the 2012 workplan of the Invasive Species Team (http://www.nieuwslog.nl/2012/12/09/werkplan-team-invasieve-exoten-nu-toch-openbaar/) . In the mean time, the species was regularly observed in most parts of the country. Figure 4 shows the geographic distribution of *O. jamaicensis* records January 2000 to January 2013. In 2010, the breeding population was estimated at 15-19 pairs and in the winter 2010/11 the total number of individuals was estimated at 33-40 individuals (Boele et al., 2012)

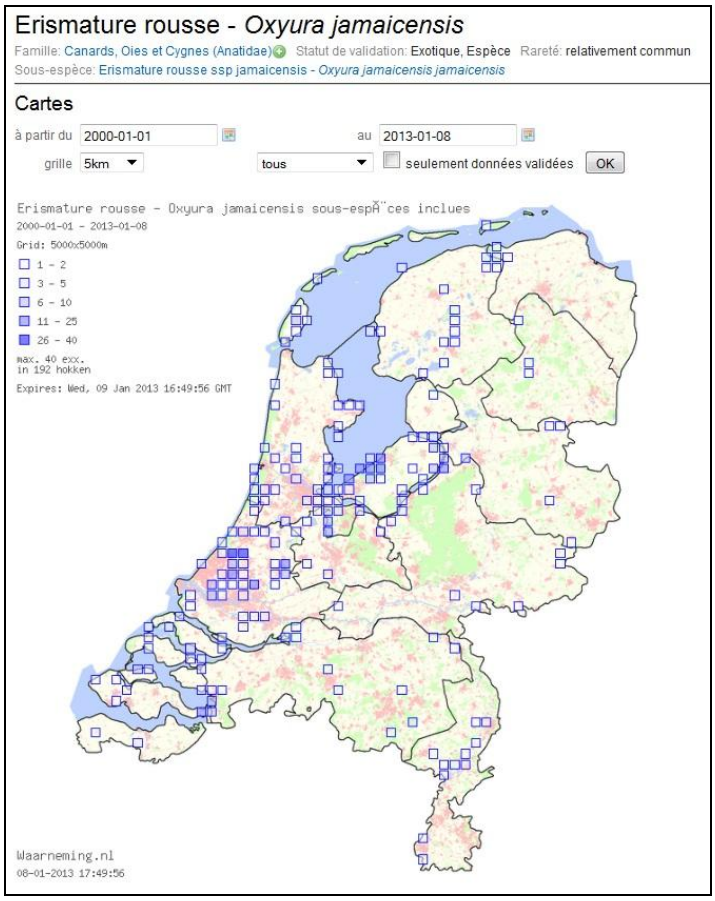

Figure 4. Geographic distribution of *O. jamaicensis* in The Netherlands from January 2000 to January 2013. Source: http://waarneming.nl

- **In France:**

In 2006 the total population of Ruddy Duck in France was estimated at around 300 individuals including about 40 nesting pairs in the wild. In winter 2010/2011, 239 birds were recorded and during winter 2011/2012 only 129 individuals were counted on the territory (ONCFS 2012). Previous population estimates are illustrated at figures 5a & 5b.

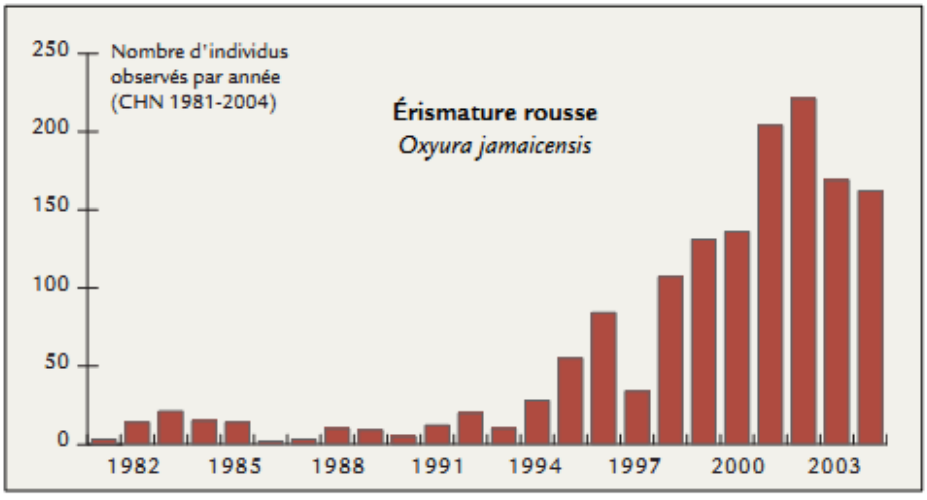

Figure 5a: Number of individuals (Ruddy Duck) observed in France between 1981 and 2004 (Dubois, 2007).

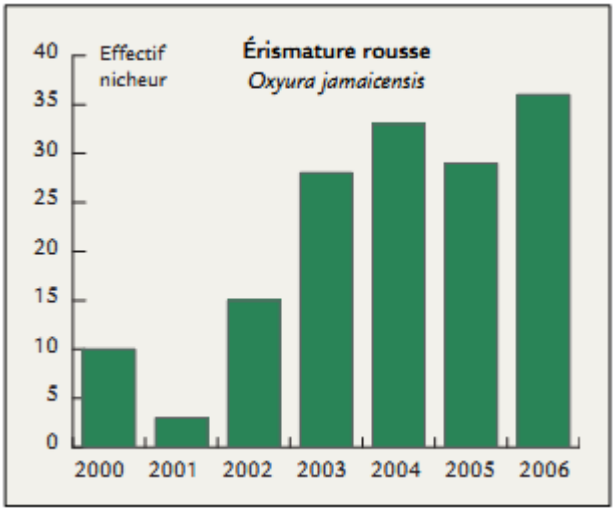

Figure 5b: Number of breeding Ruddy Duck recorded in France between 2000-2006 (Dubois, 2007).

- **In the United Kingdom and Ireland:**

Since the start of the eradication program, the Wildfowl & Wetlands Trust (WWT) has carried out independent surveys of key Ruddy Duck wintering sites. Between April 2011 and March 2012, a total of 123 adult and immature Ruddy Ducks were shot on 20 sites. As the population has fallen the birds are to be found on fewer sites and the Food and Environment Research Agency (FERA) continues to target breeding and wintering sites which have not previously been visited. Shooting of Ruddy Ducks has now taken place on 132 sites across Scotland, England and Wales since 2005, including four new sites in the last year. In January 2012 a single count was carried out in conjunction with FERA. A total of 109 sites were surveyed and Ruddy Ducks were found on 16 of these. The total count was 62 birds. Two separate counts were carried out in Northern Ireland in January and March 2012. In this case the peak count was only three individuals (January), only one of which was a female bird. Since the January 2012 counts, a further 64 Ruddy Ducks have been culled. Being aware that some birds are to be found on sites not covered by the WWT/FERA counts, the current UK population is estimated to be around 60 individuals (see trends in wild population from 1967 to 2011 on figure 6).

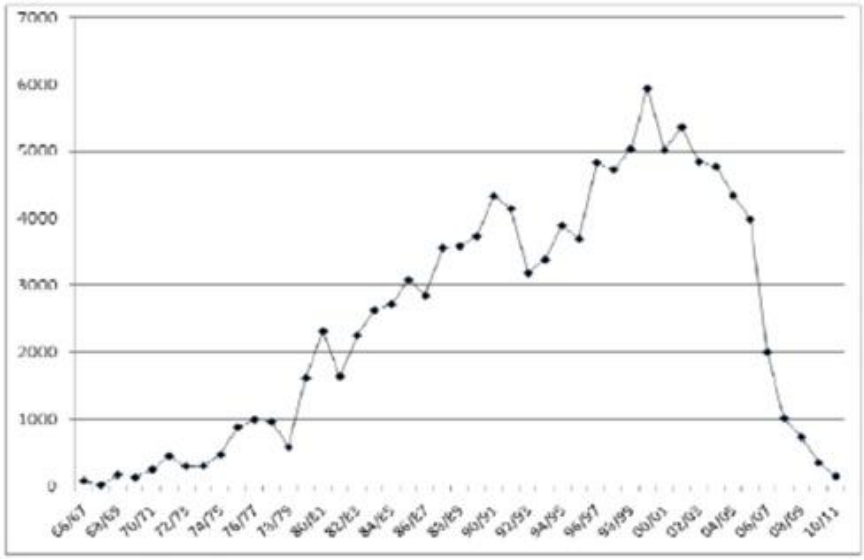

Figure 6: Number of individuals (Ruddy Duck) observed in the UK between 1967 and 2011 (FERA 2011).

It is clear that eradication of Ruddy Ducks from the UK remains feasible and that numbers continue to fall as a result of the control effort. FERA-DEFRA has agreed to fund additional work in 2012/13 in line with the commitment to eradicate Ruddy Ducks by 2015 (FERA 2012).

- **In Spain:**

From 1984 to 2011, 186 Ruddy Ducks and 68 hybrids have been eradicated for a total of 254 birds. The following figure (7) shows the information indicated graphically between 1984 and 2011.

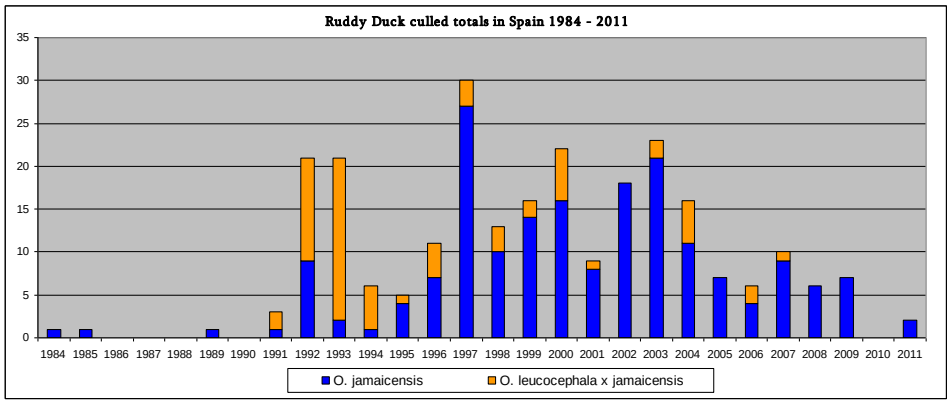

Figure 7: Number of Ruddy Duck and hybrids with White-headed Duck culled in Spain between 1984 and 2011 (Muñoz-Fuentes *et al*.2013)

The last probable breeding attempt took place in 2007 when a hybrid of *O. leucocephala* and *O. jamaicensis* was detected and shot. Since 2007 no hybrids has been detected and the number of Ruddy Ducks has been drastically reduced. Last observations were made in 2011, when two birds were culled.

A clear link between the trends in number of Ruddy Duck in UK and Spain and number of hybrids between White-headed Duck and Ruddy Duck in Spain has been recently presented (Muñoz-Fuentes *et al*., 2013).

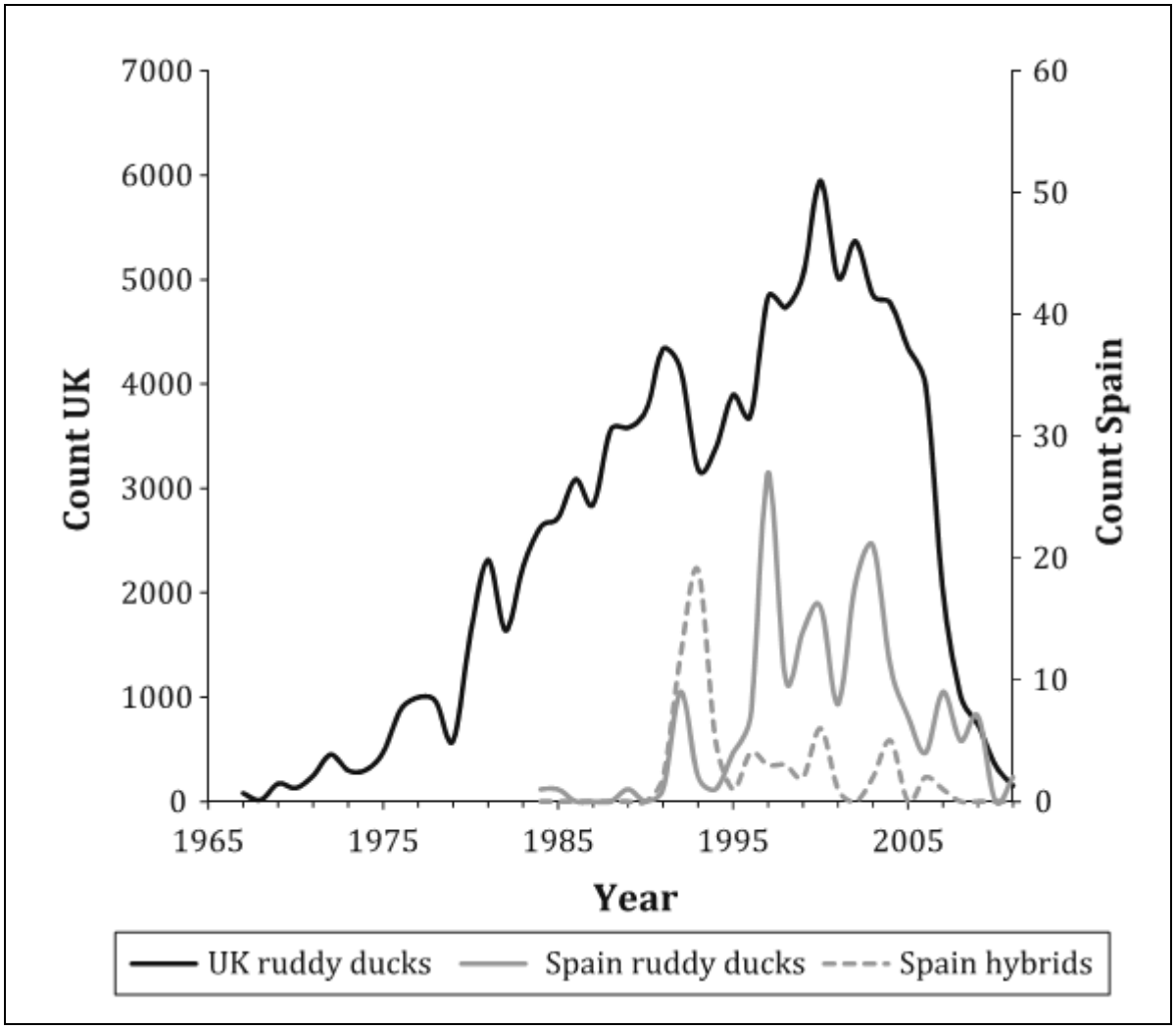

Figure 8. Population trends of Ruddy Duck in the UK and Spain, and hybrids between White-headed Duck and Ruddy Duck in Spain. A decrease of Ruddy Duck numbers in the UK correlated with a decrease in Ruddy Duck and hybrid numbers in Spain.

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).

The first observation of Ruddy Duck in Belgium occurred in 1979. The first observations of birds with breeding behaviour took place at Ploegsteert in 1991 and maybe also in 1992 (Jacob, 2010). In Flanders, first observations of birds with breeding behaviour was at Kalmthoutse Heide nature reserve in 2004. This observation coincides with the increasing population in Dutch neighbouring area 'Markiezaatsmeer' (Spanoghe et al. 2010). The first breeding attempt occurred in 2005 and the first successful breeding pair was reported in 2008. Detailed maps and accounts of important wintering locations and summering/breeding locations can be found in Adriaens et al. (2011).

The species was not deliberately introduced in Belgium and the only known pathway of entry in our country is by dispersal of individual from neighbouring countries.

ENTRY IN BELGIUM

The species first entered Belgium in 1979 by natural colonization from the UK introduced population and subsequently from established populations in neighbouring countries. The species was not introduced in Belgium although it is very likely that there are also some local escapes from private collections.

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

Reproduction is sexual and seasonal (from April to August). Timing of breeding is controlled by physiological readiness modified by food availability, stability of water levels and available nesting cover. Ruddy ducks may abandon eggs and forego breeding if conditions become unsuitable. Breeding strategy is a mixture of monogamy, polygyny and promiscuity (Snow *et al*. 1998). Brood parasitism with rails, grebes and other duck species has been reported (del Hoyo et al. 2011). Ruddy Ducks can nest up to 4 times per season if eggs are lost. There is usually only one brood per year, but there can be a double brood (2-3 young per female per year; Snow *et al*. 1998).

O. jamaicensis produce large eggs to maximize survival of large nidifugous young. They breed first when one-two years old. They arrive on breeding grounds in April, nest building occurs mainly in May, incubation in June, and most broods hatch in July. Birds leave breeding areas in August/September. In the USA, age composition in autumn is estimated at 1:1 adults to juveniles. The sex ratio is male biased (c1.1-1.2 males per female in late winter). Survival rates are unknown. Maximum lifespan of wild ringed individuals in the USA is 13 years (Clapp 1982), but most were reported dead less than 2 years after ringing (US Dept. Interior unpubl. data); 18 captive birds had mean lifespan of 2.4 years.

B/ Climatic requirements[2]

[2] 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.

The distribution of the Ruddy Duck covers a wide range of climate zones. They are distributed from Alaska to Patagonia in their native range. Comparing climatic niches of native and non-native Ruddy Duck populations the whole of Europe is suitable for Ruddy Duck and they currently only occupy a part of the suitable climate space (Strubbe Diederick, com. pers.). Currently, breeding seems confined to western and central Europe but migrant or dispersive individuals are found from the North of Scandinavia to Spain and Turkey.

C/ Habitat preferences[3]

The habitat of *Oxyura jamaicensis* (Ruddy Duck) includes marshes, lakes and coastal areas; and when not breeding, on sheltered brackish and marine coastal areas as well as lakes and rivers (temperate Zone). They nest on freshwater marshes, sloughs, lakes, and ponds, and in areas where open water is bordered by dense aquatic vegetation. The nest is a floating structure of marsh plants hidden by growing plants. Ruddy Ducks lay eggs in nests of other waterfowl species. They may nest at very small waterbodies of less than 0.5 hectare (InfoNatura, 2004).

D/ Food habits[4]

Oxyura jamaicensis feed on benthic invertebrates, especially chironomid larvae and aquatic plant seeds (Snow *et al*. 1998).

E/ Control agents

Egg predators include raccoons, minks, skunks, foxes, corvids, and Red-tailed Hawk (*Buteo jamaicensis*) and Great Horned Owl (*Bubo virginianus*) in the native range. Gulls, herons and fish such as pike and bass prey on ducklings (Snow *et al*. 1998). The species is hunted in parts of its native range. Predators have limited impact on adults in winter (excepting hunting pressure by humans).

F/ Establishment capacity in Belgium

The species is already established as a breeding bird in Belgium. Suitable habitat and climatic conditions are encountered in all districts of our territory (except probably the highest part of Ardenne district). Further extension of its distribution are therefore highly likely (without implementation of an international eradication plans).

G/ Endangered areas in Belgium

All marshes, lakes, ponds, freshwater and brackish streams and coastal areas are potentially suitable for *O. jamaicensis* establishment, where it can share its breeding habitat with e.g. *Podiceps nigricollis*. Many of these habitats may be classified as sensitive or endangered areas (e.g. natural reserves or Natura 2000 sites). Although establishment is possible, impacts of invasion in our country may be considered as minor since the main threat of the species is competition with White-headed Duck (not

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

[4] For animal species only.

present in Belgium; see chapter 1.4.). General threat of any invasion of *O. jamaicensis* should be considered at international and certainly European level.

Establishment capacity in the Belgian geographic districts:

Districts in Belgium	**Environmental conditions for species establishment**[5]
Maritime	Suboptimal
Flandrian	Optimal
Brabant	Optimal
Kempen	Optimal
Meuse	Optimal
Ardenne	Suboptimal
Lorraine	Optimal

ESTABLISHMENT CAPACITY AND ENDANGERED AREAS IN BELGIUM

The Ruddy Duck is likely to maintain a self-sustaining population in Belgium (as well as in neighbouring areas) because appropriate climatic conditions and habitats are encountered.

Endangered areas may be suitable for population establishment although with local minor negative effects to be expected in Belgium itself. But the species can expand from Belgium to other regions.

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

Ruddy Ducks *Oxyura jamaicensis* are common and widespread in their native habitat in North America where there is a stable population of around half a million birds (Wetlands International 2006). Northern populations in North America migrate south to Florida and as far south as Costa Rica. The European population is derived from introductions and escapes (Munoz-Fuentes et al, 2006). There is no confirmation of natural vagrancy from North America to Europe, even if some records from the Azores and Iceland suggest it. Seasonal migration occurs in Europe and birds may travel several thousand kilometres from breeding to wintering grounds.

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

B/ Human assistance

The species was introduced in the UK in the late 1940s, Ruddy Ducks were introduced into a private wildfowl collection and a naturalised population soon became established as a result of a small number of offspring escaping from these birds collection. Since the mid-1960s, Ruddy Duck numbers have increased rapidly in the UK, from an estimated 20 wintering birds to 5946 in January 2000 (Kershaw & Hughes 2002). It is now established that all/most records on the Continent results from natural spread to Europe from the initial UK population. There were increases in most countries where the species regularly occurred during 1996–2009. This was most notable in Belgium, but also in Nordic countries, and to a lesser extent in Italy and Switzerland. In all of these countries, numbers appear to have fallen (or at least held roughly stable) since 2005, with the notable exception of Belgium, where peak numbers were observed in the second half of the decade. In contrast, numbers in Ireland have generally decreased over the period. Small numbers of Ruddy Ducks are recorded in all Länder in Germany, though the overall trend is not clear due to the lack of data from individual Länder.

Private collections (official or not) are still present in many countries. Since escape of captive birds is always a possibility, the establishment of new feral population in Europe should be considered as a real risk.

DISPERSAL CAPACITY

Ruddy Duck can easily disperse and establish itself over large distances (several thousand kilometres is possible). Most countries in Europe, North Africa and Western Asia may be suitable for *O. jamaicensis's* invasion and establishment.

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 (Unlikely)

Competition with native species in Belgium or in Europe can be considered as negligible at this stage of invasion.

In extreme case of invasion and development of Ruddy Duck feral populations in Europe, potential negative effects on other waterfowls through competition for food and nest sites may be expected

(BirdLife International 2000; Green & Hughes 2001). A review by Hughes (1996) suggests that Ruddy Duck can be aggressive birds that (often) interact with ecologically similar species. However, none of the publications listed gives evidence that the Ruddy Duck is the driving force behind the decline of at least one native species.

B/ Predation/herbivory (Unlikely)

No cases of predation or herbivory impact are reported for this species.

C/ Genetic effects and hybridization [LIKELY]

The most important expected and well documented impact of the Ruddy Duck *Oxyura jamaicensis* invasion is hybridization in Spain with the White-headed Duck *Oxyura leucocephala* (a globally endangered species). Muñoz-Fuentes *et al*. (2007) assessed the effects of hybridization on the Spanish White-headed Duck, which constitute 25% of the World population of this species, using a panel of eight nuclear intron markers, 10 microsatellite loci, and mtDNA control region sequences. These data allowed parental individuals, F(1) hybrids, and the progeny of backcrossing to be reliably distinguished. They showed that hybrids between the two species are fertile and produce viable offspring in backcrosses with both parental species. To date, however, they found no extensive introgression of Ruddy Duck genes into the Spanish White-headed Duck population, probably due to the early implementation of an effective Ruddy Duck and hybrid control programme. They also show that genetic diversity in the expanding European Ruddy Duck population, which was founded by just seven individuals (see below a summary of the results of the study published in 2006 by Muñoz-Fuentes *et al*.), exceeds that of the native Spanish White-headed Duck population, which recently recovered from a severe bottleneck. They argue that unless effective control of Ruddy Duck is continued, genetic introgression will compromise the unique behavioural and ecological adaptations of White-headed Duck and consequently their survival as a genetically and evolutionary distinct species.

A genetic analysis (Muñoz-Fuentes *et al.* 2006) assessed 67 birds from the USA, 29 from Great Britain, 19 from France, 39 from Spain, three from Iceland and 14 from two different wildfowl collections in the UK. Limited genetic diversity in the European population was consistent with a founder population as small as the seven birds originally imported to Europe, and from which all European birds are thought to have originated. The study confirmed that the European Ruddy Duck population is likely to derive solely from the captive population in the UK and there was no evidence of recent arrivals from North America or of an admixture between Ruddy Duck from Europe and North America.

D/ Pathogen pollution [Unlikely]

Potentially, Ruddy Duck may be responsible for pathogen pollution. However no such cases were reported for Ruddy Duck and the risk of such pollution should not be considered for this species (at least not more than for any native aquatic migrating bird).

E/ Effects on ecosystem functions [Unlikely]

The impact on ecosystem processes and structure is considered negligible at this stage of invasion in Belgium.

ENVIRONMENTAL IMPACTS

Hybridization with the globally threatened White-headed Duck (*Oxyura leucocephala*) is the most important if not the only environmental impact to be expected in Europe. Ruddy Duck is dominant over this species in the wild and introgressive hybridization may lead to *O. Leucocephala* extinction. Negative effects on other aquatic birds through competition for food and nest sites or on ecosystem functions are considered negligible at the present stage of invasion and are not expected to be serious even in case of a strong population increase.

2.2.2 Other impacts

A/ Economic impacts

Describe the expected or observed direct costs of the introduced species on sectorial activities (e.g. damages to crops, forests, livestock, aquaculture, tourism or infrastructures).

No damage to crops, forests, livestocks, aquaculture, tourism or infrastructures are to be expected. Costs of eradication are, however, considerable. There is an on-going eradication program in the UK since 1992 with the objective of reducing the population to less than 175 birds or 5 % of the 1999 population at an estimated cost of 3.6 million GB Pounds or 4.4 million Euros over a 4-6 year period. By 2004, at least 15 countries in the Western Palearctic were taking actions to control populations at great costs.

B/ Social impacts

Describe the expected or observed effects of the introduced species on human health and well-being, recreation activities and aesthetic values.

No effect on human health or well-being are to be expected.

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.

Muñoz-Fuentes et al. (2013) report on a series of genetic studies that have enabled and supported management decisions to the benefit of the White-headed Duck. First, genetic data confirmed that Ruddy Duck and White-headed Duck are two distinct species, each of which is more closely related to other *Oxyura* species. Second, molecular studies indicated that Ruddy Duck in Spain, Iceland and elsewhere in Europe were of captive origin and not descendants from vagrants from their native North America. Third, genetic methods were used to distinguish among different hybrid generations in Spain and detected no Ruddy Duck introgression in birds identified morphologically as White-headed Duck. Collectively, **these results supported management decisions to eradicate Ruddy Duck from Europe**. Subsequently, a **control programme reduced the UK population by over 95 % by 2010**, and the **arrival of Ruddy Duck to Spain decreased from 21 birds in 2003 to two sightings in two years period 2010–2011**. However, **increased efforts to control small Ruddy Duck populations elsewhere in Europe and Morocco are still required** to ensure conservation of the White-headed Duck. This case of invasion by hybridization demonstrates that successful control is feasible given early detection followed by a rapid response plan; **it also shows the contribution of research to management and that to guarantee the conservation of an endangered native species action may be required in countries outside its distribution range**.

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.

Natural spread of Ruddy Duck from the introduced UK population (initially) and subsequently from feral populations in neighbouring countries (e.g. France, The Netherlands) was and still is the main (or only) pathway for Ruddy Duck entry in Belgium.

As described in chapter 2.1.1., official and non-official private collections in Belgium may represent an estimate of 400 to 700 individuals. Since the probability of bird escaping into the wild is never zero, birds in captivity are to be considered as a potential, though secondary, pathway of entry into the wild.

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.

“Managing non-native species: don’t wait until their impacts are proven.” (Simberloff D. 2003).

With Genovesi & Shine (2003) and Edelaar & Tella (2012), it is proposed that, as well as dealing with problematic established species, management of exotic birds should be especially targeted at small, establishing populations that can be eliminated effectively and efficiently, well before they become invasive on the basis of both geographical and impact criteria.

Major steps are to establish baseline information and monitor existing wild and captive populations. Legislation should be improved to prevent introductions and to limit or remove populations. Strict controls, such as licensing, should be put in place to prevent escapes or ban their inclusion in captive collections.

Nowadays, the absolute necessity and obligation to eradicate alien Ruddy Ducks in Western Europe is recognized by many international conservation conventions and agreements, such as Article 11 of the EU Birds Directive, the recommendations of the AEWA and the Bern Convention (Rec. 77, eradication of invasive exotics in general). An Action Plan for eradication in the Western Palearctic was prepared in 1999.

In Belgium, a Flemish Governmental Decree (Besluit van de Vlaamse Regering met betrekking tot soortenbescherming en soortenbeheer 15 mei 2009) prohibits any introduction of non-native species into the wild and outlaws all alien species that are not in the game legislation (= they can be controlled by legal means). It also provides the possibility of setting up a regional action plan for any invasive species through a Ministerial Decision. In the Brussels Capital Region, intentional introduction into nature is already prohibited, as the species is listed as an invasive alien on Annex IV of the recently approved Ordinance on Nature Conservation (March 1, 2012, Article 77). It is also prohibited to sell, hand over (free or with payment), to exchange or purchase Ruddy Duck. The ordinance also provides the legal basis for preventive actions, control and eradication, for which an advice of the Council for the Environment and the Brussels High Council for Nature Conservation (Art. 78) is required. In the Walloon region, a general interdiction on releasing species into the wild is in force with the Decree on Nature Conservation.

(i) Prohibition of organism importation, trade and holding

The import of Ruddy Duck in the EU has already been banned by the EU implementation of the CITES convention (EU Wildlife Trade Regulation 338/97). Owen et. al (2006) mention, based on sources within Aviornis (an organisation of bird fanciers occupied in aviculture), that distributors in the Netherlands and Belgium regularly transport waterfowl to other countries and argue that the potential number of water birds in trade may be estimated at 60,000. Figures of trade in Ruddy Duck in Belgium are unknown. Alternative options for a preventive policy for new introductions are the establishment of a positive list for wild waterfowl (Beck et al, 2002) or regional trade bans.

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

The revised EU Action Plan establishes the long-term objective to phase out all Ruddy Duck captive populations by 2020, monitoring of the captive population and prevent breeding / encourage elimination of birds in captivity (Cranswick & Hall, 2010). The only method used to prevent introduction is keeping the birds in secure aviaries and/or with their wings clipped.

Legislation forbidding introduction in the wild of potential invasive species and immediate decision of eradication at early stage of invasion 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).

The EU Action Plan also provides an extensive report about animals in captivity by the Member States (number of collections, specimens, some traded, some hatchlings etc.). To achieve this, the construction of a registry is required. If a restriction / ban on keeping birds in captivity is not feasible, obligatory sterilization of Ruddy Ducks in captivity could be an option.

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)?

Due to its size and characteristics (conspicuousness) and the very large number of people looking at birds in Belgium, the species can be detected at an early stage of his invasion. Breeding birds can be harder to detect. Observers should therefore note any territorial behaviour or courtship (the typical "drumming" behaviour of the males), before breeding starts, mostly in April.

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

Culling (shooting) has been applied in France since 1998, Spain since 1993 and Portugal. The largest population and assumed source of some introductions is the UK where culling has been performed though controversial.

In Belgium, catching adults with cages using sound and a male decoy duck was tested but proved inefficient (G. Spanoghe pers. comm.). However, the eradication effort that already took place in Flanders (2009-2011) was the result of voluntary cooperation between different bodies (governmental and others) (Spanoghe *et al.* 2010). Control actions were restricted to sites managed by the government, an operational framework to tackle breeding Ruddy Duck outside these areas is currently lacking. More recently, in 2012, two birds have been captured in a zoological park and three « wild » birds have been shot in Groot Rietveld (Beveren) in cooperation with a specialised hunter. These actions are planned to be extended over the Flemish territory and are closely monitored by a steering group uniting different stakeholders and governmental bodies (Agency for Nature and Forest).

In the UK, a four year research programme (1992-1996) evaluated the success of seven control techniques (winter rifle-shooting, winter shotgun-shooting, summer rifle-shooting, summer shotgun-shooting (all shooting land based), winter trapping using baited cage traps, nest trapping females, and egg-control). Population modeling suggested that shooting was the most efficient technique for Ruddy Duck control, particularly breeding season shooting and shooting of the large wintering flocks (Henderson, 2010). Shooting during the summer breeding season was at least 2.5 times as efficient

as nest-trapping, and at least 3.5 times as efficient as egg destruction (Hughes 1996). A regional trial of control methods (1999-2002), which culled over 2,000 Ruddy Duck, has shown shotgun-shooting from boats, throughout the year, to be even more cost effective. Following the research and trials, a program aiming to eradicate Ruddy Duck from the UK began in 2005. Since then over 6,800 Ruddy Duck have been culled across England, Scotland and Wales, and as of March 2010 the UK population is thought to have been reduced by over 95% since the start of the eradication program (Henderson, 2010).

A number of other methods are used in the native range for trapping Ruddy Duck, such as (baited) (dive-in) traps, decoy-traps, drive-by netting, submerged mist netting or nightlighting. Although labour-intensive, they might hold potential at places where shooting is not an option.

National control programs for Ruddy Ducks and hybrids are now in place in Spain (84 Ruddy Ducks and 57 hybrids shot to December 2000), France (43 Ruddy Ducks shot to October 2000) and Portugal (one Ruddy Duck and two hybrids shot), but not in other countries, such as The Netherlands, and Morocco. In France and Spain where there are much smaller numbers of birds present, often only single birds in flocks of other ducks, a more selective shooting technique needs to be used, involving the use of rifles, hides (both floating and shore-based) and boats to move birds towards marksmen.

European countries aim for complete eradication by 2015, and the most recent data show that numbers continue to fall in Europe. In 2011, only two Ruddy Ducks were observed in Spain, both of which were culled, and in France, 127 Ruddy Ducks were culled out of 239 recorded; in the UK, numbers have fallen to well below 100 as of 2012. In the Netherlands, numbers remain low despite no eradication program up to 2012 (NNSS, 2012).

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

There is no report of undesirable consequences of Ruddy Duck eradication on non-target species or on ecosystem services in Europe. When birds are destroyed (egg sterilization, trapping, culling, etc.) in habitats with high densities of native birds or close to mixed colonies, eradication 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).

When shooting, sufficient attention should be paid to minimize disturbance to other waterfowl. This is also a prerequisite for better public acceptance of the measures taken. The significance of disturbance is depending on the use of boats, the frequency of shots and the vicinity of other wetlands where native birds can divert to (Townshend & O'Connor, 1993, Briggs 2007). Furthermore, it is advisable to remove carcasses from the site and foresee proper processing of these.

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

The species is conspicuous (easily detectable) and eradication techniques are efficient. The probability to succeed to a total eradication can therefore be considered as high. Considering the fact that Belgium, unlike UK, holds no big wintering concentrations, culling during the breeding season is the preferred option. Based on the current knowledge of population management for Ruddy Duck,

active management should be aimed at - in descending order of importance (1) preventing breeding (2) reducing the number of summering birds (March to September). April is the best time because of territorial and courtship behaviour in males and the start of breeding. Controlling wintering birds (October to February) is, in Belgium, least desired, as this often concerns individual birds within large concentrations of other waterfowl which implies a high potential for disturbance.

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

Obviously, although widespread and established at an advance stage of invasion, containing Ruddy Duck to an acceptable population level is feasible. This was demonstrated in the United Kingdom but with considerable efforts and costs. From a maximum population of around nearly 6000 individuals in 2000, the feral population is now estimated at less than 60 individuals.

RISK MANAGEMENT
Management decisions to eradicate Ruddy Duck from Europe has been taken to ensure conservation of the White-headed Duck. The control programme reduced the UK population by over 98 % by 2012, and the arrival of Ruddy Duck to Spain decreased from 21 birds in 2003 to two sightings in the two years period 2010–2011. Increased efforts to control small remnant Ruddy Duck populations elsewhere in Europe and Morocco are still required. This case of invasion by hybridization demonstrates that successful control is feasible given early detection followed by a rapid response plan; it also shows that to guarantee the conservation of an endangered native species action may be required in countries outside its distribution range. **Official and non-official private collections in Belgium may represent an estimate of 400 to 700 captive individuals. Since the probability of bird escaping into the wild is never zero, birds in captivity are to be considered as a potential, though secondary, pathway of entry into the wild.** **The revised EU Action Plan establishes the long-term objective to phase out all Ruddy Duck captive populations by 2020, monitoring of the captive population and prevent breeding / encourage elimination of birds in captivity. The only method efficient to prevent accidental introduction is keeping the birds in secure aviaries and/or with their wings clipped.**

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