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FOURTH MEETING OF THE TECHNICAL COMMITTEE OF THE AGREEMENT ON THE
CONSERVATION OF AFRICAN-EURASIAN MIGRATORY WATERBIRDS (AEWA)
12-13 MAY 2003, Tashkent, Uzbekistan

GUIDELINE ON AVOIDANCE OF INTRODUCTION OF NON-NATIVE MIGRATORY WATERBIRD SPECIES

INTRODUCTION

The Meeting of the Parties adopted at its second session, which took place from 25-17 September 2002 in Bonn, Germany, the Guideline on Avoidance of Introduction of Non-native Waterbird Species by Resolution 2.3. In the operational part of 2.3 the following is stated:

1. *Takes note of the conservation guidelines on national legislation for migratory waterbirds as contained in AEW/MOP2.12 and of the conservation guideline on avoidance of introductions of non-native migratory waterbird species as contained in AEW/MOP2.13, in the sense of article IV of the Agreement, and accepts them as interim guidance for Contracting Parties in the implementation of its Action Plan;*

The 5th paragraph of the same part of this Resolution reads as follows:

2. *Instructs the Secretariat and the Technical Committee, within available resources and in consultation with Parties and appropriate organisations, to review all the existing AEW guidelines regularly, in particular taking account of the additional comments provided by participants to the Meeting of the Parties;*

This paragraph makes clear with is expected of the Technical Committee.

PROPOSAL OF THE SECRETARIAT

The Secretariat would like to publish all existing Conservation Guidelines, including the one on Avoidance of Introduction of Non-native Species as soon as possible. Technical Committee members are requested to review the current text of the latter once more. Furthermore the Secretariat would like to receive some guidance regarding the target groups for this specific guidelines and how to reach them.

Annex 1:

DRAFT

**GUIDELINES ON AVOIDANCE OF
INTRODUCTIONS OF NON-NATIVE WATERBIRD SPECIES**

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GUIDELINES ON AVOIDANCE OF INTRODUCTIONS OF NON-NATIVE WATERBIRD SPECIES

Reason for the Guidelines

Article III to the African-Eurasian Migratory Waterbird Agreement includes the following:

Parties to the agreement shall:

“prohibit the deliberate introduction of non-native waterbird species into the environment and take all appropriate measures to prevent the unintentional release of such species if this introduction or release would prejudice the conservation status of wild flora and fauna; when non-native waterbird species have already been introduced, the Parties shall take all appropriate measures to prevent these species from becoming a potential threat to indigenous species.”

Many of the states within the agreement area have also made commitments under their domestic legislation and other international conventions that strengthen their intention to maintain biodiversity and control invasive and non-native species that threaten that biodiversity, be it habitats or individual species.

The quality of the legislation dealing with non-native species in the Agreement area was assessed using a questionnaire by Blair *et. al.* (1999) and their assessment is summarised in Table 1.

Table 1. The number of states (of the 36 legislative units within the Agreement Area) with different quality and effectiveness of domestic legislation dealing with non-native waterbird species (summarised from Table 7 in Blair *et. al.* 1999).

	None	Low	Mixed/Partial	Good/high	Not Known
Legislation Quality	2	1	9	22	2
Legislation Effectiveness	-	2	20	8	4

In general, the coverage by high quality legislation in the area is good, though it is noticeable that the effectiveness of that legislation is generally mixed, even in countries with a long history of conservation achievement. This is mainly because of the difficulty of policing such legislation in countries where the keeping of exotic waterbirds in captivity, in zoos and private collections, is commonplace and the deliberate and accidental release of full-winged birds is not uncommon.

The main international instruments include the Convention on Biological Diversity (Rio de Janeiro 1992) and the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention, Bern 1979).

Contracting parties to the Convention on Biological Diversity are committed under Article 8 to take action to:

“(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;

(k) develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species or populations;

(l) Where a significant adverse effect on biological diversity has been determined....regulate or manage the relevant process and categories of activities...”

Further, Article 13 of the convention commits contracting parties to:

“(a) Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in education programmes.....”

Article 11(2) of the Bern Convention states that Contracting Parties undertake:

“(b) to strictly control the introduction of non-native species.”

Although this convention refers to the conservation of European wildlife, states outside Europe that have an influence on European wildlife (e.g. through the protection of migratory species), may be full parties and thus participate in the implementation of the convention.

It appears that there is a wide range of relevant national and international statutes, as well as the Agreement itself, to which many countries in the Agreement area subscribe.

Introduction

We will define a non-native taxon as a species, sub-species or discrete geographical population that would not occur in an area without interference by man. This includes:

- A taxon introduced as a breeding bird to a region where it normally only occurred in the non-breeding season;
- A taxon introduced entirely outside of its previous known range;
- A taxon imported and taken into captivity at a location outside of its normal range;
- Domesticated taxa that have established in the wild, including domestic-type strains that have arisen by hybridisation between wild and domesticated individuals.

Problems with introductions occur because of the:

- (a) Import of non-native species; and
- (b) Deliberate or accidental release of these species, either in the past or today.

Most likely problems with non-native waterbirds arise from hybridisation with closely related species, previously separated by geographical barriers. Outside the Agreement area a number of waterbirds, such as the New Zealand Grey Duck *Anas superciliosa* are threatened by hybridisation with the Mallard *Anas platyrhynchos* (only 17% of Grey Ducks can now be regarded as ‘pure’; Williams 1994). The North American Black Duck *Anas rubripes* is under threat and the Mexican Duck *Anas platyrhynchos diazi* has all but disappeared as recognisable taxon from North America because of hybridisation with the Mallard, a species which is able to expand its range in North America only because of interference by man by way

of release of reared birds for hunting and the provision of food on artificial habitats (Callaghan & Kirby 1996). Examples of introductions within the Agreement area are given in Boxes 1-3.

Box 1: The African Yellow-billed Duck and The Mallard

The African Yellowbill, *Anas undulata undulata* occurs throughout southern Africa and is relatively common. The Mallard has been deliberately and accidentally introduced into the Cape provinces of South Africa and has become naturalised, especially in urban and peri-urban areas. The two species easily hybridise and the progeny are fertile, so the Mallard represents a threat to the integrity of the Yellow-billed Duck. There have been efforts to control the Mallard over a number of years, but there were still some at liberty in the South-western and Eastern Cape in the 1990s and escapes from unauthorised keeping are also considered to be a problem (Cape Nature Conservation 1994). The species is still considered to be a major problem, especially in the Western Cape Province and illegal keeping is common (K.A. Shaw pers. comm.). BirdLife South Africa supports an eradication programme (Berruti 1992).

Box 2: The North American Ruddy Duck and the White-headed Duck

The Ruddy Duck *Oxyura jamaicensis* was brought into the United Kingdom in 1948 as part of the wildfowl collection at Slimbridge, Gloucestershire, and started breeding soon afterwards. The young are good divers and many escaped capture and became free-flying. About 70 juveniles escaped into the wild between 1956 and 1960, and soon afterwards became established as breeding birds (Hudson 1976, Kear 1990). Numbers increased rapidly and reached about 4,500 at the turn of the century (Musgrove *et. al.* 2001).

Birds, presumably from Britain, soon reached the European mainland, the first record being in Sweden in 1965. By the early 1990s, the species had been recorded in 19 European countries, including 76 records from Spain, where a successful conservation programme had been put in place to safeguard the very rare White-headed Duck *Oxyura leucocephalea* (Hughes 1996).

It is known from studies in captivity that hybrids between the two species are fertile, and a number of hybrids occurred in Spain in the early 1990s despite strenuous efforts being made to control the Ruddy Duck and hybrids (Hughes 1996).

The UK government instigated research into control programmes and undertook intensive public awareness programmes in the early 1990s and control was stepped up again in 1999 (despite considerable controversy) to assess whether the eradication of the species was a feasible option. The three-year trial, which killed over 2,600 birds, concluded that the UK Ruddy Duck population could be reduced to fewer than 175 birds in between four and six years.

Other potential causes of these problems include predation, disease spread, competition, and disruption of nutrient dynamics. These become a particular problem when the cause exerts a particular controlling influence on community structure. In these cases the non-native species becomes a 'keystone species', causing ecological processes to be severely disrupted and reducing or extirpating populations of many native species, particularly those that require very specific ecological conditions (i.e. 'niche specialists') (Williamson 1996). However, problems are often difficult or impossible to foresee and the extent of impacts very difficult to assess.

The impact of non-native species through ecological competition with native species is difficult to quantify, though closely related species are inevitably likely to compete for resources. For example, the Mallard is said to threaten the New Zealand Grey Duck (Williams 1994) and the North American Black Duck *Anas rubripes* (Meredino *et. al.* 1994) because of competition for habitat as well as hybridisation. No doubt closely related species or those using the same resources (such as nest cavities) are very likely to be in competition (see Appendix 1).

Apart from hybridisation, the effects of invasive non-native species on native flora and fauna in the Agreement area are not well studied. However, evidence from other areas and circumstantial evidence here suggest that they do exist and there is a general consensus that, according to the *precautionary principle*, wherever possible, such species should be controlled (see e.g. SSC 2000).

Box 3: The Canada Goose

The Canada Goose *Branta canadensis* was introduced into England in the 17th century, primarily as an ornamental bird, but was later dispersed throughout Britain, primarily to provide hunting opportunities and to lessen the effects of high densities on agriculture. It was introduced to Sweden in 1933 and to other parts of Europe in later years (Callaghan & Kirby 1996). There are well-documented cases of the effects of these geese on agricultural habitats, but the effects on native fauna and flora are less well understood, though are likely to exist (Madsen & Andersson 1990). The geese winter and breed with closely related species such as Greylag *Anser anser* and a considerable amount of territorial aggression between the two species came to light in a Swedish study (Fabricius *et.al.* 1974). However, no effect on the number of breeding pairs of the native species was detected, although this may well occur if the density of both species together exceeds the carrying capacity of the habitat.

There are reports that the species has a damaging effect on reedbeds in England, a rare habitat there, (English Nature, pers. comm.) by grazing and trampling. There may also be an effect on water bodies from the deposition of nutrients by roosting geese. This has not been investigated thoroughly but there is considerable circumstantial evidence that nutrients from roosting waterbirds cause damaging eutrophication of lakes (Callaghan & Kirby 1996, Watola *et. al.* 1996).

The species has other impacts on man, such as damage to amenity areas (which may also affect native species), threats to public health in parks and water areas, and threats to air safety (a number of collisions with aircraft have been recorded) (Watola *et. al.* 1996).

Step Chart

Step 1: Establish baseline information on imports, holdings and established populations of non-native waterbird species

Step 2: Introduce or maintain monitoring programmes to periodically revise the baseline information

Step 3: Establish levels of potential threat posed by each non-native waterbird species, so as to prioritise action

Step 4: Establish or improve legislation to prevent the deliberate introduction of non-native waterbird species and allow their control where established populations exist

Step 5: Introduce measures to prevent escapes of non-native waterbird species from captive collections

Step 6: Introduce measures to prevent the import of high risk waterbird species, where the risk is ascertained by the risk assessment proposed under step 3

Step 7: Design control strategies to limit or remove high risk non-native waterbird species, test and report on their feasibility

- 7.1 Educate and raise awareness amongst key stakeholders
- 7.2 Obtain public support for any control strategies to be implemented
- 7.3 Carry out eradication or control programme
- 7.4 Monitor the success of the control programme

Step 1: Establish baseline information on imports, holdings and established populations of non-native waterbird species

Non-native species in the wild

The UK Government environment department recently commissioned a study on behalf of AEWA to establish what information was available on the status of non-native waterbirds in the Agreement area (Blair *et. al.* 1999). The research indicates that a large number of non-native species are at liberty in the Agreement area, some in self-sustaining populations. A total of 113 species (including 2 hybrid populations) was recorded as having escaped into the wild and survived at least one year.

Table 2. Summary information on the 16 species which Blair *et. al.* (1999) considered to present a potential problem to native species in the AEWA region (but see Appendix 1).

Species	Status
Sacred Ibis <i>Threskiornis aethiopicus</i>	Established in France (increasing), Italy and UAE. Potential threat (not serious) to colonial nesting species (Hérons, Egrets).
Greater Flamingo <i>Phoenicopterus ruber</i>	Occurs in Germany, the Netherlands, UK and South Africa, but no breeding so unlikely to be a major threat.
Chilean Flamingo <i>Phoenicopterus chilensis</i>	Has occurred in most countries of northwest Europe; breeding colony in Germany. May be a problem of competition if it reaches Greater Flamingo breeding range (see Appendix 1).
Mute Swan <i>Cygnus olor</i>	Introduced to many countries in Europe and to South Africa and reported to trample nest of Black Terns <i>Chilodrias niger</i> in France (but see Appendix 1).
Black Swan <i>Cygnus atratus</i>	Occurs in many countries in Europe (breeding in the Netherlands and UK). If numbers increase, it could threaten native species.
Greylag Goose <i>Anser anser</i> (incl hybrid)	Introduced and re-established in many European countries (including some non-native subspecies). Danger of erosion of purity of races.
Bar-headed Goose <i>Anser indicus</i>	Occurs in most European countries, with a few breeding pairs. Few at present, but could threaten native species if it increases (Appendix 1).
Canada Goose <i>Branta canadensis</i>	Increasing in UK (80,000 birds) and north-west Europe (60,000+), causes widespread agricultural conflicts and other threats (see Box 3).
Barnacle Goose <i>Branta leucopsis</i>	Breeds in UK (900 birds), the Netherlands (300) and Germany (500), few elsewhere. May pose similar problems to Canada Goose if it increases.
Egyptian Goose <i>Alopochen aegyptiacus</i>	Populations in UK (1,000), Belgium (600), the Netherlands (6,000) and Germany (3,000). No major threat (no closely related native species).
Ruddy Shelduck <i>Tadorna ferruginea</i>	Small numbers in western Europe, very few breeding (but increasing). Could compete for nest holes with native species if it increases.
Muscovy Duck <i>Cairina moschata</i>	Domesticated strain has escaped in many countries in small numbers. No current problems but could dominate other breeding species.
Mandarin Duck <i>Aix galericulata</i>	Occurs in the UK (7,000 birds), Germany (1,000), a few elsewhere. Increasing, though no problem reported with native species (none closely related or using same niche). May compete for nest cavities with other hole-nesting species.
Mallard <i>Anas platyrhynchos</i>	Introduced to many countries, hybridises freely with some native taxa.

Species	Status
	Causes considerable problems in many areas and hybrids/domestic hybrids are common. See also Box 1.
Red-crested Pochard <i>Netta rufina</i>	Breeds in UK (150 birds) and the Netherlands in small numbers. Can hybridise with native species but unlikely to present major threat.
Ruddy Duck <i>Oxyura jamaicensis</i>	Increasing and spreading its range. Serious threat to the existence of the White-headed Duck unless controlled (see Box 2 and 6).

Sixteen of these (including the hybrid populations) were considered to represent a potential threat to indigenous AEW waterbirds; the remainder appeared not to be a problem. Table 2 provides a summary of the available information for the 16 potential problem species (see also Appendix 1, which updates the information provided by Blair *et. al.*).

The problem of non-native species is prevalent in countries where the keeping of exotic waterbirds is a common hobby. Notable for the number of non-native species recorded are the UK (79), Switzerland (43), United Arab Emirates (25), Germany (24), South Africa (24) and the Netherlands (20). Another four countries (all in Europe) have recorded more than 10 non-native species at liberty. The high number in the UK probably reflects the good knowledge base there (Hughes *et. al.* 1995).

The extent of our knowledge of the numbers of non-native species in the wild is mixed. In Blair *et. al.*'s survey, information was lacking from 46 out of the 125 states that were sent questionnaires and in most others the information was fragmentary. Even in areas well covered by waterbird counting networks, non-native species are often not recorded because observers do not deem them to be worthy of note. Clearly, since many non-native species are increasing and widening their range, it is essential that better systems of monitoring their numbers, distribution and interactions with native wildlife should be put in place (Step 2). International waterbird counters are soon to be encouraged to monitor these in the future (D. A. Scott, pers. comm.).

Non-native species in captivity

Waterbirds are very commonly kept in captivity because they are attractive and relatively easy to keep. There is a very long history of the keeping and breeding of waterbirds especially wildfowl (Anseriformes) stretching back at least to the 16th century (Kear 1990). The birds are generally not held in aviaries but housed in open enclosures and grounded by clipping the feathers of one wing or pinioning (the removal of the distal joint of one wing). Since many species breed freely, keepers must exercise considerable vigilance in ensuring that the progeny of non-native species are pinioned before they are capable of flight. In some cases birds are kept full-winged because they are attractive, and there have been some deliberate introductions in the past (see also Step 4).

Table 3. A summary of records held in the ISIS database for some important groups of waterbirds in captivity in Europe and Africa. The taxa include species and subspecies.

Group	No of Taxa listed	Taxa in captivity	Collections per taxon (holding species)	Total Birds
Grebes	5	2	1.0	13
Pelicans	8	5	22.0	916
Cormorants/Shags	14	5	9.0	377
Storks	18	14	17.5	1158
Ibis/Spoonbills	23	15	17.0	1790
Flamingos	6	6	31.5	4279

Group	No of Taxa listed	Taxa in captivity	Collections per taxon (holding species)	Total Birds
Whistling Ducks	8	8	15.5	848
Swans	8	8	25.0	779
True Geese	30	30	14.5	3764
Sheldgeese/ducks	13	12	19.1	1377
Dabbling Ducks	52	50	12.4	4109
Diving Ducks	14	14	20.5	2092
Sea Ducks/Sawbills	22	15	12.4	904
Stiff-tailed Ducks	6	6	6.2	287
Other Wildfowl	26	21	17.9	2950
Cranes	18	16	23.3	1192
Totals/Mean	271	227(84%)	16.4	26835

Because waterbird keeping and trading is such a common occurrence and because it is not strictly controlled in most countries, finding out how many and what birds are kept is very difficult, though there are some organisations and membership groups that enable us to obtain some clues as to the extent of keeping and the variety of birds kept and bred in captivity.

Most established zoos have representative collections of waterbirds and records of these are kept in a system known as the International Species Information System (ISIS), which holds information on 260,000 specimens of 7,600 vertebrate taxa held in more than 500 collections in 54 different countries worldwide. The data are available on line at the public site www.isis.org. A summary of the records in the database for some of the more important groups of waterbirds is shown in Table 3. Of the taxa listed in the database, no fewer than 84% are at present in captivity in the region, and many of these in substantial numbers. Most of the taxa are not native to the country where they are being held.

A large number of private breeders and dealers keep waterbirds as a hobby or a business. For example, the ISIS database records North American Ruddy Ducks in only four registered collections in Germany. An independent survey of the species found that there were 200 collections, mostly held by private individuals, holding Ruddy Ducks in the same country. The same survey found that there were more than 50 collections, together holding more than 200 Ruddy Ducks, in the Flanders region of Belgium (B. Hughes, pers. comm.).

Laar *et al.* (1994) reported on a survey carried out by Aviornis International Nederland of the number of geese and swans in captivity in the Netherlands in 1991. The number of birds reported was over 36,000, of which nearly 24,000 were young birds, indicating that they had been bred in captivity in that year. Since the respondents represented only a third of Aviornis members, the authors suggested that the totals should be multiplied by three to obtain a more realistic estimate. Moreover, the survey was incomplete in relation to captive waterbirds because huntable species were not included and a number of others omitted. It seems likely that the number of captive waterbird in the Netherlands alone exceeds 100,000, of which two thirds are reared in the year and are presumably largely bred for sale (see below).

An independent survey of waterbirds kept by breeders is carried out in the UK. In the latest survey, covering 2001, census forms were sent to 323 collectors and 210 responses (65%) received (Hughes 2002). A total of nearly 18,000 birds was held by the responders. If these are representative in terms of numbers held, then the total number of birds must be nearer 30,000. This is in itself a minimum since birds kept purely for ornament are not included and there are a large number of keepers who do not

participate in the survey. It seems likely that the number of waterbirds held in the UK may approach the Netherlands total.

It is clear from these figures that there are very large numbers of waterbirds of a wide variety of species in captivity in the Agreement area, mainly in north-west Europe.

Movements of non-native species between countries

There is no strict monitoring of the import and export of waterbirds in any co-ordinated way, except for those listed on the appendices of The Convention on International Trade in Endangered Species (CITES). However, this represents a very small proportion of the taxa available. Within the European Union, since there is no restriction of trade between the 15 members, movement of non-native birds across national borders is commonplace and is not monitored. Dealers in the Netherlands and Belgium regularly transport birds to other countries and the extent of the trade can be guessed at when we consider that 60,000 birds were available for sale from Dutch and Belgian dealers in a recent year (Anon 1998). This means that most of the young birds reared in captivity are sold and it seems likely that these leave the country.

It seems unlikely that countries will undertake routine monitoring of imports and exports of non-native species, except, perhaps, for a few special cases where species are either threatened or known to be especially troublesome. The European Union is currently reviewing its regulations on trade in species that pose an ecological threat to EU flora and fauna. Regulations are in place whereby species that are a major threat cannot be imported into the EU and there could also be a prohibition on holding such birds. The UK government has proposed to the EU that the Ruddy Duck be placed on the list of prohibited species. This could lead to a complete ban on keeping and trading in Ruddy Ducks in the EU, though what would become of existing stocks is not clear.

Range states should consider how they could ensure that the movement of species that pose a real threat to native fauna or flora can be controlled. At the very least, those species that are considered high risk (see Step 3) should be listed on a schedule that prohibits their import into a country and customs personnel should be alerted to this fact, as they are to CITES-listed taxa.

Step 2: Introduce or maintain monitoring programmes to periodically revise the baseline information

Waterbirds are generally found in open areas and are generally not difficult to find and count. In order to comply with the AEWA policy on non-native species, countries should have monitoring systems in place that assess regularly the status of these species. These monitoring data will form an essential part of the evaluation of the potential risk associated with non-natives (Step 3).

Recording of non-native species in the wild

Non-native species should always be covered in regular waterbird inventories such as the International Waterbird Census or national waterbird counting schemes. Many observers currently do not consider presumed escaped exotics as worthy of note. The totals given in the summary reports, at least in the UK, are underestimates, although attempts are made to improve these by using summed site maxima rather than the sum of monthly counts (Musgrove *et. al.* 2001).

Perhaps special surveys, targeted at particular species or groups would be more effective than regular counts in providing good estimates of numbers. For example, Delany (1993) reports on a survey of non-native geese in Great Britain, which found 14 non-native species in numbers ranging from 63,500 (Canada Goose) to 2 (Red-breasted Goose). At least 15 different hybrid geese were also found in small numbers. In a review of the status of the Ruddy Duck, Hughes *et. al.* (1999) documents the occurrence and numbers of this non-native species in Europe and Africa. A review of all non-native species is underway in Belgium, in preparation for formulating a national policy on the management or control of non-native species (O. Beck, pers. comm.).

Although such surveys are time-consuming and depend on numerous amateur observers, waterbirds are popular with bird-watchers and monitoring is possible, at least occasionally, though this may not be very realistic for some parts of the AEWA range. Nevertheless, range states should ensure non-natives are always recorded and that the results are published in reports such as Waterbird Population Estimates.

Monitoring the status of non-native species in waterbird collections

As indicated under Step 1, assessing accurately the number of birds held in captivity is not easy since legislation on captive collections is lacking in most countries. In the Netherlands it has been compulsory to mark all captive birds with rings since 1995, but how well this is being policed is uncertain. If this were widely practiced, it would be possible to identify escaped birds and compel breeders to be very careful about the way their collections are managed.

It would require legislation to make it possible to control what birds are kept in private collections (some countries already have legislation covering authorised zoos open to the public) and all waterbird collections should be registered and licensed. A condition of a license should include compulsory ringing, regular censoring and reporting of any birds missing or definitely escaped into the wild. Only Norway (Blair *et. al.* 1999) and Iceland (see Box 4) of the Agreement area states operates a system of regulation (any keeping of non-native species must be for authorised zoological reasons).

The control of what non-native species are kept in captivity and the conditions under which they should be kept are clearly inadequate in most states in the Agreement area. More stringent conditions should be applied that minimise the chances that non-native species kept in collections can be deliberately released or accidentally escape into the wild (see Steps 4 and 5).

Monitoring of imports and exports of non-native waterbird species

For any policy for assessing the potential impact of non-native species, their movement to and from the Agreement area, and between countries within it, must be regulated and monitored, though this is fraught with difficulty and would involve considerable administrative resources. However, the mechanisms exist within CITES and the EU Regulations implementing them (see under Step 1 above and Step 6 below). Both of these involve listing all the species concerned, though in reality, it is likely that such controls and monitoring will only be implemented for those species that are proven to be highly threatening to native fauna and flora.

Step 3: Establish levels of potential threat posed by each non-native waterbird species, so as to prioritise action

Clearly, some non-native waterbird species will pose a greater threat than others to biodiversity and this can be predicted to some extent based on current knowledge and a risk assessment.

Ecological risk assessment

Ecological risk assessment calculates the probability of an impact to a specified feature over a defined period of time. Methods evaluate the interaction of three components: stressors released into the environment (e.g. non-native waterbird species); receptors living in and using that environment (e.g. native species); and the receptor response to the stressor. Measurement of exposure and effect quantify the degree of interaction between these components and statistical models are normally employed to analyse the data (Suter 1993; Landis, in press).

Comprehensive assessment of the risk posed to biodiversity by non-native waterbird species requires an understanding of four main features (after Landis, in press):

1. The probability of successful invasion by a non-native species, which is related to infection rates from source areas, the habitat specificity of the non-native species, the suitability of the new environment, the isolation of the receiving environment, the size of the receiving environment, the frequency of disturbance within the landscape and historical events which may preclude or enhance invasion;
2. The life history, population dynamics and ecology of the non-native species;
3. The mechanisms through which the non-native species can impact biodiversity, such as predation (including grazing), disease, competition, hybridisation and disruption of nutrient dynamics;
4. The ecological and evolutionary processes that govern (3).

Each of these features requires that a risk assessment for a particular species needs to be understood in the context of the regional landscape. Therefore, there is a need to undertake such assessments at a national and sub-national level in order to adequately understand the risks posed to biodiversity by non-native waterbird species in the AEW region.

That accepted, Appendix 1 provides a more basic and qualitative risk assessment for non-native waterbird species currently established within the AEW region. The eleven species identified are mainly Anatidae (ducks, geese and swans) and are concentrated in north-west Europe. No doubt this taxonomic and geographic pattern has arisen from the long and popular history of keeping Anatidae in captivity in north-west Europe, leading to regular escapes and (in the past at least) deliberate introductions. The geographic bias may also be related to the highly disturbed landscapes in north-west Europe, which is a factor that has been shown to aid the establishment of non-native species (With, in press).

The analysis shows that two non-native waterbird species in particular in the AEW region are a high risk to biodiversity: (i) the Ruddy Duck (*Oxyura jamaicensis*) in western Europe and Morocco; and (ii) the Mallard (*Anas platyrhynchos*) in South Africa, and this latter species is still a problem in some provinces. Medium risk species include the Black Swan (*Cygnus atratus*), Canada Goose (*Branta canadensis*) and Egyptian Goose (*Alopochen aegyptiacus*) in north-west Europe. The other six species are considered low risk, though this is tentative.

The most serious threat posed by these species based on current knowledge arises from hybridisation with closely related native species. Grazing of natural vegetation, competition with native species and eutrophication of wetlands are also potential threats that have sometimes been documented at a local level, but they remain poorly understood and may prove to be only localised problems.

What should range states do?

Range states should therefore:

- Develop or adopt a standard methodology for Risk Assessments;
- Gather data required to apply the criteria;
- Apply criteria to determine degree of threat;
- Continue to gather data to improve above and regularly re-assess the assessments.

In the meantime, actions should be taken against non-native species according to the best available scientific knowledge and/or best practice in other range states or against similar species.

Step 4: Establish or improve legislation to prevent the deliberate introduction of non-native waterbird species and allow their control where established populations exist

Legislation to provide the framework for combating the problem of non-native waterbird species needs to address trade (see next section), release of birds and, where populations have become established in the wild, control and eradication. In particular, preventing the arrival of new non-native species through strict rules of trade, aviculture and release into the wild is the most effective and least costly management strategy to reduce threats posed by biological invasions and should always be the first lines of defence.

In most Member States of AEWA, deliberate introductions are illegal without prior consent from the respective government. However, in some others it remains legal without the need of any permission, e.g. anybody can release Ruddy Ducks into the wild in Ireland, Italy, the Netherlands and Portugal, despite the extreme risk this poses to the future survival of the White-headed Duck (*Oxyura leucocephala*) (Hughes *et. al.* 1999).

A policy usually promoted with regard to intentional introductions of non-native species is to allow it only after an appropriate risk assessment procedure has proven the species to be low risk. However, with regard to waterbirds, our ability to predict impacts of non-native waterbirds on native biodiversity is very limited (see previous section). Hence, considering the precautionary principle the wisest policy is to prohibit any intentional releases of non-native waterbirds.

Aside from the intentional release of non-native waterbirds, large numbers of native waterbirds are also reared in captivity and released for hunting purposes ('stocking programmes'). A number of species have been used in such programmes, but the vast majority of birds are Mallards (*Anas platyrhynchos*). Most programmes are in western Europe, where millions of Mallards are released each year. These captive-reared (or 'game farm') birds are genetically and ecologically different from wild Mallards, but interbreed with them freely and thus threaten the genetic integrity of wild Mallard populations (Callaghan *et al.* 1997a,b). However, this seems to be largely rhetoric given the scale and long history of releases of captive-reared Mallards throughout most of their native range in the AEW region. Nonetheless, large-scale releases of captive Mallards probably also increase the incidence of disease in wild populations, such as Duck Virus Enteritis (DVE), although this is practically impossible to measure (Callaghan *et al.* 1997a,b).

Box 4: Licensing of captive birds

An effective means of controlling captive populations of waterbirds is through a licensing scheme. Under such schemes aviculturists have to apply for a licence to keep or trade certain species.

Since January 1995 it has been illegal to trade in Ruddy Ducks (*Oxyura jamaicensis*) in the UK without an individual licence and in recent years licences have not been issued. In effect, this has ceased trade in the species and will probably lead to a major reduction, if not the elimination of the Ruddy Duck in captivity in the UK (B. Hughes, pers. comm.). Likewise, it is illegal to keep Ruddy Ducks in captivity in Norway without a permit and the government has declared that no permits will be granted (Hughes *et al.* 1999). Lastly, the Wildlife Conservation and Hunting Act in Iceland states that it is prohibited to keep any wild bird species in captivity without a permit from the Ministry of Environment, and as yet no permits have been issued for keeping any waterbirds (O. Nielsen, pers. comm.).

Such licensing schemes are often more politically attractive than out-right bans of keeping certain captive animals and in effect allow for the eradication of species from captivity if needed.

As regards stocking programmes of other native waterbird species, there seems to be little activity in the AEW region. But from a precautionary perspective, it seems wise to dissuade stocking programmes in general and where they are allowed to ensure birds that are used are 'wild-strain' individuals (i.e. less than two generations removed from the wild). An example of the former policy has been adopted in the Netherlands, where the release of any birds (and their eggs) into the wild is forbidden under The Flora and Fauna Act.

Step 5: Introduce measures to prevent escapes of non-native waterbird species from captive collections

Along a 2km stretch of the River Rhine near Wageningen, the Netherlands, nine non-native waterbird species have been recorded in recent years (Snow Goose *Anser caerulescens*, Bar-headed Goose *Anser indicus*, Black Swan *Cygnus atratus*, Mandarin Duck *Aix galericulata*, Wood Duck *Aix sponsa*, Egyptian Goose *Alopochen aegyptiacus*, Canada Goose *Branta canadensis*, Maned Duck *Chenonetta jubata* and Ringed Teal *Callonetta leucophrys*). All of these species are present in local captive breeding collections, both private and public, though not all have established self-sustaining wild populations in the area yet (D. Callaghan, pers. Obs.; S. Delany, pers. comm.; N. Gilissen, pers. comm.).

Between 1990 and 1995, a review of only 26 County Bird Reports in the UK produced 421 records of 65 species of non-native waterbird (Hughes *et. al.* 1995).

Such unintentional releases ('escapes') of captive waterbirds are frequent in the AEW region, especially in north-west Europe, and form the major pathway for the establishment of non-native waterbird species in the wild. Anatidae in particular represent such fugitives, since they are by far the most numerous waterbird group kept by aviculturists.

Combating such escapes is only possible through the strict application of rules governing aviculture, such as (after de Klemme 1996; Shine *et. al.* 2000; DCCNH 2001):

- Strict standards of rendering birds flightless (wing-clipping or 'pinioning') when they are kept in roofless enclosures;
- Strict standards of security for roofed aviaries when birds are not rendered flightless;
- The requirement that all establishments keeping captive non-native waterbirds should be licensed;
- A register of and an appropriate system to mark birds (e.g. ringing) so that their origin can be identified in the event of their escape;
- Strict rules in the event of the avicultural establishment closing down to prevent organisms from being deliberately freed;
- An obligation for avicultural merchants to inform their customers of good practice, legal regulations and of the penalties for violation;
- Prohibiting the possession of waterbirds liable to pose a risk to native fauna and flora if non-native populations become established;
- Penal and administrative sanctions that could include the withdrawal of permits, the closing of the establishment and the confiscation of birds in the event of a violation of regulations.

Considering the particular risk of the Ruddy Duck (*Oxyura jamaicensis*) escaping from captivity in Europe, much interest has been centered on controlling their captive management in recent years (Callaghan *et. al.* 1997a). Voluntary guidelines ('Codes of Practice') for their keeping in captivity have been developed in five European countries, though the impact of these is practically impossible to measure. More stringent legal measures have been adopted in some countries, with good success (Box 5). On the whole, however, progress has been very limited in Europe with regard to the legal control of Ruddy Ducks in captivity and few governments have yet imposed rules to limit escapes of birds from captivity (Hughes *et. al.* 1999).

Escape of Mallards from captivity in South Africa has led to the establishment of wild populations that pose a risk to native Yellow-billed Ducks through hybridisation (Box 1). It is proposed that the keeping of species or subspecies in captivity in South Africa which are likely to hybridise with native taxa should they escape should be prohibited (Shaw 1999, quoted in Blair *et. al.* 1999). This does not seem to have been incorporated within national legislation as yet, though a ban on importation of Mallard is effectively imposed at provincial level, though policing of inter-province movement has proved difficult (K.A Shaw, pers. comm.).

Any rules established for combating the release of non-native waterbirds into the wild need to be enforced and any breaches punished. Criminal penalties for unlawful introductions of non-native waterbirds should be as severe as for the most serious offences against legislation on protection of the environment, such as certain types of pollution. In addition, with reference to the polluter-pays principle, the person responsible for the offence should bear the cost of eradicating the species from the wild. Without enforcement, any rules are meaningless. For example, Blair *et. al.* (1999) highlighted some countries that have strong legislation preventing the introduction of non-native waterbirds into their territory, but where enforcement is weak and both intentional and unintentional release of non-native

species from captivity is happening currently in some of these states (D. Simic, pers. comm.; S. Tyler, pers. comm.).

Strict controls of aviculture through national legislation in AEWA countries are infrequent and in general waterbirds, especially Anatidae, are kept under loose rules (if any). In addition, in those countries where strict rules are established in law, enforcement is often weak. This suggests that for some time yet, escapes from captivity will continue to be the major pathway for the establishment or supplementation of non-native waterbird populations in the wild.

These measures should relate to all non-native species, whether they are in the high-risk category or not. However, it is appropriate to recognise that measures to eliminate the chances of escape of non-native species from waterbird collections are likely to be very difficult to implement because of the number of such collections in existence, the extent of international trade in many species and the ease with which many waterbird species breed in captivity. In practice, only high-risk species are likely to be subject to such strict control, since the policing of a general regulation would be very difficult and collectors may well defy restrictions if they deemed them to be unnecessarily restrictive.

Step 6: Introduce measures to prevent the import of high risk waterbird species, where the risk is ascertained by the risk assessment proposed under step 3

Waterbirds, especially Anatidae, are popularly kept in captivity and their international trade has a long history (see Step 2). Whilst accepting the principle of free trade, adequate control is a key factor in preventing the establishment of invasive non-native waterbirds in the wild in the AEWA region. Such action has two elements: legislation and enforcement (Box 5).

Legislation

Legislation governing trade in wild fauna and flora should cover as a minimum (after Raymakers 2001):

- List of species;
- Specimens regulated, e.g. birds and their eggs;
- Administrative structures in place and their power;
- Procedures for the issuance of permits and certificates;
- Possession, transport, collection, export, etc. of specimens;
- Provisions for confiscation and sanctions; and
- Enforcement structures and their power, e.g. customs, police and federal services.

GISP (2001) proposed a 'pied list' for governing the trade of species, which contains:

- A 'black list': species whose importation is prohibited;
- A 'white list': species classified as beneficial or low risk, whose importation is allowed generally, under conditions restricting the use of the species to specific purposes (research, public education, others) or only after the holding facilities to contain the organism have been inspected and approved. 'White lists' may be developed at national or sub-national level and should only include species that have undergone risk assessment.

Any species not included on either list is part of a grey category and must be subject to a risk assessment process prior to importation. Any species not yet known to be harmful or harmless is included in the

grey category. A potential option to reduce costs related to the lists system is to require anyone applying for an import authorisation for a non-native species to produce a risk assessment.

Individual States within AEWA have very variable legislation governing the trade of waterbird species, ranging from no measures at all to very strict legal instruments. The ‘pied list’ approach described above has developed, at least in part, within the national legislation of various AEWA Members States, but to very variable degrees. Comprehensive international legislation is not yet available in the AEWA region, although encouragingly ‘black listing’ of invasive species is possible through EU legislation (see Box 5).

Box 5: Restricting trade of invasive species in the European Union

Legislative background

The European Union (EU) represents one of the largest markets for international wildlife trade and 75% of the global trade in birds (Raymakers 2001). For many years, legislation to govern this trade has been a conservation priority in the region. The EU adopted Council Regulation 338/97 on the ‘Protection of the Species of Wild Fauna and Flora by Regulating Trade Therein’ in December 1997. Rules concerning the implementation of this Regulation are detailed in the Commission Regulation 1808/01. Together, these Regulations fully implement the provisions of CITES and go beyond.

Best practice feature

Under Regulation 338/97, introduction of species into the Community through trade can be restricted under Article 4, including those which present an ecological threat to wild species of fauna and flora indigenous to the Community (analogous to the ‘black list’ proposed by GISP (2001)). Although only two species have so far been treated in this manner, American Bull Frog (*Rana catesbeiana*) and Red-eared Terrapin (*Trachemys scripta elegans*), the European Commission is currently considering further additions, including the Ruddy Duck (*Oxyura jamaicensis*). Once a species is listed in this manner, it is possible under Article 9.6 of the CITES Regulations to prohibit their importation into the EU, and for restrictions to be placed on the holding and/or movement of birds within the Community.

These Regulations and the species lists are updated quarterly and made available in all official languages of the EU at:

http://europa.eu.int/comm/environment/cites/legislation_en.htm

CITES regulates international trade in specimens of species of wild fauna and flora, based on a system of permits and certificates. However, although CITES could in theory be used for ‘black listing’ trade in invasive species, the convention is focused on controlling international trade in endangered species.

Based on the analysis in the previous section the most obvious candidates to be included in a ‘black list’ of trade in the AEWA region are (in order of priority):

- Ruddy Duck (*Oxyura jamaicensis*) - throughout the AEWA region;

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- Mallard (*Anas platyrhynchos*) - in regions outside its natural range in the AEWA region (i.e. most of Africa and the Middle East);
 - Canada Goose (*Branta canadensis*) - throughout the AEWA region;
 - Egyptian Goose (*Alopochen aegyptiacus*) - in regions outside its natural range in the AEWA region (i.e. northern Africa, Europe and the Middle East).

Enforcement

With adequate legislation in place, enforcement is the next step to preventing importation of invasive waterbirds species. The main bodies involved are customs, police, prosecutors, judges and lawyers (Yeater 2001). Although still relatively uncommon, court cases and challenges in the prosecution of crime related to wildlife trade are becoming more frequent and penalties are becoming more severe (Anton 2001). However, since invasive non-native waterbird species have not been dealt with in trade legislation to any significant degree, examples of law enforcement in this context have yet to arise.

The most frequent problem regarding enforcement of wildlife trade regulations is lack of, or insufficient, border control. Aside from the obvious need of adequate human and financial resources in this regard, identification of specimens is also a basic problem. Identification of adult waterbirds traded in the AEWA region is generally straightforward given an adequate identification guide. However, the identification of eggs of many species, especially Anatidae, is practically impossible without costly molecular analysis, and so trade in eggs should not be allowed unless the owners can prove their identification.

Nonetheless, custom officials are often unskilled in the identification of adult waterbirds and it is feared that many species pass through customs under mistaken identity. It seems the best general approach to combat this problem is to issue simple identification guides and, where identification is problematic, ensure specialists are consulted before specimens are released from quarantine (G. Elliott, pers. comm.).

An on-line Global Invasive Species Database (<http://www.issg.org/database>) is being developed that includes specimen identification information, although as yet few species are in the database and descriptions of specimens are only textual (and hence is inadequate for use by customs officials). To aid implementation of CITES various identification guides have been produced for species listed in the CITES appendices, including an on-line bird guide (<http://www.ec.gc.ca/cites/birds>). Meanwhile, some national schemes have been undertaken to help customs officials identify birds listed on CITES, such as 'Green Parrot' in the UK. This is a computerised identification database, which includes:

- Visual keys for identification;
- Colour images of CITES and non-CITES species;
- An analytical system that assesses the identification characteristics entered to provide the species of best fit;
- CITES-listing information;
- Source country;
- Information and notes.

The system is developed so far to cover nearly all parrots, the majority of raptors, many reptiles and amphibians, a large selection of butterflies, corals, and traditional Chinese medicines and derivatives. The process of adding data and images is ongoing. The resulting database will be made available online for all UK H.M. Customs & Excise CITES officers nationally and may be offered to Customs in other countries. Products such as identification manuals based upon the database are in preparation.

Currently, it seems few custom offices in the AEWA region can ensure correct identification of all adult waterbirds in trade, which is a major problem when trying to prevent the import of invasive species. There is no on-line system that provides a complete aid to identification, and the only printed material is that produced for bird watchers, such as Madge & Burn (1988). It would seem the production of a guide (electronic and printed) or software to the identification of waterbirds traded in the AEWA region aimed at custom officers would be a very useful tool, similar to the 'Green Parrot' example above and paying particular attention to invasive species.

Step 7: Design control strategies to limit or remove high risk non-native waterbird species, test and report on their feasibility

If an invasive non-native species has been non-native, early detection and rapid action are crucial to prevent its establishment. The preferred response is often to eradicate the organisms as soon as possible. In the event that eradication is not feasible or resources are not available for its eradication, containment and long-term control measures should be implemented.

Paradoxically, non-native species can be automatically protected by legislation when the law protects all species belonging to a particular taxonomic group or when protection is afforded to all species by so-called 'reverse listing' other than those listed as huntable (usually during an open season) or as pests (which can generally be killed at all times). Hence, in order to allow the control of Ruddy Ducks (*Oxyura jamaicensis*) in the Netherlands the species had to be listed on Article 54 of the Dutch Hunting Law (Hughes *et. al.* 1999), while in the UK the species is still protected and only controllable through special licence (B. Hughes, pers. comm.). In some cases, such bureaucracy can seriously delay control/eradication strategies. It has been proposed that this can be avoided if legislation makes express reference to "indigenous" species in lists of protected species, thus leaving non-native species unprotected and hence freely controllable (DCCNH 2001). However, allowing uncontrolled killing of invasive species is perhaps not wise owing in particular to the threat of disturbance to native fauna. It seems the best approach is to make reference to specific non-native species within legislation and sanction their eradication/control under licence. As yet, however, there does not seem to be any examples of such a method in the AEWA region.

A major problem regarding legislation and control/eradication of non-native species is access to private land. For example, a questionnaire survey in the UK showed that only about 50% of landowners would allow access to their land for the control of Ruddy Ducks. Special land access rights would be required to ensure eradication (B. Hughes, pers. comm.). Rapid access to all land is of course vital to the success of any eradication programme and needs to be stipulated in legislation, empowering eradication teams with special land access rights. As yet, such an approach does not seem to have been taken in the AEWA region.

There is a presumption among the public in many countries against the killing of animals and many people have difficulty in understanding the conservation arguments for such control where these are considered purist or where their effects may be felt in countries other than that where the control is exercised. Convincing a public of the need to control invasive species is very difficult where they are generally ignorant of scientific or ecological principles and more aware of welfare concerns than of conservation needs.

Any control programme must be carefully planned and must include the following four elements:

7.1 Educate and raise awareness amongst key stakeholders

It is very important at the outset to identify the most important stakeholders in the species to be controlled – those organisations and individuals who perceive that they would be affected if control was exercised. No doubt the most important group are the people who deal with non-native species issues on a professional basis – if professional managers are not convinced about the need for and the probable effectiveness of a control programme, it will not succeed. Voluntary organisations concerned with animal welfare and groups that may have a particular interest in the species are also very important. Such groups should be brought in to the discussions at a very early stage or they may cause problems or even thwart the control programmes later.

7.2 Obtain public support for any control strategies to be implemented

It is also important to improve understanding of the issues amongst the general public. In order to achieve this a sympathetic media coverage is extremely beneficial, so it is very important to identify press sources that are particularly concerned with such issues and which might give positive coverage. Unfortunately some media are apt to sensationalise control programmes and generate hostility among the public. This should be avoided where possible.

Before any control of the Ruddy Duck was carried out, there was a substantial public relations campaign, which attempted to explain to each target group and to the public at large, the importance of the programme and details of steps being taken to minimise the likely cruelty involved and the effects on other species (the two most common complaints about control of troublesome animals). Despite this there was a substantial amount of adverse comment, but the extent of negative actions (e.g. resignations from membership of organisations such as the RSPB and Wildfowl & Wetlands Trust that were supporting control) was not great, and the public relations effort was generally successful.

7.3 Carry out eradication or control programme

The practical problems of eradication are likely to be considerable after a species has become established, since many non-native species are widespread and prolific breeders. They are often found on private land or in areas where control is difficult because of public sensitivities. For example, the Canada Goose in Europe lives in close proximity to Man and is considered by many to be an attractive animal that enhances people's experience, especially in city parks. A number of organisations in the UK have been deterred from taking action against the species despite considerable threat to habitats and perhaps human health because of real or perceived public pressure in favour of the birds. Many of the species concerned are long-lived and control of reproduction alone is unlikely to be successful, so control measures are likely to be contentious. In many cases any control of non-native species is likely to have a deleterious effect (e.g. through disturbance or the killing of non-target animals) on native fauna and flora.

The measures that can be taken to control non-native species are given in Appendix 2. Many of these methods are fraught with difficulty, either because of practical or political problems. However, given the will and with the support of voluntary organisations, the example of the Ruddy Duck (Box 6) indicates that control programmes can be publicly acceptable and meet with success.

7.4 Monitor the success of the control programme

Should a control or eradication scheme be undertaken, the success of this should be monitored by careful recording of control methods and their effectiveness, and assessing the impact of control on the size of the remaining population. It is likely that targeted surveys will be needed, aimed at the species controlled and the sites where control took place, as well as the routine monitoring programmes that are in place in most countries (see Step 2).

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Box 6: The control of the North American Ruddy Duck in Europe

The threat posed by this species was recognised in the 1980s and late in that decade The Wildfowl & Wetlands Trust, which was involved in conservation and research programmes to safeguard the White-headed Duck, decided that the potential threat should be examined in detail. All the steps outlined in 7.1 to 7.4 above were followed, as described in detail in Hughes *et. al.* (1999).

1. The first step was to hold a meeting involving national organisations that were likely to have an interest in the problem, including governmental and voluntary groups. A consensus was soon reached that the problem was potentially serious and deserved attention. When hybrids between the two species were discovered in Spain in 1991, the feeling grew among conservation organisations that action had to be taken to control the Ruddy Duck in Britain. An international conference was held in 1993, bringing 50 delegates from 10 countries to discuss the issue. There was general agreement that control was necessary on an international scale.
2. Before any action was taken, a campaign, organised by the RSPB and The Wildfowl & Wetlands Trust, was undertaken to inform the public at large of the situation, both through the membership publications of the organisations and by transmitting information to national and local press, radio and television. This met with considerable success, though a number of groups and individuals were vociferous in their condemnation and some members resigned from organisations supporting control.
3. The Ruddy Duck Working Group was formed in 1992, including statutory and voluntary organisations, to consider how a control programme should be carried out. The first stage was to carry out research into the feasibility of control and this was done between 1992 and 1996. It demonstrated that shooting females during the breeding season was likely to prove effective. In 1998 it was decided to move to the second stage – a regional control trial, which began in 1999 and lasted for 3 years. The aim of the project was to assess the feasibility of eliminating the species within 10 years. By early 2002 more than 2,500 Ruddy Ducks had been shot from a UK population of about 5,000 birds
4. The status of the species is monitored annually by the Wetland Bird Survey, and there have also been special surveys conducted to assess numbers in the regions and sites where control had taken place. The regional trial in the UK resulted in reductions of 66% in regional populations in an area in the west midlands of England and 93% on an island in Wales. The study concluded that shooting was the most effective method of control and that the Ruddy Duck could be reduced nationally to less than 175 birds (5% of the 1999 population) over four to six years at a cost of GBPounds 3.6 million (USDollars 4.4m, Euros 4.4m).

This programme had a very difficult task in the public relations field since the Ruddy Duck is an attractive and endearing species and since the benefits of control would not be seen in the host country. Some also doubted whether the evidence that Spanish birds originated from Britain did exist. It is a credit to the planning and structure of the programme that control continued and proved effective on a regional level. The Ruddy Duck research and control programme could serve as a model for future control operations for waterbirds.

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Appendix 1.

Assessment of risk posed to biodiversity by non-native waterbird species within the AEWa region

This analysis is restricted to those waterbird species with populations currently established outside their natural range within the AEWa region. 'Currently established' is defined as breeding in the wild for at least the last 10 consecutive years. 'Natural range' is defined as the range of a taxon excluding any portion that is the result of introduction.

For each risk assessment below a species is categorised as 'High', 'Medium' or 'Low'. This reflects an assessment based on current knowledge of the risk of negative impacts on biodiversity after considering possible effects through predation (including grazing), disease, competition, hybridisation and/or disruption of nutrient dynamics. Since our understanding of such impacts posed by each species is often poor, the categorisation of most species is provisional. Such provisional understanding is a hallmark of biological invasions in general (Williamson 1996).

Taxonomy follows Sibley & Monroe (1990).

Populations excluded from analysis

The analysis does not consider species established within captivity within the AEWa region that are not yet established as non-native species in the wild (but of course may become introduced in the future). In addition, non-native populations of the following species are not considered.

Chilean Flamingo (*Phoenicopterus chilensis*)

Introduced along with Greater Flamingos in Germany in early 1980s growing to a small breeding population (6 pairs in 1993), but the colony apparently becoming extinct since 1995 (Snow & Perrins 1998; Bijlsma *et. al.* 2001).

Greater Flamingo (*Phoenicopterus ruber*)

Introduced along with Chilean Flamingos in Germany in early 1980s growing to a small breeding population (6 pairs in 1993), but the breeding colony apparently becoming extinct since 1995 (Snow & Perrins 1998; Bijlsma *et. al.* 2001).

Mute Swan (*Cygnus olor*) – European populations

Introduced in many countries in west and central Europe starting in the 16th and 17th centuries, but within or close to natural range (Snow & Perrins 1998). Now often impossible to distinguish between *introduced* and wild populations and has become a species of high cultural importance.

Mute Swan (*Cygnus olor*) – Southern Africa population

Up until recently was established as a non-native bird in South Africa and Zimbabwe, but has become extinct for unknown reasons (Harrison *et. al.* 1997).

Mute Swan (*Cygnus olor*) – Egyptian population

Described as an introduced species in Egypt by Brown *et. al.* (1982), but not by Snow & Perrins 1998) and seemingly a mistake by the former authors.

Greater White-fronted Goose (*Anser albifrons*)

A small introduced population has become established in the Netherlands from escapes from captivity, but this is within the natural wintering range of the species (Bijlsma *et. al.* 2001).

Lesser White-fronted Goose (*Anser erythropus*)

Reintroductions in Sweden and Finland for conservation purposes have led to the establishment of a wintering population outside the natural range, mainly in the Netherlands (van den Berg & Bosman 1999), though the species has always made sporadic appearances in the Low Countries.

Greylag Goose (*Anser anser*)

Non-native breeding populations have become established in many areas of north-west Europe owing to escapes from captivity and releases for hunting (Callaghan *et. al.* 1997b; Snow & Perrins 1998). These are usually within or adjacent to the natural range of the species. It is now often impossible to distinguish between non-native and wild populations.

Snow Goose (*Anser caerulescens*)

Long history of regular escapes from captivity and irregular breeding in the wild (e.g. Norway, Sweden and Finland), but as yet no established populations there (Snow & Perrins 1998). There is a small population on the island of Coll, Scotland, which has numbered over 100 birds, but the last count revealed a maximum of only 38 birds (C.R. Mitchell pers. comm., M.A. Ogilvie pers. comm.).

Barnacle Goose (*Branta leucopsis*)

Small breeding populations have become established in recent decades in the Netherlands, Belgium, Finland, Sweden, Estonia, Denmark and the UK mostly owing to escapes from captivity but also seemingly involving wild individuals in some countries. All are within the natural wintering and migration range of the species (Snow & Perrins 1998).

Gadwall (*Anas strepera*)

Large breeding population in southern UK originating from releases from captivity, but within natural winter range and close to natural breeding range (and non-native population also augmented by wild birds) (Snow & Perrins 1998; C. R. Mitchell pers. comm.).

Biodiversity risk assessment

Sacred Ibis (*Threskiornis aethiopicus*)

Biodiversity risk: Low

Small non-native population established in France (Snow & Perrins 1998), United Arab Emirates (Richardson & Aspinall 1998) and Italy (U. Gallo Orsi, pers. comm.; M. Gustin pers. comm.). In the

UAE, free-flying collections are kept in Al Ain Zoo and Sir Bani Yas Island, where the species sometimes nests ferally (Richardson and Aspinall 1998). The species is recorded singly or in flocks elsewhere, though the absence of recent records from the UAE birders' newsletter indicates that they are not numerous outside these few locations (D.A. Scott pers. comm.).

Negative impacts on biodiversity have not been recorded and the species seems unlikely to become numerous outside its natural range. However, if large populations become established it may become a problem through, perhaps, competition for tree nest sites with colonial nesting birds such as herons.

Black Swan (*Cygnus atratus*)

Biodiversity risk: Medium

Long history of regular escapes from captivity but as yet only very small populations established in Slovenia and the Netherlands (Snow & Perrins 1998; Bijlsma *et. al.* 2001). Negative impacts on biodiversity have generally not been recorded within AEWA region, but the large non-native population in New Zealand is known to have negative impacts on biodiversity through grazing of macrophyte communities (Scott 1972). In the UK, Black Swans nest in winter and are observed to be very aggressive in the company of wild swans, such as Whooper and Bewick Swans (M. Smart, pers. comm.), which may prove serious should the numbers of this non-native species increase.

Bar-headed Goose (*Anser indicus*)

Biodiversity risk: Low

Long history of regular escapes from captivity but as yet only very small population established in the Netherlands (Snow & Perrins 1998; Bijlsma *et. al.* 2001). Negative impacts on biodiversity not recorded, but if large population becomes established may become a problem through grazing and, perhaps, competition.

Canada Goose (*Branta canadensis*)

Biodiversity risk: Medium

Long history of introductions from 17th century up to recent times for aesthetic and hunting reasons has led to large established populations in the UK, Ireland, Norway, Sweden, Denmark, Belgium, France, Germany, Russia and Finland (Callaghan *et. al.* 1997b; Snow & Perrins 1998). Negative impacts on biodiversity little understood, but some evidence of local problems through grazing, competition and eutrophication of wetlands (Allan *et. al.* 1995; Allan 1999, Hagermeier & Blair 1997; Callaghan *et. al.* 1997b, Wattola *et. al.* 1996).

Egyptian Goose (*Alopochen aegyptiacus*)

Biodiversity risk: Medium

Substantial populations have become established in the UK and the Netherlands and Germany, with smaller numbers in the UK, Belgium and France (Hagermeier & Blair 1997; Snow & Perrins 1998). Population in the Netherlands is expanding rapidly throughout the country and spreading to neighbouring regions (Bijlsma *et. al.* 2001). Negative impacts on biodiversity little understood, but may be significant locally through competition and, perhaps, grazing.

Ruddy Shelduck (*Tadorna ferruginea*)

Biodiversity risk: Low

Long history of escapes from captivity but as yet only very small population established in the Netherlands and Ukraine (Askaniya Nova), which may include some wild birds (Snow & Perrins 1998; Bijlsma *et. al.* 2001). Negative impacts on biodiversity not recorded, but if large population becomes established may become a problem through competition.

Carolina Wood Duck (*Aix sponsa*)

Biodiversity risk: Low

Long history of escapes from captivity but as yet only small population established in the UK (Snow & Perrins 1998). Negative impacts on biodiversity not recorded, but if large population becomes established may become a problem through competition for tree-hole nest sites.

Mandarin Duck (*Aix galericulata*)

Biodiversity risk: Low

Escapes and deliberate releases from captivity have led to a large established population in the UK and much smaller populations in the Netherlands and Switzerland, with populations apparently becoming established also in Belgium and Germany (Snow & Perrins 1998; Bijlsma *et. al.* 2001). Negative impacts on biodiversity not recorded, but a localised problem may be competition for tree-hole nest sites.

Mallard (*Anas platyrhynchos*) – South Africa population

Biodiversity risk: High

Small non-native populations have become established in South Africa where they are increasing and beginning to hybridise with the native Yellow-billed Duck *Anas undulata* (Harrison *et. al.* 1997). As yet this remains a very localised problem and the Yellow-billed Duck remains common and widespread in southern Africa (Young, in press). It is still considered a major problem in Western Cape Province (K.A. Shaw pers. comm.) and if the non-native populations of Mallard in South Africa increase and spread substantially, the future of the Yellow-billed Duck will be threatened.

Red-crested Pochard (*Netta rufina*)

Biodiversity risk: Low

Small and apparently stable population introduced in southern UK (Snow & Perrins 1998). Negative impacts on biodiversity not recorded and, seemingly, unlikely to arise from current population.

Ruddy Duck (*Oxyura jamaicensis*)

Biodiversity risk: High

Large non-native population in southern UK and a small population in Ireland, with annual breeding of very small numbers also in seven other European countries and Morocco. Numbers increasing and southward spread into Spain has brought it into contact with the globally threatened White-headed Duck

Oxyura leucocapala), which has resulted in hybridisation. This poses the most significant threat to the future survival of this latter species (Green & Hughes 2001; Hughes 1998). Also, if the spread of the Ruddy Duck continues southward into east and southern Africa it may come to pose a serious threat through hybridisation to the future survival of the Maccoa Duck (*Oxyura maccoa*).

Appendix 2

Methods that could be employed to control high-risk non-native species

Control of nests and eggs

This is considered acceptable to most people because it does not involve killing of adult birds. However, most species of waterbirds are long-lived and need to breed successfully in only one of several years to maintain their populations, so nest and egg control would need to be intensive and continuing, which would be very difficult if not impossible to achieve for more widespread species. Since many species nest in cover and their nests are difficult to find, there would also be considerable practical problems and resource implications.

Shooting of full-grown individuals in the hunting season

This is likely to be an acceptable control method because hunting is legitimate and considered to be an acceptable part of rural life in the region. However, shooting seasons are generally set so as to preserve the breeding potential of a population (e.g. spring shooting is banned in most countries) which is contrary to the aim of control. Because of this, placing a species on the quarry list is unlikely, by itself, to be effective in eliminating a non-native species. Hunters are in any case reluctant by nature to shoot such numbers of a quarry species as would endanger its survival and future hunting opportunities and are unwilling to be seen as pest controllers.

Shooting of adults at nest sites

This may be effective against some species whose nest sites are easy to find. However, if such sites are in public view or on private land, exercising such control would be practically difficult and politically sensitive. It may also be possible only to get access to females at nest sites if the males desert the females during incubation.

Killing flightless birds

Where a species undertakes a flightless moult (as do all Anatidae species), it would be possible to round up and humanely despatch flightless birds. This represents a very effective potential control measure for some species. For example Canada Geese are rounded up in large numbers for ringing during the moult and an intensive control programme would no doubt be very effective against this species. The main problems with adopting this approach would be problems of access onto private land and the public acceptability of such action.

The number of species for which this would be practicable is limited because access to the moulting sites of some species is difficult and others (e.g. diving birds) would be very difficult to catch in any numbers

Poisoning

Poisoning of birds using narcotised baits or poisons has been practiced in many countries to control problem species, mainly those that are considered pests because they impinge on Man's agricultural or fisheries interests or pose a threat to public health, such as a number of species of gulls. This could be very effective for species that will readily accept bait, but potential problems are many, including the acceptability of using certain chemicals, the effects on non-target species and welfare concerns.