

Invasive alien birds in Denmark

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(Med et dansk resumé: *Invasive fuglearter i Danmark*)

Abstract Avian Introduced Alien Species (IAS) constitute a threat to the integrity of native biodiversity, the economy and human health, so here we briefly review some of the problems posed by such species around the world in relation to such bird species in Denmark. A new European Union Regulation on Invasive Alien Species implemented in January 2015 establishes a framework for actions to combat alien species, which requires Member States to prevent the spread of alien species, provide early warning and rapid responses to their presence and management of established alien species where they occur. We show the importance of mechanisms such as DOF's (Dansk Ornitologisk Forening, BirdLife Denmark) Atlas project, Common Bird Census (breeding and wintering species) and DOFbasen to contribute data on the current geographical and numerical distribution of the few serious alien avian species already present in Denmark. We review the status, abundance and distribution of seven critical IAS that do, or have, occurred in Denmark in the last 10 years and conclude that none of these pose a major threat as things stand at the present, although breeding Egyptian Geese *Alopochen aegyptiaca* and Canada Geese *Branta canadensis* potentially give cause for future concern. We underline the need for continued surveillance of all avian IAS through data collection via DOF's monitoring programmes and Aarhus University's mid-winter waterbird census, hunting bag and wing surveys. These programmes are essential if we are to continue to effectively monitor the extent and nature of the problems constituted by IAS in support of the Danish Nature Agency in their direct management of alien species problems in this country.

Introduction

Humans have been introducing plant and animal species to areas across the globe outside of their natural native ranges for thousands of years, some deliberately and others accidentally. Many such modifications to distributional range have been to feed us, for instance, the Greylag Goose *Anser anser* was one of the first bird species known to be domesticated some 5000 years ago (Sossinka 1982), and the species has since been introduced around the world. In more recent times, human colonisers have taken examples of the European avifauna around the world to remind themselves of home (e.g. Thomson 1922, Lever 2010). In the case of a very wide range of wildfowl (members of the Anatidae; Fox 2009) and parrot species (from the order Psittaciformes; Cassey

et al. 2004), substantial numbers have been introduced to Europe since the 1700s as a source of curiosity, entertainment and ornamental decoration. The introduction of such alien species outside their native range as a result of human action is usually benign, because the vast majority of such organisms fail to survive in often unsuitable environments (Blackburn *et al.* 2014). However, we see some alien species adapting to new conditions and establishing viable, self-sustaining populations in the wild where they can also cause significant ecological, economic and human health impacts, although these are not always easily foreseeable (Blackburn *et al.* 2014). These impacts can be many and varied (see for example some case studies provided in Tab. 1), but because these cannot easily be predicted in advance, it is far better to

Tab. 1. Some example case studies of the effects of alien introduced species on native fauna. *Eksempler på effekter af invasive arters forekomst på den hjemmehørende natur.*

Effect	Description and examples of effects	Source references
Predation	Introduced predators such as feral cats <i>Felis catus</i> , American mink <i>Mustela vison</i> and even house mice <i>Mus musculus</i> radically effect ground nesting seabirds never previously exposed to such threats.	Craik 1997, Holdaway 1999, Keitt <i>et al.</i> 2002, Croll <i>et al.</i> 2005, Wanless <i>et al.</i> 2007, Kurle <i>et al.</i> 2008
Hybridisation	Hybridisation of alien and native forms can lead to the dilution of the native genotype, e.g. North American Ruddy Duck <i>Oxyura jamaicensis</i> with White-headed Duck <i>Oxyura leucocephala</i> in Spain.	Kershaw & Hughes 2002, Hughes <i>et al.</i> 2006, Muñoz-Fuentes <i>et al.</i> 2007
Demographic ascendancy	Despite similar survival rate, the greater breeding success of the alien introduced Mallard <i>Anas platyrhynchos</i> compared to the native and closely related Grey Duck <i>Anas superciliosa</i> in New Zealand, makes it numerically abundant over the native species.	Williams & Basse 2006
Disruption to ecosystem function	Danish lakes stocked with reared Mallards had higher phosphorus level than those not stocked, with acidic, nutrient-poor waterbodies being more sensitive to change as a result of relatively modest elevations in phosphorus concentrations. Rearing of Common Pheasants <i>Phasianus colchicus</i> creates conflict with birds of prey such as Northern Goshawk <i>Accipiter gentilis</i> which are then persecuted.	Paludan 1967, Noer <i>et al.</i> 2008
Diseases and parasites	Some Hawaiian birds are now restricted to high altitudes to escape diseases and parasites brought by introduced avian species that thrive in the lowlands. Duck Viral Enteritis is almost confined to captive reared or non-migratory waterfowl in Europe, Asia and North America, and outbreaks in wild waterbirds often follow contact with captive or released individuals.	Burgess <i>et al.</i> 1979, Burgess & Yuill 1982, Gough 1984, Brand 1988, Brand & Docherty 1988, Gough & Alexander 1990, Bibby 2000, LaPointe <i>et al.</i> 2005
Damage to agriculture	Escaped free-flying Rose-ringed Parakeets <i>Psittacula krameri</i> have bred in SE England for 40 years, where they create damage to fruits, vineyards and market gardens.	Pithon & Dytham 1999, Butler 2003, FERA 2009
Urban conflicts	Alien avian species in urban environments may have fewer predators and (at least initially) a supportive human population. However, introduced Canada Geese <i>Branta canadensis</i> in Europe and North America have caused damage to crops, disruption to golf courses, problems with droppings, have attacked humans and collided with vehicles or aircraft and created many other problems.	Conover & Chasko 1985, Watola <i>et al.</i> 1996, Owen <i>et al.</i> 2006, Dolbeer 2009
Damage, degrade or modify habitats	Introduced Canada Geese have destroyed wild rice stands in eastern North America. Mute Swan <i>Cygnus olor</i> in Maryland remove submerged aquatic vegetation (e.g. widgeon grass <i>Ruppia maritima</i> and eelgrass <i>Zostera marina</i>) affecting sediment patterns, submerged plant, invertebrate and fish communities.	Perry <i>et al.</i> 2004, Allin & Husband 2004, Naylor 2004, Tatu <i>et al.</i> 2007, Nichols 2014
Health and safety	Waterfowl can be natural reservoirs for zoonotic pathogens, e.g. abundant introduced resident Canada Geese in urban and suburban North American can potentially transmit <i>Campylobacter</i> and Avian Influenza through human contact with faecal deposits and contaminated water.	Rutledge <i>et al.</i> 2013
Competition for nest sites	In Australia, the introduced Common Myna <i>Acridotheres tristis</i> and European Starling <i>Sturnus vulgaris</i> compete with native species for nest holes, potentially affecting the breeding success of the Red-rumped Parrot <i>Psephotus haematonotus</i> , Crimson <i>Platycercus elegans</i> and Eastern Rosella <i>Platycercus eximius</i> .	Pell & Tidemann 1997
Competition for food	Native garden birds showed reduced feeding rates and increased vigilance in response to Rose-ringed Parakeet compared to Great Spotted Woodpeckers <i>Dendrocopos major</i> .	Peck <i>et al.</i> 2014

attempt to stop the arrival and colonisation of all new invasive species rather than attempt to manage a major problem once such species have become established and creating challenges. Such species spread by human agency outside their natural range are known as Inva-

sive Alien Species (IAS) and they increasingly pose problems to global biodiversity, where they are considered to be one of the greatest current threats to natural systems and species diversity (Sala *et al.* 2000). As a result of the threats such aggressive species pose to biodiversity,

the economy and human health, it is estimated that IAS have cost the European Union (EU) €12 billion (89 billion Danish kroner) per year over the last 20 years and that figure is increasing annually (Sundseth 2014). For that reason, the EU has implemented a new Regulation on Invasive Alien Species that came into effect on 1 January 2015 (European Commission 2014). This was a major objective of the EU's Biodiversity Strategy Target 5 for 2020 to coordinate EU-wide actions to prevent, minimise and mitigate the adverse impacts of IAS on biodiversity and ecosystem services, the economy and public health. The Regulation seeks to establish three types of measures, namely (i) prevention, (ii) early warning and rapid response and (iii) management of already established IAS.

But how does this affect DOF and Danish birds? Denmark has been highlighted as supporting particularly high densities of IAS compared to countries like Spain and France, even if the number of IAS is not that different (Sundseth 2014), so we have good reasons to be vigilant. Furthermore, as we hope to establish here, DOF and the volunteers contributing to the various existing recording schemes have a major role to play now and increasingly in the future in monitoring the distribution and abundance of avian IAS throughout Denmark.

In this analysis, we first assess the status of avian IAS in Denmark (which constitute problems elsewhere in Europe) based on knowledge from existing monitoring schemes and present an overview of all IAS species so far recorded here (excluding the Common Pheasant *Phasianus colchicus*). Then we review why IAS constitute such a problem and consider briefly the mechanisms with which to deal with them. We will also briefly consider how the EU's framework for action under the new Regulation can be implemented in Denmark with regard to avian IAS. Finally, we assess the importance of mechanisms such as DOFs Atlas project, the point counts schemes and DOFbasen data to contribute knowledge and advice to the Danish Nature Agency for the effective management of IAS problems in this country.

Methods

Using existing avian monitoring programmes to track IAS distribution and abundance

DOF maintains a series of different ornithological monitoring projects, all of which provide some basis for monitoring IAS now and in the future. The data on IAS from the Common Bird Census (based on point counts) are often too sparse to provide a useful perspective on such species and the present atlas period (2014–2017) means that although data will be forthcoming in the future, it is too early to use this source in the present review. Despite the unsystematic nature of data report-

ed to DOFbasen, the volume of records (c. 16 million) entered by a couple of thousand observers from many sites (c. 18 000) throughout Denmark provides an excellent basis for estimating the abundance and distribution of IAS. In our review, we included data from 2005–2014 to assess changes in the abundance and distribution for the selected species. One complication is that contributions to DOFbasen have increased considerably in this period. The number of annual records in DOFbasen have increased 2.4 times from c. 578 000 in 2005 to c. 1.4 million records in 2014, the number of visited sites have increased 1.9 times from c. 7200 in 2005 to c. 13 600 in 2014 and the number of observers have increased 2.2 times from c. 1000 observers in 2005 to c. 2200 observers in 2014. Hence, relative changes in abundance and distribution must take this increase in effort into account. However, because most IAS are relatively scarce anyway, rather than weight the observations in DOFbasen for overall annual increases in observers and observations, we here first imposed a 10×10 km grid layer across Denmark and generated annual maximum counts from all sites within each square. Whilst such an approach may generally underestimate the true numbers present, it is a very useful indicator of presence and relative change in abundance for such species. Sites were assigned to grid squares based on the central coordinate of each site. We used changes in the annual sum of all grid square maximum counts generated in this way per year as an annual index to evaluate abundance trends for each species. The present abundance status of each species was calculated as a mean from the years 2011–2014 to incorporate fluctuations from year to year. Linear regression models were fitted to trends in abundance (annual sums of grid square maximum counts) and distribution (number of occupied grid squares) for all species over the period 2005–2014. In order to normalise the residual variance, the regression models were performed on natural logarithm transformed annual indices (results are given for the most numerous IAS in Tab. 2).

Selecting species for particular attention

Under the European Commission's Sixth Framework Programme, the Delivering Alien Invasive Species In Europe project (DAISIE 2014) was established to (i) create an inventory of European invasive species, (ii) provide the basis for prevention and control of biological invasions, (iii) assess the risks and impacts of the most widespread and/or noxious invasive species, and (iv) provide distribution data and experiences from Member States as a framework for considering indicators for early warning and action against IAS. This process includes profiling of the "100 of the worst" a database of the most aggressive, noxious or problematic of IAS

Tab. 2. Fitted trends for the four most abundant invasive alien species using simple linear regression models based on records in DOFbasen from 2005 to 2014 inclusive. Information on abundance was based on the annual sum of maximum counts from sites amalgamated in 10 × 10 km grid squares distributed across Denmark and for distribution on the annual numbers of occupied grid squares (see text for details). Regression coefficient, r^2 , F -value and P value are shown for all fitted models.

Tendenser for udviklingen for de fire mest almindelige invasive fuglearter i Danmark 2005-14 baseret på data fra DOFbasen. Både tendensen i antal og i udbredelse er vist. For Canadagås er kun rastende og ynglende fugle fra månederne maj-juli inkluderet. For de øvrige arter er alle fugle fra hele året inkluderet.

Species	Included period	Trend abundance				Trend distribution			
		Coefficient	r^2	F	P	Coefficient	r^2	F	P
Black Swan <i>Cygnus atratus</i>	All year	-0.248	0.760	25.3	0.001	-0.201	0.6976	18.4	0.003
Canada Goose <i>Branta canadensis</i>	May-July	0.209	0.828	38.5	<0.001	0.126	0.919	91.1	<0.001
Egyptian Goose <i>Alopochen aegyptiaca</i>	All year	0.053	0.610	12.5	0.008	0.026	0.384	5.0	0.06
Ruddy Shelduck <i>Tadorna ferruginea</i>	All year	0.051	0.204	2.0	0.190	0.063	0.400	5.3	0.05

(DAISIE 2014), which includes only four species of birds that are present in Denmark or have been reported here, the Canada Goose *Branta canadensis*, North American Ruddy Duck *Oxyura jamaicensis*, Sacred Ibis *Threskiornis aethiopicus* and Rose-ringed Parakeet *Psittacula krameri*.

DOFbasen data on these species have been analysed and presented in the annual reports *Fugleåret* (Lange 2014), but here we present a more detailed analysis. For most of the species, we base our analysis on numbers gathered throughout the entire year, but in the case of the Canada Goose we are interested in separating the modest but potentially problematic breeding population from the much larger numbers present during the migration and winter periods.

Results

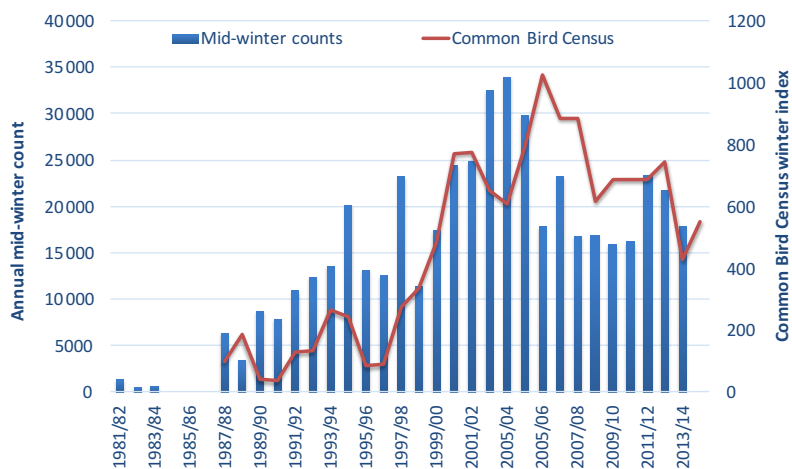
Canada Goose

The Canada Goose is a regular winter visitor to Denmark but a scarce breeder. Although introduced to this country as an ornamental waterbird in the late 1930s (Løppenthin 1967), the breeding population has not increased dramatically over the last 40 years. This is something that needs maintained vigilance and monitoring, however, since we show that the number of birds in Denmark during summer is now increasing more rapidly (see below and Fig. 3). Large established breeding populations exist in Sweden, southern Norway and southern Finland, and it is thought that considerable numbers of mainly Swedish breeding Canada Geese are those that winter in Denmark (Bønløkke *et al.* 2006),

especially in the south-eastern part of the country, but aggregations also occur in Thy and at Tøndermarsken. Usually the species occurs in small flocks of up to a few hundred, often with swans and other geese, but more than 1000 birds are regularly recorded, for example, on Basnæs Nor near Skælskør and Nyord near Møn. Management of the population occurs through hunting, as the species is legally huntable in Denmark and is a popular quarry species. Numbers killed are monitored via the Danish Hunting Bag and Wing Surveys, according to which less than 100 were shot per annum in the 1960s, this rose to 1000-1500 in the 1990s (Bregnballe *et al.* 2003) and to between 5100 (2009/10) and 10 000 (2013/14) per annum in the last six years (Asferg 2011, 2014). The recent levels of exploitation seem until now to have been compatible with holding the population at a similar level in mid-winter in recent years, as both the DOF winter point counts and the Aarhus University midwinter goose counts show that the population is relatively stable and slightly below the peak since 2000 (Fig. 1). This suggests for the avian IAS which is the most numerically threatening to Denmark, the situation is at least not currently getting any worse. This also seems to match with trends in the population breeding in Sweden (Ottvall *et al.* 2009) which also winter there, where mid-winter counts peaked at over 70000 in January of 2009 and 2010, but since numbers have declined there as well (Nilsson 2014). Such a 'holding pattern' for this IAS is important, since although this species is considered the most damaging avian IAS in Europe (Kumschick & Nentwig 2010) it would be extremely complex and

Fig. 1. Changes in the Danish winter population of Canada Goose based on changes in relative annual abundance, shown by annual winter point count indices for the Canada Goose in Denmark 1987/88–2014/15 (red line; Nyegaard *et al.* 2015, updated 2015) with 1987/88 set to a value of 100 and annual mid-winter counts of the Canada Goose in Denmark 1981–2013 (blue histograms, Danish Centre for Environment and Energy, Aarhus University).

Udviklingen i den danske vinterbestand af Canadagås baseret på henholdsvis punktællingsdata i perioden 1987/88–2014/15 (kurve) og data fra midvintertællingerne fra januar i årene 1981–2013 (søjler).



costly to agree, coordinate and mount an international programme to eradicate the species from Europe at the present time. Thus, this is likely to be a species that is maintained at acceptable levels for the current time.

In contrast, we see a significant 21% increase in the number of birds reported and a 13% increase in the number of occupied 10×10 km grid squares in the breeding period during 2005–2014 (Tab. 2 and Fig. 2). In summer, the geese are spread over most of coastal Denmark (Fig. 3). The population was estimated at c. 20 breeding pairs in the first Atlas in 1971–1974 (Dybbro 1976) and at 25–50 breeding pairs during the second Atlas project in 1993–1996. The range, defined as breeding in 5×5 km squares, increased from the first to the second Atlas by more than 180% (Grell 1998). Also now there are several confirmed breeding pairs in the southern and eastern parts of the country, as well as signs of increase on Bornholm, albeit still in low numbers, suggesting the potential for further expansion of a breeding population in Denmark. The increase in range does not seem to have continued, but this and the current size of the breeding population will become clearer after the third Atlas period in 2014–2017. So far, all recoveries of juveniles ringed in Denmark are local which indicates that there is as yet no major migration by the Danish population (Bønløkke *et al.* 2006). It remains important that contributions to DOFbasen and the present Atlas track the changing status of this species as a breeding bird now and in the future.

North American Ruddy Duck

The North America Ruddy Duck escaped from captivity in England in the mid twentieth century, and established a feral breeding population of 6000 individuals

by 2000 (Kershaw & Hughes 2002, Hughes *et al.* 2006). Although there were no apparent competitive or other adverse interactions with the native avifauna (Hughes 1992), increasing immigrants to Spain from the core concentration in Britain threatened the successful conservation efforts to restore the Spanish population of White-headed Duck *Oxyura leucocephala* from the brink of extinction. Hybrids between the two *Oxyura* species rapidly appeared, threatening to create a hybrid swarm of *Oxyura* ducks of mixed genotype with the eventual disappearance of the White-headed Duck as the genetic entity we recognise today (Muñoz-Fuentes *et al.* 2007). Conservation plans for the White-headed Duck highlighted the need for action to save the species (Anstey 1989, Green & Hughes 1996, Li & Mundkur 2002, Hughes *et al.* 2006). This led to the development of a strategy to eradicate the Ruddy Duck from throughout the Western Palearctic, because the species was increasingly dispersing from Britain and breeding elsewhere in Europe (see Henderson 2009). By the winter of 2014/15, this eradication strategy was close to success, largely due to the concentrated campaign in the United Kingdom (Robertson *et al.* 2015). Recent estimates of the cost of the Ruddy Duck eradication there have been in the order of £3.6 to £5.4 million (36–54 million DKK), a very substantial amount of money in relation to other conservation budgets. However, it is perhaps instructive to compare the relative costs of control of a species like the Ruddy Duck with those of nine invasive plant species that cause serious economic consequences, amounting to an expenditure of £300 million (3 billion DKK) per annum in the United Kingdom, and the adverse costs of native weed plant species which cost well over twice that amount without resolution (Williamson 2002).

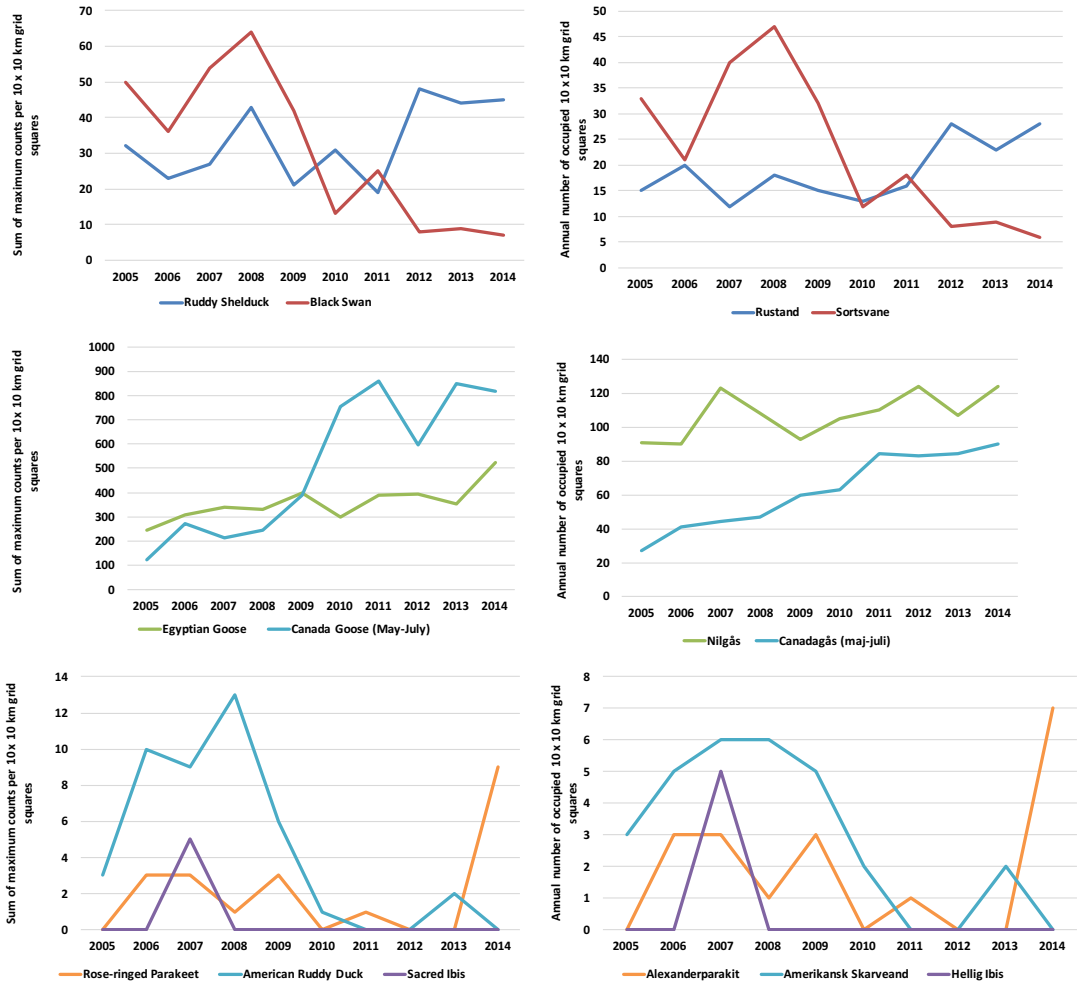


Fig. 2. The trends in abundance (left) and distribution (right) for seven invasive alien avian species in Denmark in 2005-2014 based on records in DOFbasen. See text for full explanation of the methods used and Tab. 2 for associated statistics and explanations. *Udviklingen i hyppighed (venstre) og udbredelse (højre) for syv invasive fuglearter i perioden 2005-14 baseret på data i DOFbasen.*

The first North American Ruddy Duck in Denmark was seen in 1985 (Olsen 1988). Numbers peaked in 2007 (Fig. 2), culminating in the only confirmed breeding by the species in Denmark at Maribo Nørresø in 2006, 2007 and 2008 (DOFbasen). Luckily, the species did not consolidate as a breeding species, and numbers have since fallen, almost certainly as a result of the highly successful eradication programme in the United Kingdom, where it is thought the majority of Danish birds originated. As of early 2015, it is thought that the population in Britain is less than 15 females, down from a population there of over 6000 individuals at its peak in 2000. The abundance and the distribution of North American Ruddy Ducks reported in Denmark are both significantly

declining during the last decade, confirming the trend from Britain (Figs 2 and 3). The species is listed as huntable in Denmark, and 20-30 birds are estimated to have been shot here over the last 30 years (T. Asferg pers. comm.). Clearly, Denmark needs to remain vigilant to this species given its capacity to breed here, but given the loss of the source population and the apparent lack of any observations in three out of the last four years, it would appear the species does not constitute the threat it once did in the mid-2000s.

Sacred Ibis

The African Sacred Ibis seems an unlikely threat to the European avifauna, but it has been introduced to

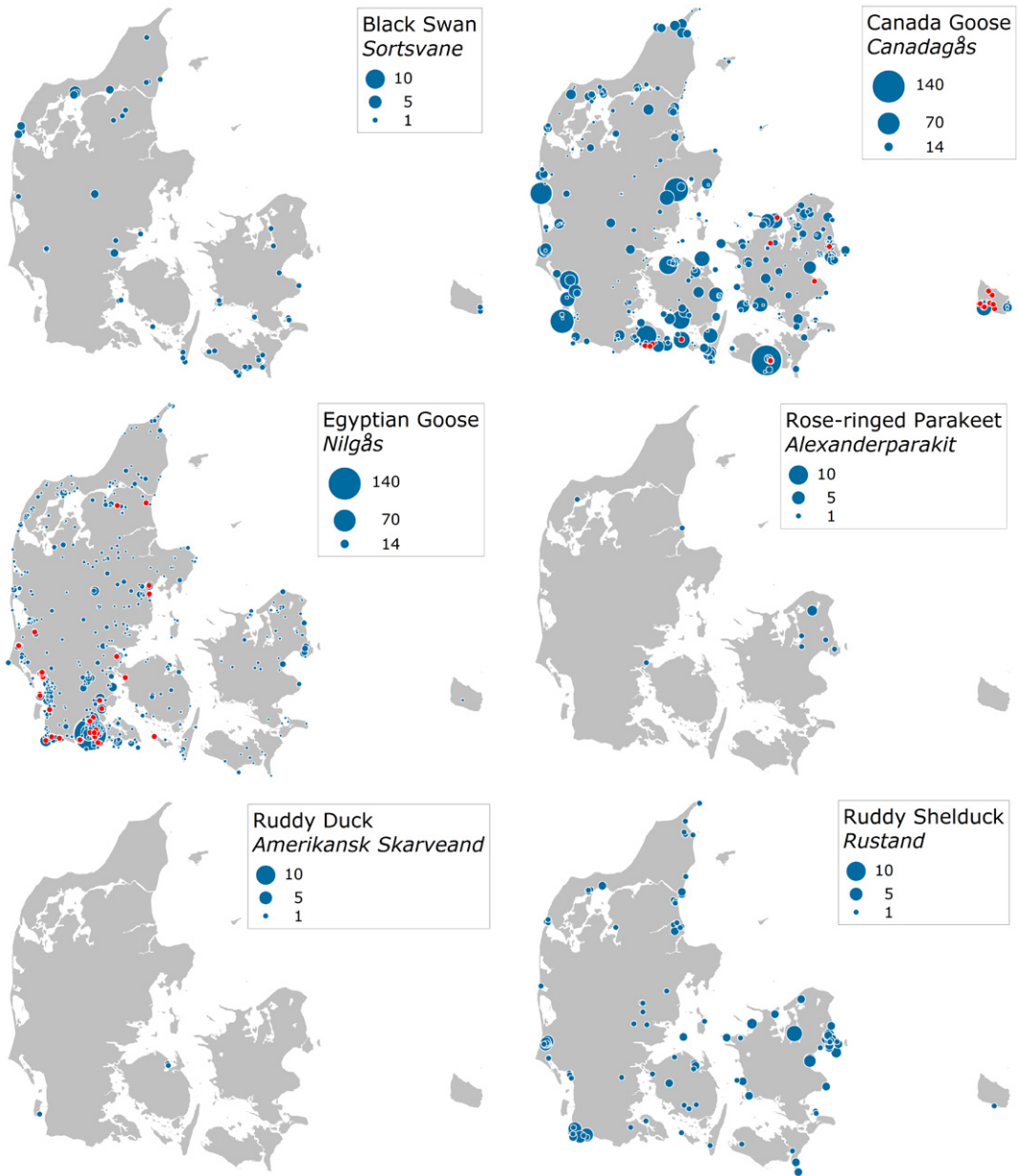


Fig. 3. Maximum counts (individuals) in DOFbasen of six invasive alien bird species in Denmark in 2011-2014. Red circles indicate breeding records. For Canada Goose, only staging birds during May-July and breeding birds are included. All other species maps include all records (regardless of season) in these years.

Maksimumantal i DOFbasen for seks invasive fuglearter i Danmark i årene 2011-14. Røde cirkler indikerer yngleforekomster. For Canadagås er kun rastende fugle fra månederne maj-juli og ynglefugle inkluderet. For de øvrige arter er alle fugle fra hele året inkluderet.

France, Italy and Spain where rapidly growing populations in southern Europe are seen as a major problem, because of their devastating effects on breeding colonies of species such as terns, as well as their successful competition with native Cattle *Bubulcus ibis* and Little

Egrets *Egretta garzetta* for nest sites (Clergeau & Yésou 2006). Their adaptability to forage on rubbish tips has enabled them to survive harsh winters in temperate regions, so it is not beyond the bounds of possibility that the species could colonise Denmark. To date there have

Tab. 3. Status of seven invasive alien species based on records in DOFbasen. The status assessment is based on annual data from 2011-2014. Values indicate the mean number of records, the mean summed maximum number recorded per 10 × 10 km grid square per year (abundance) and the number of these squares occupied (distribution). ¹indicates a pair of Black Swans seen with cygnets in 2007 where it was not known for sure whether the breeding was in a park or on a natural breeding site. *Status for syv invasive fuglearter i Danmark baseret på forekomsten i 2011-14 og på data fra DOFbasen.*

Species	Phenology	Confirmed breeding	Included period	Mean records per year	Mean sum of max per year	Mean 10 × 10 per year
Sacred Ibis <i>Threskiornis aethiopicus</i>	Occasional	No	All year	0	0	0
Black Swan <i>Cygnus atratus</i>	All year	Yes ¹	All year	33.0	12.3	10.3
Canada Goose <i>Branta canadensis</i>	All year Majority at winter	Yes	May-July	412	781	85.3
Egyptian Goose <i>Alopochen aegyptiaca</i>	All year	Yes	All year	882	416	116
Ruddy Shelduck <i>Tadorna ferruginea</i>	Occasional	No	All year	111	39.0	23.8
North American Ruddy Duck <i>Oxyura jamaicensis</i>	Occasional	No	All year	19.5	0.5	0.5
Rose-ringed Parakeet <i>Psittacula krameri</i>	Occasional	No	All year	2.5	2.5	2

been two observations of a single bird in 1994 and 36 observations of probably a single bird in 2007 in DOFbasen, although there have been other observations in previous years not formally recorded. However, there is no evidence at present for any long term colonisation of Denmark by this species, for which DOFbasen again should function as an effective early warning system.

Rose-ringed Parakeet

There have been 32 observations of the Rose-ringed Parakeet in nine different years since 1980 in DOFbasen, mostly from the Greater Copenhagen area, but also from Jutland (see Figs 2 and 3). It is thought that these individuals are escaped birds from captivity within Denmark, but they are strong fliers and it cannot be excluded that these are birds coming from areas further south where established breeding populations exist. So far, there are no signs of breeding here, but this remains a high possibility. In 2014, the species is more widespread and numerous than ever before in the last decade and we need continued vigilance via DOFbasen and the Atlas to be convinced as to whether this is part of a trend or is just a coincidence. There have also been three observations of the Monk Parakeet *Myiopsitta monachus* in DOFbasen from 2014, a species which is known to breed in the wild in small numbers for many years at Solrød Strand, Køge Bugt (K. Flensted pers. comm.). Elsewhere in Europe, both of these species are established, where they can be highly aggressive towards, and cause other

problems for, native bird species (Strubbe & Matthysen 2009, Hernández-Brito *et al.* 2014), so these constitute species of concern which also require continued surveillance.

Other species of potential concern

All invasive species give cause for concern, but three waterbird species are, to some extent, already present in Denmark and are considered 'pest' species in neighbouring countries, namely the Egyptian Goose *Alopochen aegyptiaca*, Ruddy Shelduck *Tadorna ferruginea* and Black Swan *Cygnus atratus* (Tabs 2 and 3, Figs 2 and 3).

The first observation of Egyptian Goose in Denmark was in 1983 (Netfugl), but the first confirmed breeding record is from 2000 (DOFbasen). The Egyptian Goose is largely confined to the southern and western parts of Denmark (Fig. 3) where it now breeds in small but increasing numbers that give some cause for future concern if these trends continue. The species seems to have originated from the Dutch population, part of an IAS population estimated at over 26 000 breeding pairs in 2010 (Gyimesi & Lensink 2012). Numbers in Denmark do seem to be increasing (Tab. 2), with flocks of up to 136 birds reported from Uge, close to the German border in southern Jutland. It is a legal quarry species in Denmark, shot in relatively small numbers (155 in season 2012/13, 128 in 2013/14; Asferg 2014), but should the population show signs of major increase, this offers a potential form of control.

The Ruddy Shelduck is less numerous and usually encountered singly or in very small groups in Denmark (Tab. 3, Fig. 3). The last survey suggested 105-425 breeding pairs in Western Europe, where it is not considered native, mostly in Germany and Switzerland (Banks *et al.* 2008). However this species has been documented to occur in western Europe since the 1800s and in the past has been notable for 'eruption years' when substantial numbers of apparently wild origin birds (probably from further east in Eurasia) occur simultaneously, even reaching Iceland and Greenland, so some birds may still be of truly wild origin. In 1994, as many as 100 birds were reported in Denmark, although a breeding pair reported from Himmerland that year (the only confirmed recent breeding record) is likely to have been the result of escaped individuals. There is a tendency (which closely approximates to statistical significance at $P = 0.0502$) for an increase in the population in Denmark in 2005-2014, with a marked increase since 2011, which may be partially the result of the free-flying young dispersing throughout the Copenhagen area from a pair of wing-clipped Ruddy Shelduck in Tivoli Gardens (Tab. 2).

Black Swans have been introduced from Australia and are thought to number 155-225 breeding pairs in Europe in 2004-2007, mostly in Netherlands, Belgium and the UK (Banks *et al.* 2008). Numbers reported to DOFbasen seem to show relative low levels since 2010 compared to previous years (Fig. 2), and the species has declined significantly in abundance and distribution during 2005-2014 (Tab. 2). There is one observation of a breeding pair with cygnets near Rågø in 2007 in DOFbasen, but there is doubt whether this confirmed breeding stems from local captive birds within a park there or from a natural site. There have also been other accounts of this species breeding in the past (e.g. on Lolland and Fyn; K. Flensted pers. comm.). Black Swan is also listed as huntable during the open season, but has not been reported shot in very recent years. Since Black Swan does not yet seem to have established itself as a breeding bird, this remains another species for which active management does not seem urgent, but monitoring vigilance is required to ensure no sudden expansion in numbers and range.

Discussion

Does Denmark currently have a serious problem with introduced alien species?

The simple answer appears to be "no, not yet". Of Europe's 100 worst avian IAS, only the Canada Goose is numerous enough as a winter visitor to cause concern, but all the monitoring indications are that after a period of increase, the Nordic population of this species is a legal popular quarry species showing relative stable

trends and indeed has shown slight declines in recent years. Worryingly, we see an increase in the numbers of Canada Geese in Denmark during the breeding period. This could potentially be the first sign of an establishing Danish population, which is also confirmed by reports of number of breeding pairs in the last few years. The increasing German population was estimated at 3600-5400 breeding pairs in 2005-2009 (Gedeon *et al.* 2014). Of these, the population in Schleswig-Holstein was estimated to have increased from 180 pairs in 1999 (Berndt *et al.* 2002) to 700 pairs in 2005-2009 with the majority near Kieler Fjord c. 50 km away from Denmark across the Baltic Sea (Koop & Bernt 2014). It remains unknown whether the increasing number of summer visitors is the result of the increasing breeding population south of Denmark (as seems likely) rather than being related to the many geese of Swedish origin that winter in Denmark.

Of the species of known concern in neighbouring European countries, the Egyptian Goose is clearly increasing in Denmark and is a species to watch. The Egyptian Goose has arrived in Denmark recently and was not even mentioned in the second Danish Atlas project in 1993-1996 (Grell 1998), which indicates how fast the species has colonised Denmark. The species is also increasing in Germany with an estimated population at 5000-7500 pairs in 2005-2009 (Gedeon *et al.* 2014) of which more than c. 250 pairs are found in Schleswig-Holstein (Koop & Bernt 2014). We recommend that both of these species be made the subject of future and more detailed analysis of changes in their behaviour, distribution and abundance which should consider their effect on other wildlife and potential management options. Other species do not currently appear to constitute a problem at the present time.

How do we best maintain vigilance with regard to introduced alien species?

The short answer is to continue to improve what we are currently doing. Denmark has a system of avian monitoring in place through DOFbasen that provides data on exotic species, including IAS, as these occur. We therefore urge all contributors to the system to continue to enter records of non-native invasive species as well as native species, so that the programme can contribute to our knowledge of the distribution and abundance of such species. Although DOFbasen data requires correction for spatio-temporal variation in observer effort, it provides an early warning system and the basis for developing more sophisticated systematic monitoring of IAS populations, should the need arise. The same is true for the Common Bird Census system for breeding and wintering birds and Atlas fieldwork, as these are further

means of collecting and collating data on the more numerous species that are already present in Denmark but also as a means of tracking new IAS as they occur.

As huntable species, annual reporting of Black Swan, Ruddy Duck and Egyptian Goose by hunters continues to be important in contributing data on the numbers of birds shot. All of these sources of data are essential to supporting the work of DOF to supply the Nature Agency with information on these species, in concert with the mid-winter counts, hunting bag statistics and wing surveys carried out by Aarhus University.

As we have seen earlier, contributing regular monitoring of these species, even at very low levels of abundance, is essential in supporting all the stages of the EU Regulation on IAS. In particular, monitoring provides vital data to the Nature Agency to support (i) prevention of spread of IAS, (ii) early warning and rapid response to IAS where and when they occur and (iii) management of already established IAS. The famous British ornithologist Colin Bibby (2000) once remarked that IAS were 'the only form of pollution which spontaneously self-replicates'! Many birdwatchers consider IAS as a form of pollution, but that does not mean we should not be recording their presence and numbers, given the threats that these species constitute to our own biodiversity, avifauna and economy! The new EU Regulation gives us ample reason to continue this monitoring in the future, and we thank all those that have been diligent in reporting IAS to the present.

How do we deal with the problem once introduced alien species have arrived?

The new EU Regulation on Invasive Alien Species Regulation proposes three distinct types of measures, which follow an internationally agreed hierarchical approach to combatting IAS. Firstly through prevention, by being aware of the IAS that threaten our avifauna and biodiversity and implementing robust measures to prevent new IAS from entering the EU in the first place, either intentionally or unintentionally. Secondly, by having early warning systems in place to enable rapid responses where these are necessary. The Regulation requires that Member States must put in place an early warning system to detect the presence of IAS as early as possible and as we have shown above, DOFbasen makes a very significant contribution to this mechanism, in concert with breeding bird and winter point counts and through coverage of the present and previous breeding Atlas projects. The existence of such vital monitoring mechanisms provide Denmark with an assessment of the numbers and distribution of IAS as they occur and provide the Nature Agency with the spatial and, to some extent, numerical information required to implement rapid re-

sponse measures when these are required to prevent such species becoming established. Finally, the Regulation requires management of previously established IAS to minimise their spread, abundance and impact, again a task that falls to the Nature Agency to fulfil. Clearly to judge the effectiveness of such measures requires regular monitoring of the status and distribution of IAS whilst subject to such management, so again the Atlas projects but especially DOFbasen and the point count networks can make direct and essential contributions to this process.

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Resumé

Invasive fuglearter i Danmark

Introducerede arter fra andre geografiske områder udgør en potentiel risiko for den hjemmehørende natur. Dette gælder også for fugle. I denne artikel præsenteres status for og udvikling i bestandsstørrelse og udbredelse for syv af disse invasive fuglearter, der har vist sig at udgøre et problem i andre lande. Status er beregnet som et gennemsnit af forekomsten i perioden 2011-14, og bestandsudviklingen dækker perioden 2005-14 med bemærkninger om forekomsten før denne periode.

I starten af januar 2015 implementeredes et nyt EU-regulativ, der har til formål at skabe en platform for, hvordan EU-medlemslandene skal forvalte de forskellige invasive arter og sikre, at de ikke spreder sig. Målet er at sikre et godt kendskab til arternes udbredelse i de enkelte lande, sikre en tidlig varsel og en hurtig respons på deres forekomst og at forvalte bestandene, hvor de allerede har etableret sig.

I denne forbindelse er der udarbejdet en liste over 'de 100 værste arter' (se DAISIE 2014), hvoraf fire af de her inkluderede arter er med: Canadagås *Branta canadensis*, Amerikansk Skarveand *Oxyura jamaicensis*, Hellig Ibis *Threskiornis aethiopicus* og Alexanderparakit *Psittacula krameri*. Da alle invasive arter potentielt udgør et problem, har vi yderligere inkluderet tre arter vandfugle, der i varierende grad har etableret sig i Danmark: Nilgås *Alopochen aegyptiaca*, Rustand *Tadorna ferruginea* og Sortsvane *Cygnus atratus*.

Der er talrige eksempler på, at invasive arter skaber problemer, når de introduceres til områder uden for deres naturlige udbredelse. Der er eksempler på, at de invasive arter påvirker



Ornamental birds have developed into invasive alien species in many parts of the world. Photo: Steen E. Jensen, Black Swans. *Prydfugle har udviklet sig til invasive arter mange steder I verden. Sortsvaner.*

andre arter ved fx prædation, hybridisering og konkurrence. De kan også påvirke levesteder ved fx eutroficerung og overgræsning af vandplanter. Endelig kan de skabe konflikter med mennesker som følge af spredning af sygdomme og afgrødeskader (se Tab. 1 for eksempler). Da det er svært at forudsige konsekvenserne ved etablering af en invasiv art i et nyt område, er det bedre at forsøge at stoppe og begrænse arten før indvandring og etablering. Omkostningerne ved at bekæmpe invasive arter vurderes at være stigende, og skønnes at have kostet EU 89 milliarder kroner pr. år i de sidste 20 år, dog primært til kontrol af ukrudt. Dette er baggrunden for, at det nye regulativ er trådt i kraft i 2015. Regulativet er en følge af mål 5 i EU's Biodiversitetsstrategi for 2020 om at lave en koordineret indsats på EU-plan for at undgå, minimere og imødegå påvirkningerne af invasive arter.

De forskellige danske fugleovervågningssystemer er gennemgået for at undersøge deres anvendelighed for denne analyse, og DOFbasen viste sig at udgøre den bedste database for en vurdering af de syv arters forekomst i Danmark. Da anvendelsen af DOFbasen er steget markant i den valgte periode (antal observationer med en faktor 2,4; lokaliteter med 1,9; observatorer med 2,2) er det nødvendigt at forholde sig til denne ændring. DOFbasens lokaliteter er derfor grupperet inden for et 10×10 km netværk, hvortil DOFbasens lokaliteter er grupperet baseret på deres centerkoordinat. For hver art er herefter anvendt det maksimale antal fugle pr. kvadrat pr. år. På baggrund af summen af disse maksima beregnes en tendens for artens bestandsudvikling. Antallet af kvadrater pr. år anvendes tilsvarende til at vurdere, om der er sket en ændring i artens udbredelse. For Canadagås fokuseres på dens forekomst i yngletiden, hvorfor kun rastende fugle fra månederne maj-juli samt ynglende fugle er inkluderet.

Af de nævnte arter vurderes fem at være uproblematisk i øjeblikket, mens bestandsudviklingen for to bør følges nøje. De enkelte arters tendens er vist i Fig. 2 og deres udbredelse i Fig. 3. Et overblik over arternes tendens og status er vist i henholdsvis

Tab. 2 og Tab. 3. De to opmærksomhedskrævende arter er Canadagås og Nilgås. Canadagås har sin primære forekomst her i landet i vinterhalvåret, hvor et stort antal svenske ynglefugle (introducerede) kommer hertil for at overvintre. Både midvintertællingerne af vandfugle og vinterpunktællingerne viser, at denne bestand var i fremgang i 1980'erne og 1990'erne, toppede omkring årtusindeskiftet og nu er for nedadgående. Det seneste årti ses dog en fremgang i antallet af fugle i yngletiden, hvilket kan være et tegn på, at arten er ved at etablere sig som fast ynglefugl i Danmark. I Tyskland, nær Østersøkysten spredt Canadagåsen sig og har gjort det i de seneste årtier, og spørgsmålet er, om ikke den danske bestand udvikler sig fra denne og er uafhængig af den svenske?

Nilgås er den anden art, som bør følges nøje. Siden første ynglefund i 2000 er der nu kendskab til talrige ynglepar i Jylland med størst koncentration i Sønderjylland, og bestanden er i signifikant fremgang med meget høje antal registreret på lokaliteter nær den dansk-tyske grænse. Spredningen til Danmark kommer givetvis sydfra, idet der er meget store bestande af Nilgås i både Holland og Tyskland.

De øvrige arter vurderes ikke at ville udgøre et problem i den nærmeste fremtid. Sortsvane har været signifikant nedadgående i de seneste 10 år, og Amerikansk Skarveand er næsten helt forsvundet fra den danske natur, ganske givet som følge af en systematisk forfølgelse af arten i Storbritannien, hvor bestanden er bragt ned fra cirka 13 000 i 2000 til blot 15 hunner i 2015.

Rustand har haft en spredt og nogenlunde stabil forekomst i Danmark i perioden. Det er dog værd at bemærke, at der ses en stigning i udbredelse med et højere antal siden 2012, der dog måske kan forklares af, at der netop i 2012 kom unger af et stækket ynglepar fra Tivoli i København, der opholdt sig på mange lokaliteter i hele Storkøbenhavn.

For Alexanderparakit er der kun ganske få observationer om året, og da det er en almindelig burfugl, er det ikke utænkeligt, at det kan skyldes undslupne fugle. Hellig Ibis er registreret med mindst to fugle her i landet, senest i 2007.

DOFbasen har vist sig at være et glimrende værktøj til at følge udviklingen for de invasive arter i Danmark, og det er vigtigt, at der opretholdes et stort netværk af ornitologer til at bidrage til såvel den systematiske overvågning (fx Atlas, punkt-tællinger og midvintertællinger) som den mindre systematiske overvågning via DOFbasen.

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