NOBANIS – Invasive Alien Species Fact Sheet

Branta canadensis

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Species description

Scientific name: *Branta canadensis* (Linnaeus 1758), subspecies *B. c. canadensis* Family Anatidae
Synonym: *Anas canadensis* Linnaeus, 1758

Common names: Canada goose (*B. canadensis canadensis* = Atlantic Canada goose) (GB), Kanadagans (DE), Kanadagås (DK), Kanada lagle (EE), Kanadanhanhi (FI), Øshvít gás (FO), Kanadagæs (IS), Kanadine bernikle (LT), Kanādas zoss (LV), Kanadagås (NO), Bernikla kanadyjska (PL), канадская казарка/Kanadskaja kazarka (RU), Kanadagås (SE)

Fig. 1 Canada goose *Branta canadensis*. Photo by Hans Erik Svart.

Species identification
There are several subspecies of Canada goose, but the Canada geese introduced to northern Europe are assumed to belong to the nominate race *B. canadensis canadensis* (Andersson *et al.* 1999), the Atlantic Canada goose. In the United Kingdom introductions may have included the Giant Canada goose (*B. c. maxima*) as well as *B .c. canadensis.* The Small cackling goose (*Branta hutchinsii minima*) has been incidentally observed *i.e.* in Germany, Denmark, Sweden and Finland (Andersson

et al. 1999) where it has escaped from captivity, and in Iceland where the birds are assumed to be of wild origin (Icelandic Rarities Committee, unpublished). The Small cackling goose was previously considered a subspecies of *Branta canadensis*, but is now considered a separate species.

Branta canadensis canadensis is larger and has a longer neck than native European geese. It is 90–100 cm long with a wing span of 160–185 cm. The males and females are similar in appearance, but the males are somewhat larger, weighing 3.5–6.5 kg to the females 3–5.5 kg. The head and neck are black, with a white band under the chin. The breast is light in colour and the body plumage brownish-grey. The bill and feet are black, and the bill has lamellae, or "teeth" around the edge that are used as a cutting tool. Canada goose can be confused with the Barnacle goose (*Branta leucopsis*), but the latter is smaller, has a shorter neck, white face, black breast, and grey, rather than brownish, body plumage (Bruun & Singer 1983, Jägareförbundet 2006). The goslings are yellow with some greenish-gray colouring on top of the head and back.

The Canada goose is a strong flier, and can cover 2,400 km in 24 hours when riding with the wind. The classical V-formation is very energy efficient, as it allows the geese to take advantage of the air currents created by the bird ahead. During flight the birds call to each other, their honking sounds sometimes likened to that of a pack of hounds (Encyclopædia Britannica 2007).

Native range
The Canada goose is native to North America, where the various subspecies breed across the tundra in much of Alaska, Canada, western Greenland, and parts of northern and central United States, migrating to southern Canada, United States and northern Mexico in the winter. The Atlantic Canada goose has its main range in the eastern parts of Labrador, but also including New Foundland and Nova Scotia (Fabricius & Norgren 1987).

Intentional introductions and translocations have made the Canada goose a resident (non-migratory) species south of its natural breeding range in much of the United States (BirdLife International 2006). There has been a dramatic increase in the population sizes of resident geese in North America since the 1970s, creating an increasing amount of conflict with farmers and the general public, as well as serious concerns for aviation safety (Dolbeer & Seubert 2006, French & Parkhurst 2001).

Alien distribution

History of introduction and geographical spread
The Canada goose was first introduced to Europe as an ornamental species in 1665, to the waterfowl collection of King Charles II at St. James's Park in London (Kirby 1999). It was later dispersed throughout Britain to provide hunting opportunities and to lessen the effects of high densities of this introduced bird on agriculture (Callaghan & Kirby 1996). Approximately 100 years after its introduction, the species was seen to live in the wild in England as a consequence of birds escaping from captivity and strongly aided by intentional releases (Weidema 2000). The Canada goose is now abundant across much of the United Kingdom (Kirby 1999). Vagrants from North America and Scandinavia occur in the United Kingdom from time to time (Kirby 1999), but no observations of Canada geese from the United Kingdom have been made in Scandinavia or on the continent (with the exception of France). Andersson *et al.* (1999) conclude that the two European populations are almost completely separate.

In the NOBANIS area the Canada goose was first introduced in the late 1920s and early 1930s: to Germany in 1928 (Geiter *et al.* 2002), Sweden 1929 (Andersson *et al.* 1999), Denmark 1930 (NOBANIS 2006) and Norway 1936 (Andersson *et al.* 1999).

In addition to the NOBANIS area, the Canada goose is also observed at least occasionally in most countries around the North Sea and along the Atlantic coast, with breeding populations in *i.e.* the Netherlands and Belgium and vagrant and sometimes wintering birds observed in France, Spain, Portugal, and Ireland, as well as in parts of central and eastern Europe, and northern and north-western Russia (Fauna Europaea 2006, UNEP-WCMC 2006, BirdLife International 2006). Outside Europe the Canada goose has also become established in New Zealand (Heggberget & Reitan 1994) and is considered vagrant *i.a.* in Australia, North and South Korea, and Japan (BirdLife International 2006).

Pathways of introduction

The Canada goose was originally introduced to Europe as an ornamental species, *e.g.* to the United Kingdom and Sweden, but later hunting became the main purpose of introduction, *e.g.* in Denmark, Finland, Germany, Norway, Russia and Sweden. Escapees from parks and zoos continue to add to the feral population, as has happened *i.a.* in Poland (Solarz 2007). Additionally secondary dispersal from the original points of introduction has contributed to its presence in Iceland and the south-eastern Baltic Sea area (Estonia, Latvia, Lithuania, and Poland). In the areas where it is now established, repeated introductions and translocations have often occurred before the species has started breeding and begun to disperse on its own. In Fennoscandia (Norway, Sweden and Finland) repeated translocations and natural dispersal have extended the breeding range to the extent that in many areas the Canada goose now outnumbers native goose species (Andersson *et al.* 1999). In *i.a.* Denmark, Germany and Russia free-flying populations have become established through introductions or from escapees, and several of these populations are now growing rapidly (*ibid*.).

Alien status in region

Introduced Canada geese have been observed in all of the NOBANIS area except Svalbard and, probably, Jan Mayen, and breeding has been observed in all countries but Estonia and Iceland (Miljøinfo Svalbard 2005, NOBANIS 2006). Several subspecies occur naturally on western Greenland (Long 1981, Fox *et al.* 1996), and spontaneous occurrences of migrating North American geese, *e.g*. the cackling goose (*Branta hutchinsii*) have been observed on Svalbard (Mjøs *et al*. 2004) and Iceland (Icelandic Rarities Committee, unpublished).

The Canada goose was intentionally introduced to Denmark in 1930 for hunting. The Canada goose has also spread to Denmark from neighbouring countries (NOBANIS 2006). An increasing number of Canada geese appear as migratory birds during winter, but otherwise the species occurs mainly as a park bird with relatively few (<50) breeding pairs in the wild (Dybbro 1985, Andersson *et al.* 1999).

The first record of Canada goose in Estonia is from 1968 (Leibak *et al.* 1994). The species is neither intentionally introduced nor established, but occurs as a summer visitor, transit migrant and irregular winterer, mainly in coastal areas of northern and western Estonia (DASE 2006, Elts *et al.* 2003). It is also present in the Kaliningrad region of the European part of Russia, as well as in northern and north-western Russia (Fauna Europaea 2006). It was intentionally introduced for hunting, and though it is established the species is rare (NOBANIS 2006).

In the Faroe Islands two birds arrived in 1984 at Sandoy and began to breed in 1985. Their offspring have since spread to other localities (Sørensen & Bloch 1990). In Finland the first birds

were introduced in 1964 (Nummi 2000) when they were released by hunting clubs (Vikberg & Moilanen 1985). Their main presence is in the south-western part of Finland, with several groups also occurring further north (Andersson *et al.* 1999). The species is also present on Åland. The Finnish populations of Canada goose are migratory, and many winter in southern Sweden, Denmark and northern Germany (Jägareförbundet 2006). In Germany the Canada goose was first introduced into the wild in 1928, and today there is a resident population of about 6,000 individuals, with an additional 30,000 wintering geese from Scandinavia along the North Sea coast (Geiter *et al.* 2002). The breeding population is a result of intentional introductions as well as escapees from parks.

As mentioned above, some subspecies of Canada goose occur naturally in western Greenland. According to Fox *et al.* (1996) there has been a spectacular increase in numbers since the late 1970s, when the species was still described as rare and irregularly breeding, and there are now substantial numbers of Canada [or cackling] goose summering and breeding on the western coast of Greenland, especially north from Disko Island. This breeding population of Canada goose on Greenland is estimated to 2,500 pairs (BirdLife International 2004).There is even concern that Canada geese are now colonizing breeding and moulting habitats of Greenland white-fronted geese (*Anser albifrons flavirostris*), affecting their reproductive output, but hard evidence for this occurring on a large scale is lacking (Fox *et al*. 2005, 2006).

The first observation of Canada goose on Iceland was made in 1961. As opposed to many other parts of the NOBANIS area, its presence here is unintentional, *i.e.* it has arrived from other parts of Europe (NOBANIS 2006) or North America (*cf.* below). The species has remained vagrant, *i.e.* it has not established breeding populations, but birds are seen every year (Weidema 2000 and references therein). The species is considered rare, although 131 birds have been recorded in the country up to (and including) 2003 (Péturson 2006). Additionally several of the subspecies, including *B. c. interior, B. c. parvipes, and B. c. hutchinsii* have been observed. This circumstance, as well as the observation of Canada goose in flocks with Greenland white-fronted geese in autumn, or with Greylag geese (*Anser anser*) in spring, indicates that birds from both sides of the Atlantic are found on Iceland (Weidema 2000 and references therein).

In Latvia the Canada goose has become unintentionally established from escaped birds. It was first recorded in 1982, but is rare (NOBANIS 2006). The introduction to Lithuania was also unintentional, and as in Latvia it is established but rare (NOBANIS 2006). The Lithuanian Ornithological Society (Lietuvos Ornitologų Draugija) however lists it as an occasional species (LOD 2007).

The first introductions of Canada goose to Norway were made in 1936 for hunting purposes (Heggberget 1991, Andersson *et al.* 1999). The initial introductions in the late 1930s were not very successful, but from the mid-1960s to mid-80s at least 750 Canada geese were released in the southern parts of Norway, and this caused a substantial increase in population size. Despite the gradual introduction of hunting starting in 1986, the population was estimated to comprise more than 15,000 geese in the 1990s, and Andersson *et al*. (1999) found that the numbers seemed to be increasing all over the country.

The Canada goose has been unintentionally introduced to Poland by birds spreading from neighbouring countries and escapes from a local zoo. The species was first recorded in Poland before 1935 and since the early 1980s is a regular visiting and wintering species on the Baltic coast, with smaller numbers recorded inland. Since 2005 successful breeding has been observed in Gdansk on the Baltic Sea coast (1 pair in 2005-2007 and 4 pairs in 2007). At least some of the breeding birds had escaped from a local zoo (Solarz 2007). The majority of these birds were caught, ringed

and rendered flightless (S. Bzoma, pers. comm. 2007). According to Solarz (2007) the increasing numbers of wintering birds, and the fact that successful breeding has already occurred, suggests that a stable breeding population may soon be established in Poland, and that measures to control the species, *e.g*. through hunting, are desirable.

The Canada goose is probably not present on Svalbard, and it is not listed among the introduced species at the Miljøinfo Svalbard website (2005). For Jan Mayen no information (positive or negative) has been found. As noted above, spontaneous occurrences of migrating North American species of *Branta* have however been observed on Svalbard (Mjøs *et al*. 2004).

The Canada goose is present in most of Sweden, the greatest numbers in the southern parts, and it has become the most common of all goose species (Andersson *et al.* 1999). It occurs along all the coasts, and inland along rivers and lakes (Fabricius 1983). The Swedish populations winter mainly in Skåne, Denmark, and Germany, but during harsh winters some venture as far as the Netherlands, Belgium and northern France (*ibid.*). The first introduction of Canada goose in Sweden was made in 1929 by a private citizen with the intention of enriching the native fauna (Anderson *et al.* 1999), and the first breeding in the wild, in Kalmarsund in the county of Blekinge, was observed in 1933 (Fabricius 1983). Introductions by local hunting clubs and private citizens continued in many parts of the country into the 1960s, and in the northern parts of the country into the 1970s, when the population was judged, quite correctly,– to be able to grow and disperse by natural means (Jägareförbundet 2006, Fabricius & Norgren 1987). Annual inventories indicate that the population continues to increase, and in September 2005 43,500 individuals were counted in the southern part of Sweden during the regular goose count (Nilsson 2006) (See also table 1).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Denmark					X		
Estonia		X	X				
European part of Russia			X				
Finland				X			
Faroe Islands				X			
Germany				X			
Greenland				Native			
Iceland		X	X				
Latvia			X				
Lithuania			X				
Norway						X	
Poland			X				
Sweden						X	

Table 1. The frequency and establishment of *Branta canadensis,* please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** – The species is not found in the country; **Not established** – The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** – Few sites where it is found in the country; **Local** – Locally abundant, many individuals in some areas of the country; **Common** – Many sites in the country; **Very common** – Many sites and many individuals; **Not known** – No information was available.

Ecology

Habitat description
The Canada goose prefers open, grassy habitats and lives in or near lakes, marshlands, coastal plains, prairies, tundras and grain fields (Long 1981). It is primarily a grazer, and feeds on aquatic plants, grasses, herbs, and roots, including planted crops. Juveniles require a high protein diet and will consume insects, small crustaceans and molluscs attached to aquatic plants (French & Parkhurst 2001). The Canada goose is also common in urbanized areas and manmade habitats, such as city parks and golf courses, close to humans. In the NOBANIS area it is present in coastal areas, by lakes and watercourses, wetlands, agricultural, and urban areas (NOBANIS 2006). In *i.a.* Norway it also occurs in coniferous forests with access to water and forage (Heggberget & Reitan 1994).

Breeding takes place close to open water. Outside the breeding season Canada geese often live in large flocks, and during autumn and winter they often find their food in agricultural areas, while spending the nights on open water or ice covered lakes or coastal areas, sometimes far from the area where they forage (Jägareförbundet 2006).

Reproduction and lifecycle
Canada geese are monogamous, and most couples remain partners for life. They reach sexual maturity after two years, but usually the first breeding takes place when they are 3–5 years old (Fabricius & Norgren 1987). Both parents protect the nest during incubation of the eggs, and the male vigorously defends the nest and young once the eggs are hatched. They are however, highly social animals, and sometimes groups, called crèches, are formed with goslings of several parents being watched over by a couple of adults. Young birds often remain with their parents until the next breeding season. Outside of the breeding season, Canada geese live in large flocks, often together with other species of geese.

The nests are made by the female in a small depression on the ground and filled with grass, mosses, twigs and such, and insulated with down or feathers. They are located close to water, often in a raised spot providing good visibility, preferably on islands. The eggs are laid in spring (April to May). Information about clutch size varies between areas and authors: for Norway 3–5 (Heggberget 1987), for Sweden 2–10 (Jägareförbundet 2006) and 5–9 (Dahlfors 2006), and for the UK 4–7 (Kirby 1999) and 5–6 (RSPB 2006). The eggs are incubated for 28–30 days, and the chicks fledge in 40 to 48 days (RSPB 2006). Hatching success is highly variable, but usually 40–60% (Kirby 1999). Gosling survival to fledgling is usually high, but can vary between 45 and 77 %, and may be enhanced by crèching (*ibid*.).

After the breeding season the Canada goose moults, in which it sheds some of its feathers and becomes temporarily unable to fly. Pairs with goslings moult at the breeding site, whereas sub-adults and those without goslings gather in groups, often on lakes similar to those used for breeding (Andersson *et al*. 1999). According to Andersson *et al.* (1999) no large-scale moult migrations have developed in the north European breeding areas.

Canada geese are potentially long lived birds, and the maximum reported life span in captivity is 80 years. In the wild, more than 20 years is probably quite unusual, and average life span considerably shorter due *e.g.* to hunting mortality (Fabricius & Norgren 1987). In a Swedish study of recovered (dead) ringed geese the mean age at death was 4.5 years, with hunting as the most common cause, accounting for 70% of the deaths. Less than 4% of the birds were more than 7 years old (*ibid.*). Natural enemies include other large birds (gulls, ravens, and crows) preying on eggs or chicks, and dogs (Dewey & Lutz 2002). For the United Kingdom, ringing recoveries have indicated that 72% of dead birds have been killed by man, either shot or culled (Kirby 1999).

Dispersal and spread
Site faithfulness, especially in females, has probably slowed the natural spread of the Canada goose to new habitats (Allan *et al.* 1995). However the spread of the Canada goose has been accelerated by intentional translocations in *i.a.* the United Kingdom and Scandinavia.

The Canada goose is a long-lived and highly fecund species, producing up to six young per pair and year. Fledgling success is high, and, having few natural enemies, adult mortality is low when no culling by man takes place. In *e.g.* the United Kingdom population growth has been most rapid in urban areas with little shooting pressure and correspondingly low adult mortality (Allan *et al.* 1995).

Populations of many of the various subspecies of Canada goose have shown a dramatic increase over the past decades. At the turn of the 20th century the Canada goose was feared to be nearing extinction in parts of its native range. Protective measures and large-scale man-made changes in the landscape (*e.g*. the proliferation of lawns and changes in agriculture) have made the species numerous to the point of being considered a pest in many areas. The global population is today estimated at 1,000,000–10,000,000 individuals, and it is evaluated as a species of Least Concern on the IUCN Red List (BirdLife International 2006). In North America the total population increased five-fold between 1970 and 2005, from about 1 million to 5 million birds. Most of this was due to a 15-fold increase in the populations of resident (non-migratory) geese, today comprising two thirds of the entire population as compared to 18% in 1970 (Dolbeer & Seubert 2006). In Greenland, where several subspecies also occur naturally, the increase since the late 1970s has been described as spectacular (Fox *et al.* 1996). In Europe, the number of Canada geese in the United Kingdom remained low for almost 300 years, *i.e.* until the 1950s, when the species was translocated across the country to try and relieve local conflicts, which unintentionally created new centres for a population explosion (WWT 2007). In 1953 the previously stable UK population of about 3,000 geese began to increase at an average rate of about 8% per year, and was estimated to around 130,000 birds by Austin *et al.* (2001, in CAA 2002), or 82,550 adults in 1999 (Baker *et al.* 2006 in WWT 2007).

Andersson *et al*. (1999) found that the pattern of population increase in Fennoscandia was similar to that recorded for the British Isles from the 1950s and onwards, but that the increase seems to have been even faster in the Finnish, Swedish and Norwegian populations. In Sweden the population increased from 5 individuals in the 1930s to some 3,000 breeding pairs and 30,000 birds in the early 1980s (Fabricius 1983), and 10,000 pairs in the mid-1990s (Jägareförbundet 2006). Though it is difficult to determine how many pairs are actually breeding in the wild, for a more recent figure Dahlfors (2006) gives 10,000 to 20,000 breeding pairs as a likely estimate. In Finland, a rapid increase started during the 1980s, two decades after its introduction, and the estimated growth rate between 1987 and 1996 was 22–31% (Andersson *et al*. 1999). As noted above the initial introductions to Norway in the 1930s were not very successful, but continued introductions lead to a population of more than 15,000 geese in the 1990s, with numbers increasing all over the country (Andersson *et al.* 1999). The 1980s and 90s also saw substantial increases in Germany (Andersson *et al*. 1999). A stabilisation or even decrease in numbers has been predicted from time to time (*e.g.* Fabricius 1983, Andersson *et al.* 1999), but *i.a*. in Sweden the totals during the annual goose counts have shown a steady increase into the 21st century (Nilsson 2006).

The Canada geese breeding in Fennoscandia are migratory, except for a substantial proportion of Norwegian geese. The wintering areas for Swedish and Finnish populations are mainly located in the southernmost part of Sweden, in Denmark and northern Germany, concentrating on coastal

areas. The Norwegian Canada geese are resident or undertake short-distance migrations to open waters along the coast or migrate to Sweden and Denmark (Andersson *et al.* 1999). A small number of Finnish Canada geese move along the east side of the Baltic passing Estonia, Latvia and Lithuania before reaching wintering areas in Poland and the eastern part of Germany (*ibid.*). The populations in the United Kingdom (Kirby 1999) and on the European continent (Andersson *et al.* 1999) are mainly resident. The birds on the Faroe Islands, which originated from Yorkshire, migrate to England (Sørensen & Bloch 1990).

In Sweden the Canada goose moves south from its breeding grounds in October to December, and return in March or April. There is however substantial variation between populations, and during mild winters many geese remain in their breeding areas (Fabricius 1983), especially those in the southern parts of the country as well as many of the populations in urban areas. Conversely, cold winters with heavy snow cover can take the birds further south to Continental Europe.

In North America a northward range shift has been observed in that some migratory populations don't move as far south during the winter as they used to. This has been attributed to changes in farming practices making waste grain more available during autumn and winter, as well as changes in hunting pressure and weather (All About Birds 2006, van der Graaf *et al*. 2006).

Impact

Affected habitats and indigenous organisms
Overgrazing by Canada geese can cause physical as well as economic damage to natural vegetation, agricultural crops, parks and recreational areas. In addition to loss of crops, trampling of large flocks of geese can compact the soil and prevent new growth. Feeding damage can also create bare spots that may be subject to erosion (French & Parkhurst 2001). Intense herbivory by Canada geese can severely damage natural vegetation along shorelines and in shallow waters (Gebhardt 1996).

Bird droppings can lead to reduced water quality through the addition of bacteria, nitrogen, phosphorous, and particulate matter, and the continuous influx of nutrients contained in Canada goose faeces can contribute to the eutrophication of small water bodies, especially if they have limited circulation and flow-through. Increased nutrient levels may in turn promote the growth of water weeds and algae. A well-fed Canada goose can produce up to 0.7 kg of fecal matter per day (French & Parkhurst 2001), which means that 10 geese can produce 2.5 tons of manure in one year. In extreme cases up to 70% of the phosphorous load to small lakes and ponds in the United States has been attributed to Canada geese (Manny *et al.* 1994 in Lerner 2006). In a study of lakes in Skåne, Sweden, the estimated contribution by geese was however much lower, ranging from less than 1 to 6% (Lerner 2006).

Generally interactions between Canada goose and native fauna are not well investigated (Ebenhard 1988), and thus remain a concern (Madsen & Andersson 1990). In Sweden the Greylag goose and Canada goose have been observed to show interspecific aggression and territorialism (Andersson *et al.* 1999), but other studies have found no ill or even positive effects on other species, including greylag goose (Fabricius 1983, Fabricius & Norgren 1987).

In its native range the Canada goose is susceptible to a number of diseases including avian cholera, botulism, salmonellosis, chlamydiosis, duck virus enteritis (DVE or duck plague), aspergillosis, and various parasites (French & Parkhurst 2001). In a German study of Canada goose eggs, a number of pathogens that might cause disease in poultry and waterfowl were tested for. No viruses were

isolated, but antibodies against Newcastle disease and avian influenza were found, as well as against egg drop and duck plague viruses (Bönner *et al.* 2004). Like many species of waterfowl Canada goose can be affected by avian influenza, and during 2006 there were a few reports of dead Canada geese from northern Europe (Feare 2006), including Sweden (Mörner *et al.* 2006, SVA 2006), that tested positive.

Genetic effects

The populations of Canada goose in Scandinavia seem to originate from only five individuals; four from the Hagenbeck Zoo in Hamburg, probably originating from the British population, and one male from North America (Fabricius 1983, Tegelström & Sjöberg 1995). The reduced amount of genetic variation available to this founding group, and the further losses of variation over time, has apparently not hindered the successful establishment and dispersal of the species. A possible explanation for this could be that the introduced individuals were taken from a group of birds that had gone through a period of domestication, a process known to cause elimination of deleterious alleles as a consequence of close inbreeding (Sjöberg 1996).

Hybridization between Canada goose and other species of geese is commonly observed in captivity, but is thought to be more uncommon in nature, and hybrids observed in the wild may often be escapees (Fabricius 1983). Hybridization is however also known to occur in the wild. Like many other goose species the Canada goose exhibits both intra- and interspecific nest parasitism (*i.e.* when a nest and its eggs are taken over) as well as brood amalgamation (when hatched chicks are adopted) (Söderholm 2005 and references therein). One consequence of interspecific parasitism or amalgamation is that the adopted offspring can be sexually imprinted on the wrong species, which may cause them to take a mate belonging to the same species as their perceived "parents", rather than a con-specific, resulting in hybridization (Fabricius 1991). The most common cross seems to be with Greylag goose, but crosses with Snow goose (*A. caerulescens*), Bar-headed goose (*A. indicus*), Barnacle goose (*Branta leucopsis*), Bean goose (*A. fabalis*), White-fronted goose (*A. albifrons*), and Lesser white-fronted goose (*A. erythropus*) have been reported (Jägareförbundet 2006). Hybridization also occurs between the Canada goose and domestic geese (All About Birds 2006). Hybrids between Canada goose and Greylag goose have been observed *i.a.* in Germany (Gebhardt 1996), Sweden (Söderholm 2005), the Faroe Islands and on Iceland (Weidema 2000 and references therein). The greatest concern would of course be hybridization with already threatened species such as the Lesser white-fronted goose, for which the current estimate of the Fennoscandian subpopulation size is only 30–50 breeding pairs (Ruokonen *et al.* 2000).

Human health effects

Goose droppings can contain micro-organisms that may cause diseases in humans. Such pathogens have been shown to survive and multiply in Canada goose faeces for up to one month after deposition (Feare *et al.* 1999). The Canada goose can thus serve as a vector for various diseases, and goose droppings can contain viruses, bacteria and parasites that may be spread to humans and other animals. Pathogens that have been identified in faeces in studies from the United States include coliform bacteria, with pathogenic forms such as enterotoxogenic (ETEC) and enterohemorrhagic (EHEC) forms of *Escherichia coli* (Kullas *et al*. 2002), and protozoans such as *Giardia* and *Cryptosporidium* (Kassa *et al.* 2004), including oocysts of *Cryptosporidium parvum* (Graczyk *et al.* 1997, 1998), an intracellular parasite that can potentially infect humans. Consequently, in the United States, Canada geese are sometimes considered a problem in relation to watershed management and the protection of sources of drinking water. Birds, including Canada geese, are reported to be one of the most common and significant sources of microbial contamination of open water reservoirs (EPA 2001).

Economic and societal effects (positive/negative)
Like many other successful introduced species, the Canada goose manages well in habitats influenced by man. Although lakes, ponds, marshes, and open fields are the environments in which Canada geese naturally live, manmade equivalents such as parks, recreational areas, golf courses, and airports provide attractive and accessible habitats for the geese (Encyclopædia Britannica 2007). The Canada goose's tolerance to, and even preference for, habitats created by man has caused it to be considered a nuisance or even pest species in many areas. Its competition with man for space, food, and other resources has certainly been better documented than its effects on wild flora and fauna. Even so, the extent and cost of the damage caused has not been fully evaluated in most countries (Allan *et al.* 1995). Since its introduction to Europe, Canada goose has established itself as a species with some hunting benefit (Madsen & Andersson 1990). The management problems are, however, increasing as the number of birds increase. Thus there is an apparent conflict between hunting interests on one side, and on the other concerns about native wildlife and agricultural damages (Weidema 2000).

The Canada goose can cause damage to agricultural crops and amenity areas resulting in significant localised economic loss, particularly in areas close to water (Allan *et al.* 1995). In the agricultural landscape damage from overgrazing and fouling have been reported, when great flocks of geese (Canada geese together with native and wintering geese) settle on fields with potato or beetroot or on winter crops (rape, wheat or rye) (Svensson 1992). Grazing damage and trampling can be quite severe, and in a survey of affected German states the damages were estimated to amount to DEM 1–3 million annually (Gebhardt 1996). In Sweden there have been an increasing number of reports of damage to crops, but the actual extent and associated costs are poorly documented (Jägareförbundet 2006). Also urban areas (parks, meadows and water bodies used for swimming) may be affected negatively by feeding and fouling geese (Nummi 1996, Andersson *et al.* 1999). As mentioned above a Canada goose can produce up to 0.7 kg of faecal matter per day, and aside from aesthetic considerations, the addition of bacteria and particulate matter is a problem in relation to public beaches and sources of drinking water (French & Parkhurst 2001).

Of potentially great concern is the threat to aviation caused by collisions between large birds and aircraft. Because of its large size, flocking behaviour, attraction to the type of environments provided by airports for grazing and resting the Canada goose can cause a disproportionate amount of damage to aviation (Dolbeer & Seubert 2006). According to the UK Civil Aviation Authority (CAA) the combination of the dramatic increase in the global population of large flocking birds, such as Canada geese, and the parallel growth of air traffic has caused a significant aviation safety issue. The growing populations of non-migratory geese near urban centres are of particular concern, since the present air safety requirements have not been developed for birds of this size (CAA 2002).

In the United States the economic costs, through loss of airtime or, in the event of a crash, entire aircraft, have been estimated to well over US $ 1 billion per year (Dolbeer & Eshenfelder 2003). The insurance industry places the figure even higher, at US $ 4.5 billion per year for United States and Canadian aviation alone (DeFusco *et al.* 2005). Even more serious is the associated loss of human life. In 1995, a US Air Force AWACS aircraft ingested 13 Canada geese into the engines on take-off. The plane, valued at US $ 190 million, crashed, killing all 24 people on board (Dolbeer & Seubert 2006, French & Parkhurst 2001). Globally there have been a minimum of 147 fatalities and over 120 aircraft lost due to bird strikes since 1990 (DeFusco *et al.* 2005). In addition to the management and control of wildlife in and around airports, airworthiness standards, operational procedures of aircraft, techniques to detect birds by radar and, conversely, to make aircraft more visible to birds need to be developed and implemented (Dolbeer & Eschenfelder 2003).

Management approaches

Prevention methods
Intentional introductions of alien species are in principle controlled by law. As a minimum most countries in the NOBANIS area require a permit from a national authority for the import and release of alien species into the wild, sometimes including a general prohibition on their importation and/or release. Some countries have "white lists" of game species for which permission may be granted (*e.g.* Denmark and Sweden where breeding and release of the introduced pheasant (*Phasianus colchicus*) may be allowed), others have "black lists" of species that may not be introduced (*e.g.* Estonia). Some countries have even developed legislation and national strategies specifically dealing with alien species and populations. For further information about national legislation in the NOBANIS area, see www.nobanis.org/Regulations.asp.

According to the Birds Directive (79/409/EEC), the Canada goose belongs to the species that may be hunted in accordance with the legislation of the Member States (Article 7 and Annex II/1). No species may however be hunted during the various stages of reproduction, nor, in the case of migratory birds, during the period when the birds are returning to their rearing grounds. As this presents a problem in managing populations of Canada goose, it is strongly recommended that this species be removed from the Birds Directive and the Bern Convention's Appendix III.

The Canada goose was originally intentionally introduced, mainly as a game species, and hunting is sometimes also allowed to prevent economic damage to crops or sanitary problems. In the Nordic countries Canada geese are protected during the breeding season, with hunting allowed for part of the rest of the year (Madsen & Andersson 1990). On Iceland, however, the species is protected all year round (Weidema 2000). In Sweden there is an open hunting season starting late summer to the end of December. In order to prevent damage to crops, Canada geese may also be shot outside the hunting season, as may geese that are considered a sanitary problem. The yearly hunting mortality of the Swedish-Finnish population is about 20,000–25,000 geese, corresponding to approximately 35% of the population after breeding (Jägareförbundet 2006).

In general shooting does not seem to limit range extension in this species. In Britain the species is controlled by a combination of shooting and destruction of eggs, and these control measures seem to slow down the growth of the population (Kirby 1999).

Eradication, control and monitoring efforts
Since the Canada goose is in many areas considered a nuisance or pest species there are a great many suggestions for how to control it. Methods to control and manage the Canada goose can, in accordance with the principles of Integrated Pest Management (IPM), be divided into three major categories of increasing severity; husbandry, non-lethal and lethal methods (French & Parkhurst 2001). A combination of husbandry/habitat management, non-lethal/behavioural modification measures and, as a last resort, lethal/population reduction methods may have to be combined and should be specific to the site concerned (Allan *et al.* 1995). The result and efficacy of any such activities should be followed up and evaluated, and, obviously, only carried out in accordance with applicable national legislation.

Husbandry methods entail reducing the attractiveness of a site, *e.g.* in terms of the availability of food and/or space, and methods will vary depending on the resource one wants to protect (crops, recreational areas, airfields *etc.*). Methods for protecting crops include reducing the amount of fertilizer applied to reduce the nutritional value of forage such as grains, and/or altering the planting/harvesting schedule so that the ripening of crops does not coincide with the expected time

of migration. For recreational areas the addition of plants that are unpalatable to the geese, and/or manipulating the amount of cover by removing or adding vegetation, have been suggested (French & Parkhurst 2001).

Non-lethal methods can be divided into scare devices or strategies (auditory, visual, physical) and physical deterrents (barriers of *e.g.* vegetation, fencing, or rocks; chemical repellents) (French & Parkhurst 2001). For airfields in the United Kingdom, habitat management to discourage nesting, roosting and feeding is employed, such as the netting of ponds and lakes to prevent access to open water, fencing or other obstacles to reduce accessibility of forage *etc.*, and removal of nesting sites. Bird patrols using scaring or dispersal techniques are also employed (CAA 2002).

Lethal methods include hunting, which may be effective in agricultural but not urban areas. Reducing population numbers through treatment of eggs, *e.g.* by pricking them with needles, coating them with paraffin or removing the eggs and replacing them by dummies (to discourage the female from laying another clutch) has also been attempted *e.g.* in the United Kingdom. Even if this method can be efficient, it will however take a number of years before any reduction in population size occurs, and it has been suggested that reproductive control needs to be combined with an increase in adult mortality if the population size at a particular site is to be reduced in a reasonable time (Allan *et al.* 1995).

Information and awareness
No available information.

Knowledge and research

Annual censuses of waterfowl and geese populations are carried out in several countries, *i.e.* in Sweden (*cf.* Nilsson 2006).

An overview of existing, current and needed research in Fennoscandia and the European Continent is available in Andersson *et al.* 1999.

Recommendations or comments from experts and local communities
No available information.

References and other resources

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