

Information about GB Non-native Species Risk Assessments

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

Common misconceptions about risk assessments

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:

<https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51>

comments should be emailed to nnss@fera.gsi.gov.uk

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

For more information visit: www.nonnativespecies.org

Name of Organism:		<i>Branta canadensis</i> - Greater Canada Goose	
Objectives:		Assess the risks associated with this species in GB	
Version:		FINAL 21/03/11	
N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk Assessment?		Request made by GB Programme Board
2	What is the Risk Assessment area?	GB (England, Wales and Scotland).	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
A	Stage 2: Organism Risk Assessment SECTION A: Organism Screening		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Give the full name & Go to 7)	<i>Branta canadensis</i> (Linnaeus 1758) Greater Canada Goose - Anseriformes - Aves - Chordata - see q.6.
6	If not a single taxonomic entity, can it be redefined?		Almost all 'Canada Geese' in the UK are what are now called Greater Canada Geese (<i>Branta canadensis</i>) by the British Ornithologists' Union (see http://www.bou.org.uk/recnews05.html). This assessment considers and refers to Greater Canada Goose as Canada Goose throughout this assessment. Some vagrant and rare Lesser Canada Geese (<i>Branta hutchinsii</i>), which breed in Alaska and Canada, do turn up in Europe but are not identified in any large European breeding concentrations (e.g. 2 max; Austin <i>et al.</i> 2008). Several European nations still consider <i>B. hutchinsii</i> to be the same species.
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	Natural and feral populations in North America and Europe conflict with human and environmental interests by damaging amenity grassland, golf courses, polluting water courses, predating crops (Allan <i>et al.</i> 1995, Rusch <i>et al.</i> 1998) and posing risks to flight safety (Baxter & Robinson 2007). They are also cited as conflicting with airport operations, agriculture, water courses, public beaches and swimming facilities, water-treatment reservoirs, corporate business areas, schools, college campuses, private lawns, athletics fields, amusement parks, cemeteries, hospitals, and along/between highways in the US Federal Register (2006). Several states in the USA have closed beaches due to excessive faecal coliform levels that have been traced back to geese. Additionally people have been bitten, chased and hit by wings when aggressive geese have been nesting and brood rearing. All such problems have increased in the USA as resident Canada goose populations have increased (Federal Register 2006). Catastrophic birdstrikes with Canada geese have occurred across the USA with over 1400 strike incidents with this species occurring with civil aircraft between 1990-2007 (BSCUSAii). Amongst others, a multiple engine failure caused by Canada goose ingestion occurred on a Concorde at a cost of \$9million in June 1995 and a fatal air crash killing 24 airmen occurred at Elmendorf airbase, Alaska when at least four geese were ingested into two engines of an AWACS aircraft later the same year (BSCUSAi). In New Zealand, introduced populations deter sheep and cattle from grazing due to increased fouling of pasture. Pasture damage was directly correlated to the number of geese present and farmers (at 1996 levels) estimated that damage from geese amounted to between \$1,375 and \$47,500 per farm (Spurr and Coleman 2005). Populations also contribute to the eutrophication of small waterbodies, acting as hosts to various avian pathogens thus indirectly affecting other waterbirds (Blair <i>et al.</i> 2000) and possibly humans (Bonner 2004). The relevance of Canada geese, however, to cryptosporidium transfer may not be significant (Kassa <i>et al.</i> 2004). Similarly, Converse <i>et al.</i> (2003), suggest that there is a minimal risk of disease through contact with Canada goose faeces but that the prevalence and survival of organisms could vary with season and area. When Canada geese adopt a residential life strategy (as opposed to migratory), the nuisance, damage and risk they create within their range appears to consistently increase with population size. Ironically in the UK, the original dispersal of birds undertaken in the 1950s that led to the expansion in the population seen today, was aimed at reducing risk to agriculture (Kirby <i>et al.</i> 1999).
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	
10	Is the organism widely distributed in the Risk Assessment area?	YES & Future conditions/management procedures/policies are being considered (Go to 19)	Widespread in England, expanding range in Wales and Scotland (Gibbons <i>et al.</i> 1993). Abundant - estimated 82,000 birds in GB (Baker <i>et al.</i> 2006), 88,800 birds in 2000 with a possible peak of 127,000 depending on count method used (Austin <i>et al.</i> 2007). The most recent data, up to the year 2006/2007 (Austin <i>et al.</i> 2008), shows a population continuing to increase with numbers above average in every month of the year and the total population higher than at any time since records were started in 1965/66. The population was increasing at 8.3% p.a. (Allan <i>et al.</i> 1995) whilst Austin <i>et al.</i> (2007) suggest a 166% increase between 1989 and 2000. The WWT moult counts for their part of the naturalised goose survey and the BTO naturalised goose work contrasts with these findings and suggest a decline of 1.9% p.a. (Rowel <i>et al.</i> 2004). The vast majority of research confirms the population is increasing.
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	Artificial and natural wetland habitats, agriculture and parkland suitable for all aspects of the birds ecology are widespread in GB.
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		

14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	Natural range in North America includes areas with a similar climate to GB. Can breed anywhere in temperate zone with suitable feeding and reasonable distance to open water (Blair <i>et al.</i> 2000). Also adapts quickly to human settlement.
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?	YES (Go to 16)	Already present in many zoological gardens throughout UK (e.g. grounds of Kew, London). Present on an abundance of fishing lakes, particularly where islands are present in the waterbody. Is unlikely to establish under enclosed conditions unless introduced.
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	First introduced to GB in 1665, successful breeding first recorded in the 1800s but did not become widespread until after deliberate relocation (for sport) began in the 1950s (Allan <i>et al.</i> 1995). Banks <i>et al.</i> , 2008, provides a review of the successful introductions and establishments of this species across many European, African and Middle Eastern countries and confirms how the species is capable of expanding into new areas. The species was also introduced to New Zealand (Evans 2009) in the early 1900s and has shown similar spread from its original range and is now found extensively across the South Island. Canada geese were introduced widely into 16 European countries (Rehfishch <i>et al.</i> 2006), and are now routinely widespread and increasing rapidly in Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Sweden, Switzerland and the UK (Austin <i>et al.</i> 2008).
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	Initial expansion aided by human assistance (Kirby <i>et al.</i> 1999). By 1995 population increases all via natural expansion into available habitat. Populations confirmed as spreading by Austin <i>et al.</i> 2007.
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	Local damage can be severe and incur high costs to farmers and landowners (Allan <i>et al.</i> 1995). Potential vector of avian and human pathogens (via faeces) including avian flu virus (Allan <i>et al.</i> 1995, Bonner <i>et al.</i> 2004). Known hazard to aviation safety (Baxter & Robinson 2007). The recent birdstrike out of La Guardia airport on January 15th 2009 resulting in the destruction of a twin engined civil airliner (Airbus A320) highlights the potential risk. The species could impact on conservation via displacement of, or aggression towards, native species. Habitat damage through trampling and erosion of agriculture is thought to cause significant damage (Pimentel 2002). Some indirect damage to shellfish beds were reported in Cape Cod whereby puddling and depressions created by Canada Geese increased accessibility of clams and other shellfish to Mallard and Black Duck (Heusmann 1981). Overall damage has rarely been quantified however, and no national assessment has been undertaken in Great Britain.
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences				
Probability of Entry		RESPONSE	UNCERTAINTY	COMMENT
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	few - 1	LOW - 0	i) Expansion of existing population, ii) escape or release of captive birds from wildfowl population, iii) immigration from naturalised European birds.
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Expansion of existing population.		
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4	LOW - 0	Species already present, abundant and widespread in GB.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	very likely - 4	LOW - 0	Population was estimated at 82-88 thousand birds in 2000; counts suggest it has increased since that time. The species is semi-colonial, gregarious and has a social structure based around large family groups (Kear 2005).
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	The species is widely hunted but annual adult mortality of 15-40% (Allan <i>et al.</i> 1995) did not prevent rapid population expansion in the mid 1990s. Change of status under the general licence in England does not appear to have limited the population increases that are occurring.
1.6	How likely is the organism to survive or remain undetected by existing measures?	very unlikely - 0	LOW - 0	The species is conspicuous, prefers human settlement and is very likely to be detected in new areas by the bird watching community.
1.7	How likely is the organism to survive during transport /storage?	likely - 3	LOW - 0	No reason to presume the species cannot reach any suitable habitat currently unoccupied in GB. Some individual birds undertake local or regional migrations within the UK (Scottish Executive 2007), confirming mobility of this species. PhD studies undertaken during the 1990s (Stevens, M. pers. comm.), confirm large moult migrations of birds from the Yorkshire Dales breeding colonies to the Beaulieu Firth in Scotland.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	N/A		
1.9	What is the volume of movement along the pathway?	moderate - 2	MEDIUM -1	Expansion of the population (at 8.3% p.a. in the mid-1990s (Allan <i>et al.</i> 1995)) was the main pathway movement. Estimates are uncertain with reports of both increases of 9.7% p.a. (Austin <i>et al.</i> 2007) and declines of 1.9% p.a. (Rowell <i>et al.</i> 2004). The most recent declines were based on counts from fewer sites so may not reflect the entire GB population. The maximum count of 56,486 birds in December 2006 (approximately half the estimated population), recorded by Austin <i>et al.</i> (2008), has the most current data confirming the overall population continues to expand at the same rates experienced in the past.
1.10	How frequent is movement along the pathway?	very often - 4	LOW - 0	Expansion is occurring between years at a rate described in sec 1.9. Expansion in North America, where traditionally migrating geese have adapted to a year round urban environment, saw numbers increase from a few thousand in 1965 to 1.1million by 1996 (Smith <i>et al.</i> 1999). The major driver of this expansion is reported as high fledgling survival rates in an urban environment (77%) (Johnson & Sibly 1991).
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	widely - 3	LOW - 0	Breeding bird surveys conducted by the BTO indicates that the species is widespread and expanding its range (Gibbons <i>et al.</i> 1993). Canada Geese are present in urban, rural and upland areas across the UK and have the potential to colonise any areas that provide safe breeding grounds, food and resting areas. Birds are known to breed in or on land, in or next to any potential waterbody (ponds, canals, rivers, lakes, gravel pits etc.). They have also been observed breeding on islands, in trees, on walls, spits, promenades, flower beds, gardens, parks and industrial areas (pers.obs).
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	Establishment is driven by expansion of the breeding population in urban environments followed by dispersal into new areas. Localised movements, and some longer distance moult movements, are recorded and provide a route through which colonisation of new areas can and does occur.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	N/A		
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	very likely - 4	LOW - 0	Suitable foraging and breeding habitat is widespread in GB. The species also readily adapts to human settlement.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	very similar - 4	LOW - 0	The species can survive anywhere in the temperate zone with suitable habitat. Survival in the UK is shown via the increasing populations currently observed.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	very similar - 4	LOW - 0	See 1.18
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	LOW - 0	Edible plant material for grazing a reasonable distance from open water is abundant within numerous habitats in GB, but the factors that influence the suitability of water bodies for breeding geese and the number of pairs that they can support are not fully understood (Allan <i>et al.</i> 1995).
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	Suitable habitats, including natural and man made wetlands, amenity parkland, farmland and human settlement are widespread in GB.
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A		Canada geese are self sustaining and increasing within the risk assessment area. Provision of artificial food (bread etc.) by the public, and wetland habitats (e.g. through restoration schemes following mineral extractions etc.) may mean their association with people is a key driver of their population.
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	likely - 3	LOW - 0	There is some evidence of competitive exclusion by Mute swans for winter forage (Allan <i>et al.</i> 1995). However, no interspecies competition has been recorded in the literature during the breeding season with Mute swans or Greylag geese (Allan <i>et al.</i> 1995). Anecdotal evidence from local studies in London (Baxter, pers. comm.) show Canada Geese and Mute Swans nesting side by side. It is likely that its establishment will not be prevented by competition from existing species.
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	likely - 3	LOW - 0	No major impact from natural predators has been detected so far, and natural mortality (excluding shooting) is very low (Allan <i>et al.</i> 1995). There is some evidence of localised failures due to the actions of some land based predators (Fox, Mink etc.), and some evidence of displacement by species competing for breeding space (Mute Swans) (Baxter and Cropper 2009), but this is not consistent between sites or years and is unlikely to result in any wholesale reductions in the numbers of geese present in the UK.
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	unlikely - 1	LOW - 0	No known differences occur. However, the factors that influence the suitability of water bodies for breeding geese and the number of pairs that they can support are not fully understood (Allan <i>et al.</i> 1995).
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	LOW - 0	The population can sustain high annual mortality and still expand. During a period of rapid population expansion in the 1980s, shooting (bag) returns reported by the British Association for Shooting and Conservation (BASC) combined with other causes of death suggested that adult mortality approached 40% p.a. (Allan <i>et al.</i> 1995). Integrated management, however, where egg oiling and habitat management are combined with limited moult management and adult shooting has resulted in successful declines in local populations (Baxter & Robinson 2007). Nationwide increases, however, are likely to offset any local reductions thereby requiring a national integrated strategy should prevention of further establishments be required.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	N/A		Canada geese arrived from North America when they were introduced into collections in St. James Park (London) during the reign of King Charles II in the mid 17th century. Greater Canada geese are routinely recorded at or around wildfowl collections or in parkland but are entirely free flying and are not, to our knowledge, still kept in protected conditions except when recuperating at swan sanctuaries.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	likely - 3	LOW - 0	The species lays large broods (avg. 4-7 eggs), often breeds semi-colonally and has high breeding success (Kear 2005). Clutches lost to predation can be re-laid (Cramp 1977). The species is also long-lived; the oldest ringed UK bird was 24.2 years (Kear 2005).
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	See question 10 above.
1.27	How adaptable is the organism?	adaptable - 3	LOW - 0	See question 14 above.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very unlikely - 0	LOW - 0	The genetic diversity of the GB population is not known but is unlikely to be low as early introductions were probably derived from various populations and natural vagrancy occurs albeit at an unknown rate.
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	very many - 4	LOW - 0	See Question 16 above. Note the species has also been introduced into many parts of Europe.
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	unlikely - 1	LOW - 0	The whole UK population undergoes a full moult of flight feathers in June/July each year which renders birds flightless for a given period. During this period the majority of the UK population congregate into relatively large flocks (>100 birds) which would allow effective eradication to be achieved if implemented on a suitable nationwide scale. Additional management of the smaller flocks would be required through, for example, shooting. Egg removal and/or oiling can also be effective over the longer term (Gibbons <i>et al.</i> 1993), but would need to be implemented year on year across all breeding locations to impact on overall numbers. A comprehensive evaluation would be required to determine the level of control required to eradicate the Canada Goose from the UK and prevent any subsequent risk of repopulation via feral populations of birds established on the continent. Given sufficient will however, eradication would be possible across the Risk Assessment area and could be maintained indefinitely.
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	moderately likely - 2	MEDIUM - 1	Feral populations are now abundant on mainland Europe. Presumably movements from these bird into GB are possible.

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	intermediate - 2	LOW - 0	The number of occupied 10km squares nearly doubled between the survey periods conducted for the 1968-72 and 1988-91 breeding bird atlases (681-1196), (Gibbons <i>et al.</i> 1993). In the 1990s the population was doubling every 10 years and there were many apparently suitable sites still unoccupied (Allan <i>et al.</i> 1995). Localised monitoring in the London area shows significant increases. Data from culling exercises in west London confirm significant immigration has occurred (Baxter 2007). In the USA, Cooper and Keef (1997) show that after a release into urban areas in the 1940s Canada goose populations grew exponentially from fewer than 1,000 in 1967 to 190,000 in 1994. Numbers along the Mississippi Flyway grew to 1 million in 1996, mostly from re-established flocks. Problems were reported across the USA. It is likely that a continued spread of this species into the UK will occur.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	very slow - 0	LOW - 0	Direct introductions are no longer known to occur.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	difficult - 3	LOW - 0	Effective and complete eradication could be achieved (see section 1.30). The majority of birds moult at a limited number of sites and with sufficient resource, the bulk of birds could be removed. The GB population is very large, well established and public opposition in many cases is likely as this is often peoples main contact with wild birds in country parks. Containment of the population through egg control and moult management in localised areas occurs already in some areas (Baxter 2007).
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	Amenity grassland, water courses, golf courses, arable farmland.	MEDIUM -1	Damage can be extensive but the overall economic cost remains uncertain (see question 18 above).

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	Canada geese are responsible for significant losses to agriculture, amenity clean up, and birdstrike with aircraft. No national assessment of economic loss has been attempted in Great Britain although local damage can be severe and incur high costs to farmers and landowners (Allan <i>et al.</i> 1995). Golf courses suffer grass management issues whilst geese are a potential vector of avian and human pathogens (via faeces) including avian flu virus (Allan <i>et al.</i> 1995, Bonner <i>et al.</i> 2004). In the USA, estimates suggest that flocks of 60 geese or more result in complaints about faeces and feather deposits in parkland (Smith <i>et al.</i> 1999 quoting Cooper, University of Minnesota). In birdstrike terms, Canada geese are one of the highest risk species present in the UK. The increasing population, particularly in urban and semi-rural environments that house airports has resulted in an increasing number of birdstrike incidents. The majority of aircraft in operation around the world cannot tolerate an impact with a bird of this size. There are numerous certification standards for aircraft engines the majority of which require nothing other than safe shut down following an impact with a bird of this size (Eschenfelder 2000). The recent birdstrike incident out of La Guardia Airport in New York highlighted the outcome of such a situation. On this occasion there was no loss of life but the cost of aircraft loss and damages will run into many millions of US dollars. Some of the most catastrophic birdstrike incidents have occurred with Canada geese. At Elmendorf Airbase, Alaska, for example, an AWACS aircraft was lost in September 1995 after striking a flock of Canada geese on take off. The aircraft cost was estimated at US\$184 million and 24 lives were lost. Engine losses when Canada geese are ingested are not infrequent (Dolbeer). Some 35% of all damaging birdstrikes in the USA are reported with waterfowl and 58% of these are with geese and swans (Smith <i>et al.</i> 1999). In the UK, an analysis of damage occurrence following a strike with Canada geese reveals 40% of events cause damage to aircraft (CAA data, unpublished). Canada geese may therefore be responsible for a significant proportion of the US\$1.2 billion annual costs of damage and delays caused by birdstrikes around the world (Allan 2000). In the UK, there were 20 confirmed strikes with Canada Geese (where bird remains allowed an identification to be made) and a multitude of strikes with 'goose spp.' that are most likely to have been with this species. To date in the UK there have been no fatalities caused by birdstrikes with Canada Geese and no aircraft have been lost. As a large flocking species, however, and in conjunction with the outcome of recent incidents in the USA, they clearly have the potential to result in an aircraft crashing in this
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	major - 3	MEDIUM -1	No national assessment of economic loss has been attempted in GB but some costs reported from grazing, fouling, trampling and bird strike have been reported. In GB, yield losses of 20% on winter cereals have been cited (Allan <i>et al.</i> 1995, Pimentel 2002). Evidence from North America suggests that the timing of grazing, crop type and growing conditions influence the impact of Canada goose grazing on arable land. Yield losses as high as 70% have been recorded on sprouting winter wheat and in rye grass but no yield losses were recorded on dormant winter wheat. Borman <i>et al.</i> 2002, showed varied losses in grain yield of between 5 and 19% based on timing, intensity and extent of grazing by geese. Conversely improvements in yield were also reported on winter wheat grown on nutrient poor soils (due to improved fertilisation from the goose droppings) as well as rye grass seed in another investigation (Allan <i>et al.</i> 1995). The cost of reinstating damaged grassland and fouled footpaths in a London park was cited at £40 per bird in the 1990s. Canada geese in the USA have been responsible for the loss of human lives and aircraft through birdstrike (Thorpe 2005). Birdstrike events with this species in the UK have occurred and have resulted in damage to aircraft. Some airports have invested hundreds of thousands of pounds in the management of this species to prevent significant losses (BAA pers. comm.). Airports have the legal right to manage this species on their property and have the opportunity under the general wildlife licences to manage them in the vicinity of the airport provided they can obtain the necessary landowner permissions. Despite this, there will remain a risk of a catastrophic birdstrike as long as they continue to thrive in environments around airports. Had the strike with the A320 occurred in the UK and the aircraft had crashed into a built up area with the result that 500 people were killed, costs of clean up, aircraft replacement, legal proceedings and insurance of at least £1million per person could easily result in a total cost of UK£1billion for loss of an aircraft due to a birdstrike with a flock of Canada Geese.
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	minor - 1	MEDIUM -1	Incidents of agricultural crop damage in GB are not yet widespread. E62 Most birds are sedentary and occur on parks and other areas of water-based human activities (Blair <i>et al.</i> 2000).
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minimal - 0	LOW - 0	There is the potential for crop damage to affect yield and/or defecation to reduce the quality of product. Localised impacts can be high and as such, further nationwide expansion could impact on quality of crops. A catastrophic birdstrike incident could result in reduced demand for air travel.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	unlikely - 1	LOW - 0	Unlikely to impact on trading and export.
2.10	How important would other economic costs resulting from introduction be? (specify)	minor - 1	LOW - 0	Costs incurred by farmers, landowners, local authorities and government institutions for damage repair, local culls, compensation and research can be locally high. Golf courses and amenity parkland suffer from defecation and associated clean up costs and potential for disease transmission <i>via</i> faeces.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	minor - 1	LOW - 0	The main concerns are interspecific competition with native waterfowl and indirect effects on other species through modification of habitat e.g. breeding islands. So far indirect effects have not been investigated (Allan <i>et al.</i> 1995). There are differing results of research relating to the eutrophication of waterbodies caused by faecal deposits. These are summarised by Unckless & Makarewicz (2007), who suggest deposits are unlikely to alter water quality unless present in small ponds whose banks and bases can be disturbed by wave action. There is little current evidence that environmental harm such as faecal enrichment and associated plant, agricultural or conservation impacts are currently occurring on a widespread basis in the UK.
2.12	How important is environmental harm likely to be in the Risk Assessment area?	moderate - 2	MEDIUM -1	It is unclear to what level environmental harm could extend. Canada geese are classified as aggressive towards native wildlife, cause ecological disturbance and habitat damage and can be an agricultural pest (Rehlfisch <i>et al.</i> 2006). They therefore have the potential to become more problematic. Seymour <i>et al.</i> 2002, confirm that Canada geese are associated with foraging on Eel Grass, a key food for other species such as Brent geese (<i>Branta bernicla</i>) around the UK coastline in winter. Expansion could, for example, reduce the availability of food for this species. Hybridisation (Welch <i>et al.</i> , 2001), is suggested as a possible impact on species such as Greylag geese if the populations were to expand throughout the available range particularly in Scotland where natural populations of Greylag geese are present. However, Fabricius <i>et al.</i> (1974), suggest both species are capable of residing successfully alongside each other. Canada geese have however, been recorded hybridising with at least 16 other species of anatidae and if expansion out of the UK were to spread northwards, they could hybridise with the rare Red-breasted Goose (<i>Branta ruficollis</i>) (Rehlfisch <i>et al.</i> 2006). There is little evidence of impacts on other species although it is clear that high densities of Canada geese on waterbodies are likely to result in erosion of bankside vegetation and potential reductions in the sizes of reedbeds (Josefsson & Andersson 2001). These could therefore impact on other waterfowl or wading species that utilise this habitat. There is also evidence that high levels of faecal deposits could change the structure and diversity of plant life (Best 2008).

2.13	How important is social and other harm caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	Faeces contain several human pathogens but as yet there is no conclusive evidence of transmission to humans (Allan <i>et al.</i> 1995). Potential vector for the avian flu virus (Bonner <i>et al.</i> 2004).
2.14	How important is the social harm likely to be in the Risk Assessment area?	major - 3	HIGH -2	As per 2.13. A catastrophic birdstrike could result in significant harm through loss of life of passengers or homeowners alike. Contamination of waterbodies through faecal deposits.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	unlikely - 1	LOW - 0	Hybridisation with other goose species is becoming more frequent in GB, however, there are few native breeding geese in GB and most incidences have been with other feral species (Allan <i>et al.</i> 1995). There is concern that, if the population of Canada Geese continues to expand into and through Scotland, this could create a risk <i>via</i> introgression to other native breeding goose species (Welch <i>et al.</i> 2002).
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	likely - 3	LOW - 0	Annual adult mortality (without shooting) is low (Allan <i>et al.</i> 1995) thereby confirming there is little or no impact from natural predators etc. at slowing the population increases that are being recorded.
2.17	How easily can the organism be controlled?	easily - 1	LOW - 0	Local populations can be effectively reduced by shooting, rounding up during the moult season, egg removal and/or egg oiling but some opposition from the public and immigration from neighbouring sites is likely. Control methods therefore need to be on-going and long-term or target wider scale eradication by region.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	unlikely - 1	LOW - 0	Effects of disturbance likely to be minimal and short-term. Round-up and removal at the moult, for example, is likely to result in a maximum of 3 hours disruption at a particular site.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	moderately likely - 2	LOW - 0	Geese faeces host several human pathogens but there is little conclusive evidence for transmission to humans (Allan <i>et al.</i> 1995, Feare <i>et al.</i> 1999). Kassa <i>et al.</i> (2004) suggests that direct contact with contaminated animals, faeces or surfaces could lead to parasitic infection with cryptosporidium, a cause of diarrhoea. Jannsen <i>et al.</i> (2007) suggested a possible cause of an outbreak of Parvovirus that resulted in almost complete mortality for farmed geese could have come from a clutch of infected wild Canada Goose eggs. Canada geese are also one of many potential host species for avian influenza (Kuiken <i>et al.</i> 2006).
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	GB (England, Wales and Scotland).		Most low lying water-side habitats and some areas of high ground with suitable feeding areas.

Summarise Entry	very likely - 4	LOW - 0	Feral Canada geese will continue to occur in GB through natural expansion of established populations.
Summarise Establishment	very likely - 4	LOW - 0	The species is already widespread in England and is expanding its range in Wales and Scotland (Gibbons <i>et al.</i> 1993).
Summarise Spread	intermediate - 2	MEDIUM -1	An estimated 82,000 to 88,000 birds already occur in GB with possible further expansions occurring to date. Estimates suggest the population is capable of increasing at 9% p.a. Many apparently suitable habitats remain unoccupied. It is entirely possible that this species will continue to expand across the UK in both its existing areas and into areas that are currently unoccupied. It is recorded, for example, breeding in reedbed areas, islands, embankments and fallen trees on reservoirs, gravel pit restorations, nature reserves and local ponds in the Greater London area (Baxter 2007ii). Large numbers also breed in Moorland and Sedge tussock grassland in the Yorkshire Dales (Allan <i>et al.</i> 1995). The species is able to adapt to breed in new environments and in a variety of habitats, both rural and urban.
Summarise Impacts	moderate - 2	MEDIUM -1	No national assessment of economic loss has been attempted in GB, but local damage can be severe. No national assessment on their negative impact on other waterbirds in GB has been investigated. The species is a potential vector for avian and human pathogens including the avian flu virus but there is no confirmed evidence of transmission to humans. There is clear evidence of agricultural damage, nuisance and defecation in parkland and risks to flight safety. It is possible that erosion, displacement of other bird species and disease transmission may also be a feature of this species and its expansion. No national quantification of the levels of any such impact has, however, been undertaken.
Conclusion of the risk assessment	MEDIUM -1	MEDIUM -1	Continued entry is likely through on-going expansion of the established population. There may be some limited, natural vagrancy. Establishment is likely to continue aided by high breeding success at some localities, longevity and an abundance of suitable habitat. The species is likely to spread further over GB although the speed of the spread is difficult to establish. Economic loss through agricultural damage, amenity damage and flight safety risks can be high but has not been assessed on the national scale. Control measures such as removal at the moult, shooting and egg management can reduce losses but may require ongoing activity at the local scale or extensive action on a national scale to be fully effective.
Conclusions on Uncertainty	MEDIUM -1	MEDIUM -1	Localised problems suggest that agricultural, amenity parkland, golf courses, nature conservation and waterbodies may be impacted but there has been no national assessment of economic loss in GB and the actual overall cost of damage is unknown. The indirect impact of the species on native waterbirds has not been investigated. This species may be an important vector of avian as well as human pathogens. There is clear risk to aviation flight safety although no quantitative assessment has been made to establish the actual or potential costs associated with this species. A full assessment and comprehensive literature review of the financial and other impacts of Canada geese in all areas of concern should be undertaken alongside a cost

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