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FERAL CANADA GEESE (*BRANTA CANADENSIS*) AS A HAZARD TO AIRCRAFT IN EUROPE: OPTIONS FOR MANAGEMENT AND CONTROL

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ABSTRACT

- The British Canada Goose population is around 60,000 birds and is increasing at 8% per year. Similar increases are being seen in a number of European countries.
- There have been only two recorded birdstrikes with Canada Geese in Britain. Both were with birds overflying an airfield situated close to reservoirs and gravel pits. Both resulted in damage to the aircraft.
- Canada Geese cause localised damage to agriculture and amenity grassland. They may also cause hazards to public health and affect water quality.
- Canada Geese respond well to standard aerodrome bird scaring techniques and are unlikely to constitute a significant 'on airfield' problem at sites with good bird control and habitat management, unless the airfield is immediately adjacent to a lake or river. Hazards from birds transiting airfields to and from nearby water bodies are likely to be more significant.
- Because Canada Geese are an introduced species, pressure to conserve them is less than for indigenous birds. There may therefore be scope for population control and management of this species away from the airfield to reduce the hazard from overflying birds.
- Available control techniques fall into two categories: behaviour modification and population reduction.
- Few data are available on the effectiveness of population reduction techniques such as control of reproduction or the culling of adults. The likely effects of such programmes on the behaviour and biology of Canada Geese are also poorly understood. Research into both is currently in progress at CSL.
- The development of Integrated Management Strategies (IMS) to control bird numbers at the local level must be the first objective. Local populations have differing biology which will profoundly influence the choice of strategies that make up the IMS.
- Expert advice should be sought by landowners/airport operators to ensure that the most cost effective IMS is developed for a particular situation.

1. Introduction

The threat posed by birds to aircraft is not a static one. The nature and severity of the hazard can change on a daily or seasonal basis, or in response to short term changes in factors such as weather conditions. More difficult to evaluate, however, are changes in birdstrike hazards which may occur in response to longer term changes in the overall abundance or distribution of bird populations. Such processes occur relatively slowly (e.g. the Collared Dove (*Streptopelia decaocto*) which has spread across the whole of Western Europe since the 1930's (Gibbons et al. 1993)). These changes in range or abundance may be driven by natural processes or assisted by man. Some, such as the Collared Dove, may have little impact on the aviation community, but others have the potential to cause serious hazards. One such species is the Canada Goose (*Branta canadensis*)

The Canada Goose is a native of North America where between eight and twelve distinct races are recognised (Delacour 1959, Palmer 1976, Madge & Burn 1988). There is considerable overlap between the races, but in general birds are darker towards the west of their breeding range and larger towards the south. Most of the races are highly migratory, and some, particularly the larger races, show a pronounced northward migration before the summer moult (Sterling & Dzubin 1967 Salomonsen 1968 Wege 1980, Zicus 1981, Davis et al. 1985).

1.1 The growth of Canada Goose populations in Europe

Canada Geese were first introduced to Great Britain as an ornamental waterfowl in the collection of King Charles II (St. James's Park, London) in 1665. A number of other introductions to wildfowl collections around the country followed (Owen 1983). The morphology and colouration of the current British and European populations suggest that the original introductions were from the larger, less migratory, eastern races: the nominate (*B.c.canadensis*) *and* the Giant Canada Goose (*B.c.maxima*) (included in *B.c.moffitti* by some authorities (Palmer 1976)). Most introduced Canada Geese therefore show little migratory behaviour, the exception being the Scandinavian populations which migrate south in winter in response to harsh weather conditions (Fabricius 1983).

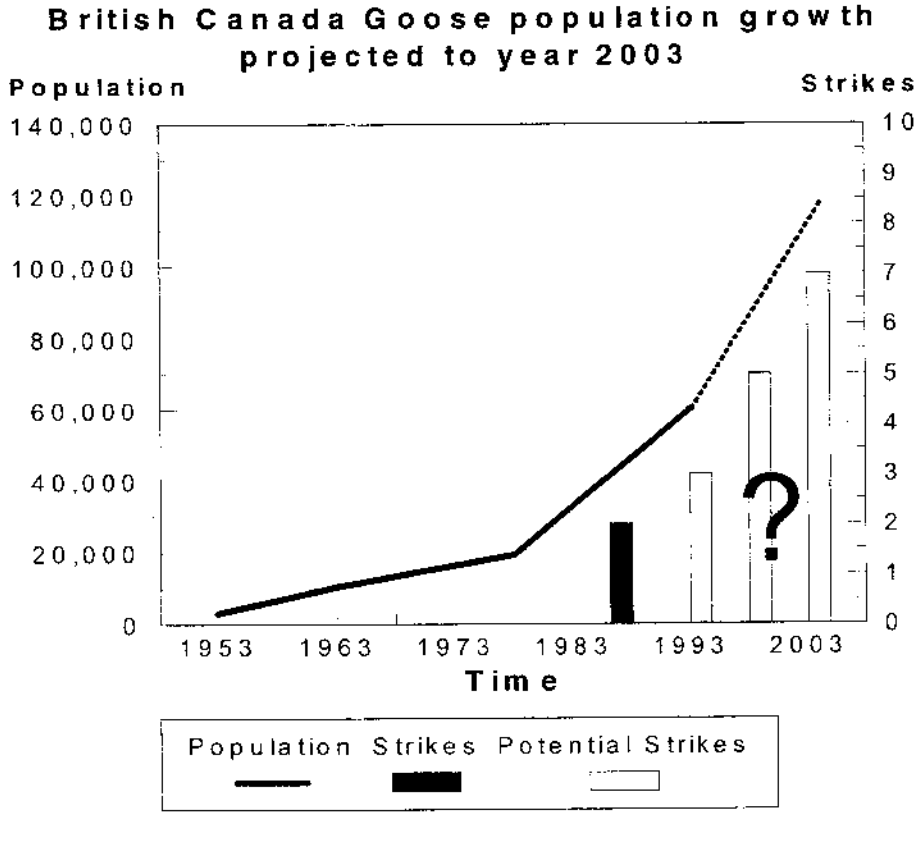
The population in Britain remained relatively small until the 1950's when the first deliberate relocation of birds occurred. At least 700 birds were moved by the Wildfowl Trust (now The Wildfowl & Wetlands Trust - WWT) to relieve local agricultural problems, and many hundreds of birds were translocated by the Wildfowlers Association of Great Britain and Ireland (WAGBI, now the British Association for Shooting and Conservation - BASC) to provide shooting of wild geese in southern Britain. These movements, together with the creation of gravel pits and other artificial habitats along river valleys, resulted in the spread of the species and the first calls for control (by the Wildfowl Trust) were made in the 1960's

Elsewhere in Europe, a similar pattern occured with population growth following deliberate introductions or relocations of geese either as ornamental waterfowl or as a shooting quarry. This has led to the establishment of a number of expanding

populations (e.g. 60,000 birds in Scandinavia (Vikberg & Moilanen 1985, Udo 1979, Masden & Andersson 1990, Heggberget 1991), and smaller populations in many other countries including the Netherlands, Belgium and the Republic of Ireland). There are still plans to introduce the species to Russia for sport shooting (Masden & Andersson 1990, Gabuzov 1990).

The first organised summer census of Canada Geese in Britain was carried out in 1953, when between 2,200 and 4,000 birds were recorded. At that time, the birds formed discrete, localised, sub-populations, each with a rather restricted range, and little or no movement between them. Surveys in 1967-1969 indicated that the population had increased to 10,500 and many new localities had been colonised. A census in 1976 indicated an estimated 19,400 birds. A national survey of all introduced geese in 1991 produced 60,834 Canada Geese. These survey results suggest a five-fold increase in the population over the 24 years from 1953 to 1976, whilst the 1991 survey produced 220% more birds than in 1976 (see fig. 1). Over the whole period, the population appears to have been growing at a progressively faster rate, from 6.8% to 8.0% per year; the average growth rate since 1976 was 8% per year (Delany 1992).

Fig. 1



As the size of the British population of Canada Geese has increased, conflicts between the birds and human interests have become more frequent. Requests for licences to control agricultural and amenity damage by Canada geese have increased in number (UK government data) and calls for a national strategy to reduce the population size and/or prevent further spread have been made by landowners, municipal authorities and some biologists. Although complaints about Canada Geese damaging agricultural crops, fouling amenity grassland or harassing native waterfowl species are common, the extent of the present or likely future problem posed to aviation interests has been little studied.

1.2 The birdstrike hazard posed by Canada Geese

Only two birdstrikes with Canada Geese have been recorded in Britain (UK Civil Aviation Authority data). On 5th. August 1989 a Boeing 747 struck two Canada Geese on take off from London Heathrow at a height of 200 feet. Damage to the nose-wheel door was sustained but the flight continued. On 20th. August 1990 a Boeing 747, also at Heathrow, struck three Canada Geese on the take-off run. The aircraft scraped its tail on the runway during take-off and returned for an overweight landing. The aircraft was removed from service for repair.

London Heathrow, although not immediately adjacent to large water bodies, is close to a number of reservoirs and gravel pit complexes which carry large and growing populations of Canada Geese. As numbers continue to increase in the rest of Britain and Europe, the potential for more such incidents at other airports also increases. Because of their highly social nature, flocking habit and high weight (birds in the British population weigh between 3 and 4 kg (pers. obs.)) there is clearly the possibility of that a very serious incident could occur if birdstrikes with this species become more frequent.

In their native North America, Canada Geese are a migratory species, but in recent years a large population of non-migratory birds has built up in a number of US cities. Laycock (1984) estimated the total population of urban Canada Geese to number 'hundreds of thousands' in North America as a whole, mostly of the race *B.c.maxima*. The increasing numbers of Canada Geese in the urban environment has coincided with a rise in the number of incidents of collisions with aircraft in recent years. For example, between 1986 and 1989 Canada Geese were involved in 11 birdstrikes costing $250,000 at Reno-Sparks airport, Nevada USA which resulted in the US Federal Aviation Administration threatening to close the airport if control measures were not instituted (Fairaizil 1992). Similar problems occurred at Minneapolis St. Paul airport, where four strikes with Canada Geese occured between 1980 and 1984 (J. Cooper pers. comm.) In both cases the problems were exacerbated by the arrival of large numbers of migrant geese, but the rising population of feral birds in Britain, often on urban fringe sites close to airports, clearly has the potential to cause serious hazards to aircraft.

Both of the birdstrikes involving Canada Geese in Britain were with birds overflying the airfield. Canada Geese breed and roost on or around bodies of water. They feed mostly by grazing short turf or agricultural crops, and may fly considerable distances to find suitable feeding areas. Canada Geese are therefore unlikely to frequent

airfields with an effective long grass policy and, since they may be hunted in the open season, respond well to scaring with pyrotechnic devices. The hazard posed by Canada Geese on the airfield itself is therefore easily manageable at most sites. Exceptions to this situation are airfields which are immediately adjacent to lakes or rivers, e.g. Burke Lakefront Airport, Cleveland USA is flanked by Lake Eirie and, despite a long grass regime, is frequented by large numbers of Canada Geese which breed nearby (pers. obs.). Airfields with large bodies of water such as balancing ponds on the site may also attract Canada Geese from time to time. For example, Chicago O'Hare Airport has a large lake on the property which attracts Canada Geese to the airfield and a number of strikes with this species have occurred (R. Sliwinski pers. comm.) Nevertheless, it is overflying Canada Geese that constitute the greatest hazard at most airfields. If these problems are to be controlled, management of bird numbers or behaviour away from the airfield needs to be considered.

Because Canada Geese are an introduced species in Britain and Europe, there is less pressure to conserve them than for native species. They are, however, protected under the Birds Directive of the European Union, and have varying degrees of protection under the national laws of the member countries. It is possible, in Britain at least, to obtain special licenses to control bird populations if a clear hazard to aviation can be demonstrated and if other control methods not requiring licenses have failed. Because most Canada Goose hazards to aircraft are likely to result from birds flying over airfields, any effective management programme will require work to be conducted off the airfield and could involve the licensed destructuion of birds. Such control methods can be extremely controversial and should not be undertaken lightly or without a reasonable prospect of success. This paper reviews the available management techniques, both lethal and non-lethal, for controlling Canada Geese away from an airfield, and describes a number of integrated management strategies that could be employed to reduce the hazard to aircraft posed by Caanda Geese by reducing their numbers at a particular site or sites. **The techniques described are legal in Great Britain providing the appropriate licenses are obtained where necessary. Workers in other countries should ensure that their national laws permit the use of the methods described.**

2. MANAGEMENT OPTIONS CURRENTLY AVAILABLE TO CONTROL CANADA GEESE

Feare (1991) reviewed the options for the control of Canada Geese in Britain, but research into agricultural and amenity damage prevention has concentrated on only one option, involving reducing reproductive output (Giles & Street 1990, Baker et al. 1993). Other work has taken the form of *ad hoc* population management, usually without proper experimental design and with little or no follow up or publication of the data. Research (funded by the UK Ministry of Agriculture Countryside Division) into the effectiveness of a number of population control techniques is currently in progress at CSL (Watola unpubl). Assessment of the likely effectiveness of the various management techniques available therefore leans heavily on American research, and on experience with other waterfowl species in Europe.

The control methods currently available fall into two categories: behaviour modification (by scaring (including shooting), habitat management, exclusion and chemical repellents); and population control (by relocation, shooting in or out of season, egg control, culling at moult, and culling with other capture techniques (e.g. narcotised baits or traps)).

The main objective of managing Canada Geese for flight safety would be to remove or deter the Geese from a water body or feeding ground which involved them making flights across an airfield. Deterring birds from using a temporary food source e.g. sprouting winter wheat is analogous to a farmer protecting a temporarily vulnerable crop, and may involve the short term deployment of behaviour modification tactics such as scarers. Preventing birds from making long term use of a water body or feeding site site may require management of the population to reduce numbers or to eradicate the birds altogether because they will eventually habituate to scaring techniques.

2.1 Behaviour modification techniques:

2.1.1 Scaring with acoustic stimuli

The pyrotechnic "shell-cracker' commonly used in airfield bird control may be used to deter Canada Geese from a site. This method has the advantage that the human operator can respond to the behaviour of the birds and thus reduce habituation to the stimulus. The presence of the operator also adds a visual stimulus to the technique. If supported by occasional shooting (see below) this is a most effective scaring method, but its use in public areas may not be possible for safety reasons.

The most commonly used agricultural bird scarer is the gas cannon, a device designed to emit one or more explosive reports, usually at set intervals. Although not reccomended for long term scaring on airfields, such devices can be effective in the short term scaring of most birds, particularly those subject to hunting pressure, as the sound of the cannon simulates that of a shotgun. Other acoustic scarers produce a variety of loud shrieks, distress calls, infrasound and ultrasound. These systems were developed mainly to protect agricultural crops, many of which are vulnerable to bird damage for a relatively short period. Heinrich & Craven (1990) detected no habituation of migrant Canada Geese to a sonic scarer over a seven week trial period. If acoustic scarers are to be deployed for longer periods, they should be regularly moved (ADAS 1987) or combined with other techniques to reduce the rate at which the birds become habituated to the scaring stimulus. **Urban Canada Geese, which are not hunted and are accustomed to the kinds of unusual stimuli associated with living in close proximity to man, may very quickly learn to ignore gas cannons and other noise-producing devices.**

Many species habituate less rapidly to scarers incorporating their own distress or alarm calls and the structure of these calls is being examined to increase their effectiveness further through the synthesis of superstimuli by enhancing certain particular segments of the calls (Aubin 1990). The distress calls of birds are

extensively used to deter them from airfields (Bridgman 1980). Mott & Timbrook (1988) successfully used the alarm calls of Canada Geese to deter birds from damage sensitive areas for 2-3 week periods, but the birds moved only a short distance and returned immediately after scaring stopped. Canada Geese do not produce distress calls.

2.1.2 Scaring with visual stimuli

Visual scarers can take a variety of forms, from the familiar scarecrow, through plastic strips attached to poles, to kites or balloons representing birds of prey, and even inflatable human figures which rise from a box in the ground carrying an imitation firearm! Kites and baloons may not be suitable for use on airfields, but could be deployed effectively at other sites. As with acoustic scarers, these devices are effective in deterring birds from areas for as long as the birds natural neophobia persists. Heinrich & Craven (1990) found that Canada Geese were deterred from fields where brightly coloured strips of mylar tape 1.5m long and 15cm wide attached to poles 1.7m high. Poles were set out at densities of 1.5 per hectare. The geese were not deterred, however, if they landed in an adjoining field and walked into the protected area. In the same study, human effigies (scarecrows) were also found to deter migrant Canada Geese particularly from small fields with tall boundary features such as woods. As with the mylar flags the deterrent effect only occurred if the birds saw the scarecrow from the air. Birds that landed nearby and walked into the field were not deterred. The trials described above were conducted on migratory Canada Geese subject to hunting pressure. Urban geese may be far less easy to scare using passive acoustic or visual stimuli.

2.1.3 Scaring by shooting

Although shooting is more usually regarded as a means of population control, it can also be used to reinforce scaring programmes. Shooting to scare geese combines visual (the presence of the shooter) with acoustic (the sound of the gun) stimuli and is reinforced by the occasional killing of a bird. An increase in the shooting pressure on geese at a particular site is likely to make them generally more wary and more responsive to other scaring techniques, particularly gas cannons and scarecrows. In Britain, Canada Geese can be legally shot in season (1 September to 31 January, or to 20 February below high water mark of average spring tides) and licences to shoot a limited number of birds to aid scaring during the close season can be obtained in order to reduce risks to flight safety.

2.1.4 Chemical repellents

Attempts have been made for many years to develop a harmless chemical repellent with which to treat crops in order to prevent wildlife damage. So far none have proved wholly successful, either due to lack of repellency, toxicity to plants or to the birds themselves or lack of persistence of the effect. Methyl anthranilate has been successfully employed against Canada Geese in the United States (Cummings et al. 1992). In Britain, cinnamamide has proved effective in preventing many bird species from feeding on treated foods (Crocker et al 1993, Crocker & Reid 1993) and experiments with Canada Geese are needed. Research is continuing in this area

(Cummings et al. 1992) but at present there are no fully effective chemical repellents licensed for use in Britain.

2.1.5 Physical exclusion

Canada Geese can be excluded from an area either by fencing to prevent birds from walking in, or by the use of wires or tapes strung across the area to prevent them from landing. Such techniques are frequently and successfully employed to restrict access of a variety of bird species to small areas such as ponds or ditches (Rochard & Irving 1987). It is probably impractical to attempt to exclude geese from large water bodies or fields, and this would also restrict access to the public, farm machinery and other bird species.

2.1.6 Habitat modification

In some cases, it may be possible to modify an area used by Canada Geese to make it less attractive. Planting of dense scrub on the banks of lakes could deter geese from walking out of the water to feed, but such scrub would require adequate protection from the geese during establishment. To prevent breeding, nesting cover could be removed or, where birds breed on islands, the islands could be removed or water levels raised in order to flood them: this would have clear implications for other island-nesting species!

Conover & Kania (1991) have shown that feeding sites are chosen on the basis of their proximity to water and their openness in terms of both detection of approaching threat and the angle of climb needed to fly out of the site. Separating grassed areas from water bodies with a belt of trees high enough to require a climb out angle of over 13 degrees is suggested as a way of reducing the use of foraging sites near water. Replanting grass areas with plant species unpalatable to Canada Geese could deter birds (Conover 1991) and modification of cropping patterns, so that vulnerable crops are not available to Canada Geese, could be included in hazard alleviation programmes (Feare 1994, Trump et al. 1994).

All of the above solutions present problems in terms of the impact of habitat modification on other bird species, restriction of public access, or loss of recreational or landscape value in public areas.

2.2 Population management techniques

All of the behavioural modification techniques described above have the disadvantage that they simply move the problem elsewhere and, possibly, encourage the further spread of Canada Geese. Many behaviour modification techniques lose their effectiveness over time, and some are expensive, requiring substantial investment in equipment or staff costs over a long period. Population reduction, on the other hand, can offer permanent solutions to local problems without risk of moving geese elsewhere, and with at least some of the techniques, the effects can be immediate. Unfortunately, the techniques are often difficult to apply

and those involving the destruction of birds can be controversial. In Britain, apart from shooting in season, all population control techniques require special licences.

2.2.1 Shooting

Canada Geese can be legally shot in Britain between 1 September and 31 January (20 February on the foreshore) but they are not highly regarded by as a quarry species by wildfowlers (Harradine 1991). Nevertheless, data from the British Association For Shooting And Conservation suggest that Canada Geese accounted for 36% of the geese shot in Britain in 1987-88, compared to 11% in 1980, and that most Canada Geese are shot early in the season when other species are not present (Harradine 1991).

In terms of direct population control, increased shooting pressure has a number of difficulties, however. It would be extremely difficult to shoot enough birds at a site to achieve a rapid population reduction, as the birds would quickly become wary and increasingly difficult to shoot. Intensive shooting pressure may also stimulate birds to move to other sites, thus moving the problem elsewhere and possibly increasing the rate of spread of the species. Both migratory and sedentary populations of Canada Geese in North America have been shown to withstand heavy hunting pressure, with annual harvests of up to 40% of the population (Sheaffer et al. 1987, Chapman et al. 1969).

2.1.2 Reproductive control

Production of young can be inhibited by preventing adults from breeding, or by preventing eggs from hatching.

While chemical contraception for Canada Geese is conceptually attractive, there are so many practical difficulties that this technique is not yet available. Nor is there a mechanism for delivering any such chemical selectively to adult Canada Geese, thereby avoiding risk to other bird species; these problems are common to all species for which chemosterilisation is considered (Feare 1990).

Adult geese may be prevented from producing young by shooting them at the nest, a technique that has dual advantages in both reducing breeding output and at the same time reducing the number of breeding birds in the adult population. The shooting of adults at close range while they are defending their nest would be emotive but, in that a quick, clean kill could be achieved, this would be a humane way of killing adults.

One of the commonest ways of attempting to control Canada Goose numbers has been the destruction of eggs or their treatment to prevent hatching. Such treatment usually takes the form of pricking the eggs with a small nail and destroying the embryo. Treated eggs are left in the nest and the female allowed to sit as normal (if eggs are removed or destroyed the female may lay a new clutch). Other techniques that achieve the same objective include replacing the eggs with wooden dummies or hard boiling the eggs to prevent hatching. Hatching can also be effectively and

humanely prevented by coating the eggs with liquid paraffin (Baker et al. 1993), although approval of this chemical for this use in Britain is still awaited.

Canada Geese are long-lived birds with relatively low annual mortality at many urban sites, with the result that it may take many years for the size of a population to fall if reproduction is prevented. Also, if a small number of broods is missed, the limited recruitment that results may be sufficient to replenish the annual losses through mortality. Wright & Phillips (1991) reported no significant population reduction following a programme of egg replacement and suggested that a programme to increase adult mortality by shooting would also be required.

Reproductive control might thus be an effective technique in preventing further population growth at sites with large breeding colonies, but cannot alone reduce a flight safety hazard within an acceptable time scale without some additional means of increasing adult mortality.

2.2.3 Relocation

One of the most frequently used means of reducing problems with non-migratory Canada Geese in North America is to relocate large numbers of birds to rural areas, either to form new colonies or to increase the size of migratory populations (Addison & Amernic 1983, Laycock 1984, Converse 1985, Cooper 1986, Conover 1992). Early relocation experiments in Britain were largely unsuccessful, with some birds returning to the original capture site. This does not appear to be a problem in North America, where birds are shipped over large distances (Converse 1985, Cooper 1986). Canada Geese can be easily captured by rounding up during the moult or by the use of traps (Nastase 1982) or stupefacient baits (Woronecki et al. 1990) at other times of the year. These operations require the appropriate licences and should only be carried out by trained professionals. Mass relocation of birds is therefore an extremely expensive operation and it is unlikely, given the problems currently being encountered with Canada Geese, that many landowners would be willing to take more birds. Even in the United States, where the birds are values as a hunting resource, it is becoming increasingly difficult to find landowners willing to take relocated geese (J Cooper pers. com.). Further redistribution in Europe is likely to encourage the spread of this species and possibly increase the rate of population growth. For these reasons relocation of birds should be discounted as a control option.

3.2.4 Culling of adult birds

a) At the moult

Canada Geese become flightless for a three to four week period in late June and early July while they moult their wing feathers. During this period the birds are vulnerable to predators and remain on or close to water. Here, large numbers can be easily captured by rounding them up using canoes or small boats and herding them into a pen on the bank. Birds must be humanely dispatched, e.g. by cervical dislocation, lethal injection or shooting at close range with a small bore

firearm. The presence of a veterinary surgeon at such an operation may help to allay public fears about humaneness.

There is clearly the potential to effect a dramatic reduction in the numbers of geese at any site where a round-up can be carried out and this technique would achieve an immediate reduction in any flight safety hazard. A number of such culls have been conducted in the past with varying degrees of success but none has been followed up to determine the number and frequency of culls needed to reduce the population to a predetermined level. MAFF is currently researching the effectiveness of culling as a control strategy in order to determine where culls should be undertaken, what proportion of birds needs to be killed and how culling should be combined with other techniques to achieve specific population reduction goals.

b) At other times

The killing of adults at the nest is discussed above. In addition, traps or stupefacient baits can be used to capture small numbers of geese at sites where round-ups of moulting birds are not possible. Small scale culls using these techniques may be employed at sites where killing needs to be carried out discreetly, but both techniques require that the target birds are attracted to bait. This may be relatively easy in public parks where Canada Geese are used to receiving food from people, but may be more difficult in rural areas where geese have less contact with the public and less experience of novel foods. All culling should be undertaken by trained personnel and must be conducted under appropriate licences.

3. INTEGRATED MANAGEMENT STRATEGIES (IMS) FOR THE CONTROL OF CANADA GEESE

3.1 The choice of control techniques

The choice of which techniques to employ will depend on the precise circumstances at the airfield concerned. The management techniques which could be used to control birds originating from a nearby farm or country estate (e.g. concerted shooting, physical exclusion or large scale culls) may be very different to those which may be employed in a city centre park where access to the public cannot be easily restricted.

If population control forms part if the IMS, the bird controller needs to have some knowledge of the behaviour patterns and biology of the geese in the area. Different populations may have profoundly differing population biology (e.g. levels of recruitment, mortality and movement patterns) which will influence the best choice of control measure.

An excellent example of the need to understand the population biology of the birds concerned is the Canada Goose control programme instituted around Minneapolis St. Paul Airport in the USA (J. Cooper pers. com.). Here, problems were being encountered with Canada Geese from surrounding populations frequenting the airfield and surrounding wetland areas to feed. Biologists captured and marked most

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of the geese in the surrounding populations. They discovered that birds from each site had traditional feeding areas which they always used, and that only those birds originating from certain lakes (not necessarily the lakes closest to the airport) were causing the problems. Eighty to ninety percent of the birds in the populations that were causing the hazard were relocated out of the state. The numbers of birds in the vicinity of the airport was reduced by between forty and ninety percent. This reduction persisted despite the fact that the uncontrolled populations continued to increase in size. If the control had not been preceded by a study of the movements of the birds, extra resources would have been unnecessarily expended controlling populations that were not causing a flight safety hazard.

3.2 Examples of possible management strategies:

a) An airfield close to a public park where geese breed and roost. The geese fly out to feed on nearby fields crossing the airfield. Shooting is not possible in the park and public pressure may prevent culling.

The mortality of Canada Geese in such situations is likely to be very low so egg control may take many years to reduce the population size. If the park suffers problems with damage to grassland etc. staff may be made available to assist in a long term egg control operation. In this case, any small influx of birds from surrounding populations may be enough to maintain numbers. If the park is not important as a nature reserve, habitat modification to exclude geese from breeding sites may be an acceptable alternative. In order to achieve a rapid reduction in the hazard, scaring, shooting or exclusion at the feeding site may be the only option. If transiting flights are at predictable times (e.g. dawn and dusk) flying operations may be able to be modified to reduce the hazard.

b) An airfield close to country estate where shooting is practiced and culling is possible. The geese fly out to feed and cross the airfield.

Culling during the moult can be carried out to effect an immediate reduction in the hazard. If the estate wishes to keep some geese, then egg control combined with shooting in season can be used to keep the total population down to an acceptable level. If birds from surrounding areas move in, further smaller culls could be employed to manage the hazard

c) A farm with winter cereals near the airport is attracting geese from a nearby water.

Since the food source, and hence the hazard, is short term, scaring and exclusion (e.g. gas cannon and tape streamers) reinforced by shooting at the feeding site can effectively eliminate the hazard and protect the crop in this situation. Assistance from the farmer may therefore be a way of reducing costs

d) There is a complex of lakes and gravel pits close to the airfield. Geese move from one area to another throughout the year and cross the airfield at unpredictable times.

If the movements of the geese are not predictable and they have a number of alternative feeding or roosting sites then scaring at a given site is unlikely to be effective. A concerted population reduction programme, targeted at the birds which actually cause the problems, and coordinated across a number of the sites is the only way to effectively reduce the hazard in this situation.

In conclusion, the control of Canada Geese depends upon the development of IMS which are appropriate for the location, nature and scale of the problems encountered. The one feature that all situations have in common is that the population biology of the birds at that site will profoundly affect the effectiveness of the IMS employed. **A thorough understanding of the processes involved in the population biology of Canada Geese is therefore required if successful IMS are to be developed. Expert advice should be sought before expensive and potentially controversial control programmes are implemented.**

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