THE CONTROL OF MAMMAL PROBLEMS AT CANADIAN AIRPORTS: TECHNICAL REPORT

by

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ABSTRACT

A study of mammal problems at airports was undertaken to evaluate the types and severity of mammal hazards to aircraft and airport equipment, and means of controlling mammal problems at airports. Based on this technical review, a guidelines manual for the reduction and control of mammal problems at airports will be developed. Information on wildlife hazards and control at airports was obtained through a computerized search of the published literature, interviews with knowledgeable sources, site visits to the Calgary, Winnipeg, and Halifax International Airports, and a questionnaire survey of the major Canadian civil airports.

Three types of mammal problems at airports are common: (1) mammals can collide directly with aircraft, (2) mammals may attract other species of wildlife, and (3) mammals may damage airport equipment, aircraft, or property. Mammals that present the greatest problems are ungulates, canids, and small mammals. Ungulates present a strike hazard to aircraft, canids present a strike hazard to aircraft and damage equipment, and small mammals can attract other species and damage equipment.

Based on a review of currently available methods of control it was concluded that ungulate problems are controlled most effectively by excluding them from airfields; modifications to regulation security fencing are recommended. Canid strike hazards are best controlled by reducing the availability of prey, whereas canid damage to equipment (mainly cables) is best controlled through use of chemical repellent coatings on the cable. Populations of small mammals, and, consequently, the attraction of avian and mammal predators, can be reduced by habitat manipulation or use of chemical toxicants. Small mammal damage to equipment can be controlled by use of repellent coatings.

Because mammal problems at airports and their causative factors are poorly documented, it is recommended that a reporting system, similar to that for bird strikes, be established for mammal strikes (or near-strikes) with aircraft and damage to airport equipment.

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1. INTRODUCTION

Rapid expansion of urban environments has resulted in increasing numbers of conflicts between man and wildlife either through the simultaneous use of areas by man and wildlife or through the attraction of animals to areas disturbed by man. Airports, as a necessity of their function, create large open areas of near-homogeneous habitat with minimum human presence and, as a consequence, are attractive to a wide variety of wildlife species.

Numerous collisions between birds and aircraft have been documented and a large volume of material is available that discusses the types, severity and seasonality of bird hazards to aircraft, the environmental factors that contribute to the problem, and methods of controlling or reducing bird strikes with aircraft (Blokpoel 1976). Collisions between mammals and aircraft, and damage to airport equipment by mammals, occur less frequently and are generally of a less serious nature than bird strikes. Nonetheless, mammals can occasionally present a significant hazard to aircraft, airport equipment, and human life. However, very few studies have addressed the problem of mammal hazards at airports, and little information is readily available on the type or extent of mammal hazards, causative factors, or methods of control.

Transport Canada consequently requested that LGL Limited conduct a study (1) to summarize information on mammal hazards at airports in Canada, and (2) to develop a guidelines manual for the reduction or control of mammal hazards at airports. These two major objectives were to be accomplished through a series of specific tasks that involved a literature review of information on mammal hazards to aircraft; visits to several Canadian airports that recently have been confronted with mammal problems; interviews with federal and provincial agencies and airline personnel knowledgeable about mammal problems at airports and state-of-the-art methods of control; and a questionnaire survey of the major Canadian airports concerning mammal hazards. Based on the information obtained during this study, this technical report discusses the species or species groups that cause the most serious mammal problems at airports, the factors that induce these species to frequent airport property, problems associated with mammal control at airports, and means of

successfully controlling or reducing mammals at airports. A companion guidelines manual will offer practical advice about control procedures.

Common names of animals and plants are used throughout this report to enhance readability. Scientific names are included with the first occurrence of each common name and are based on Banfield (1974) for mammals, American Ornithologists' Union (1957, 1973, 1976) for birds, Moss (1959) for non-woody vascular plants, and Hosie (1969) for trees.

2. METHODOLOGY

Relatively little relevant information on mammal problems at airports is available in the literature. Three different methods--a literature review, interviews with knowledgeable sources, and a questionnaire survey--were used to evaluate current wildlife problems at airports, the species or species groups involved, and methods of control.

2.1 LITERATURE REVIEW

Based on a general familiarity with literature pertaining to wildlife hazards at airports, it was anticipated that little relevant published material would be available. To ensure a thorough and time-efficient search of the available published information, a computerized literature search was conducted using the Alberta Information Retrieval Service (AIRS) of the Alberta Research Council. Data bases searched included Agriculture On-Line of the U.S. National Agriculture Library, Current Research Information System (CRIS) of the U.S. Department of Agriculture, Enviroline of the Environment Information Centre of the National Research Council of Canada, and National Technical Information Service (NTIS) of the U.S. Department of Commerce.

In addition to the computerized literature search, literature concerning bird hazards at airports (e.g., Proceedings of the Bird Strike Committee Europe, publications of the Associate Committee on Bird Hazards to Aircraft, Proceedings of the Bird Control Seminar, and Proceedings of the Vertebrate Pest Conference) was scanned manually for information relevant to mammal problems at airports. During interviews with knowledgeable sources, information about additional relevant publications was sought.

2.2 AIRPORT VISITS AND INTERVIEWS

In cooperation with the Transport Canada Project liaison office, visits were made to the Winnipeg, Halifax, and Calgary International Airports on 16, 20, and 27 July, 1981, respectively, to discuss with key personnel the mammal problems extant at these airports. (The Pittsburg International Airport, which has a serious problem with deer hazards to aircraft, also was to have

been visited, but as a result of labor disputes at that airport, the visit was cancelled by the hosts.) Where possible the following types of information were obtained:

1. the major mammal hazards, their severity, and their seasonality;
2. the major species of mammals involved;
3. the major bird hazard problems and their relationship (if any) to mammal hazards;
4. the types and success of control measures that have been used in the past or that are currently being employed; and
5. the extent of the mammal hazards at other major airports in the region.

The types and severity of wildlife hazards at airports are determined in part by the characteristics of the areas adjacent to the airports. Thus, information about numbers and distribution of wildlife, the availability of wildlife habitats, and the extent and type of human activities (e.g., industrial, agricultural) on adjacent areas was obtained. Information on vegetation types and human activities in adjacent areas was obtained during interviews and from direct observations. Local fish and wildlife agencies also were contacted with regard to information on wildlife populations in adjacent areas and suitable means of control.

Knowledgeable individuals within federal and provincial agencies and the private sector were contacted to discuss wildlife problems at airports and methods for the control and reduction of these mammals. A list of the individuals contacted and their affiliations is provided in Appendix I.

2.3 QUESTIONNAIRE SURVEY

In order to obtain a regional perspective on the severity, seasonality, and variability of mammal problems at airports, a questionnaire was developed by Transport Canada and was sent by Transport Canada to appropriate personnel at 25 major Canadian airports. An example of the questionnaire is provided in Appendix II. Responses were reviewed for 19 airports (see section 5).

3. REVIEW OF MAMMAL PROBLEMS AT AIRPORTS

Existing published information on mammal problems at airports is largely anecdotal. Exceptionally few studies have evaluated quantitatively the numbers of animals present, temporal or spatial variation in the problem, the factors that attract problem species to airports, alternative means of control, or the success of the control methods. Information obtained during visits to the Calgary, Winnipeg, and Halifax International Airports and from the questionnaire survey of major Canadian airports is discussed in Sections 4 and 5, respectively. Alternative methods for the control of mammal problems at airports, and information about the success of these procedures, is discussed in Section 6.

Based on the available information, three distinct types of mammal hazards at airports appear to be common: (1) mammals can collide directly with aircraft during landing and takeoff, (2) mammals may serve as attractants to birds or other mammals, and (3) mammals may damage airport equipment, aircraft or property.

3.1 DIRECT COLLISIONS WITH AIRCRAFT

Documented collisions between mammals and aircraft have involved moose (Alces alces), American elk (Cervus elaphus), deer (Odocoileus sp.), pronghorn antelope (Antilocapra americana), coyote (Canus latrans), leporids (hares and rabbits), and bats (Order Chiroptera). Table 1 summarizes direct mammal strikes or near-strikes involving commercial and military aircraft at major Canadian airports between 1969 and the present. Any incidents that were not reported to the Department of National Defence or Transport Canada are excluded.

Deer appear to be attracted to airports by some of the commonly-used species of ground cover such as alfalfa, clover and agronomic grasses, the availability of shrub and tree cover (and browse), and the absence of human disturbance and predators. Deer-aircraft collisions or near-collisions have occurred at a number of airports in Canada and the United States and have resulted in minimal to moderate amounts of damage to aircraft (Hild 1969a,

Table 1. Documented mammal strikes with aircraft in Canada between 1969 and 1981.

Group	Species	Agency/ Airline[a]	Aircraft Type	Airport[b]	Date of Strike[c]	Extent of Damage	Comments[d]
Ungulates	deer	DND	Starfighter	Cold Lake AFB, Alta.	69 06 24	- struck nose wheel fairing door and right landing gear	- during TO; TO aborted
	deer	DND	Silver Star	Winnipeg, Man.	69 09 02	- stabilator flap and link damaged	- 2 deer on runway during LD, one struck
	deer	DND	Silver Star	River, Man.	69 11 25	- struck main landing gear	- during LD
	deer	DND	Buffalo	Comox, B.C.	70 11 18	- near strike	- deer crossed runway during LD
	deer	DND	Voodoo	Comox, B.C.	75 08 14	- near strike	- deer crossed runway during LD; swerved to miss
	deer	DND	Starfighter	Cold Lake AFB, Alta.	76 11 09	- NI[e]	- struck 2 deer on TO
	deer	DND	Starfighter	Cold Lake AFB, Alta.	76 11 09	- NI[e]	- struck 2 deer carcasses on LD (see above entry)
	deer	DND	Starfighter	Cold Lake AFB, Alta.	77 11 08	- left main landing gear damaged	- struck on LD
	deer	DND	Freedom Fighter	Cold Lake AFB, Alta.	78 06 16	- right pylon tank damaged	- struck on LD
	deer	CP	NI	Winnipeg, Man.	78 06 18	- near strike	- deer on runway prior to LD
	deer	DND	Hercules	Edmonton, Alta.	78 12 05	- damaged rear door of nose gear	- struck on LD
	deer	DND	Hercules	Trenton, AFB, Ont.	79 09 09	- near strike	- 3 deer on runway at TO
	deer	DND	Freedom Fighter	Cold Lake AFB, Alta.	80 11 07	- damaged stabilator	- struck on TO
	deer	AC	DC-8	Halifax, N.S.	80 - -	- damaged nose gear	- struck on TO; deer in blind spot
	deer	AC	DC-9	Halifax, N.S.	NI	- suspected strike	- dead carcass found on runway after TO
	deer	NI	NI	Fredericton, N.B.	NI	- near strike	-
Canids	red fox	NI	NI	Dorval, P.Q.	NI	- no damage to aircraft	- adult fox struck
	coyote	NI	NI	Williams Lake, B.C.	NI	- no damage to aircraft	- coyote pup struck
Small Mammals	jack rabbit	AC	DC-9	Calgary, Alta.	81 04 15	- possible strike to left main engine	- not confirmed
	jack rabbit	NI	NI	Calgary, Alta.	NI	- no damage reported	- carcasses found on runway
	porcupine	NI	NI	Halifax, N.S.	NI	- no damage reported	- carcasses found on runway

[a]DND=Department of National Defence; CP=Canadian Pacific Airlines; AC=Air Canada.

[b]AFB denotes a military airport.

[c]Date of strike: year/month/day.

[d]TO=takeoff; LD=landing.

[e]NI=not indicated in incident report.

1969b; Compton 1973; Kuhring 1973; Blokpoel 1976; Airport Services and Security 1979; Solman 1980; M. Harrison, pers. comm.[a]; W. Thompson, pers. comm.). In no instance have collisions between deer and aircraft resulted in loss of human life. Other ungulates such as moose, elk, and pronghorn antelope have created similar problems at other airports (Blokpoel 1976; V. Solman, pers. comm.; W. Thompson, pers. comm.).

Coyotes and foxes, presumably attracted by an abundance of small mammal prey such as mice, ground squirrels and hares, generally are wary enough of human disturbance to avoid collisions with aircraft. In some respects, their ability to control numbers of some small mammals may be a benefit. Nonetheless, canids have been struck by aircraft in several different locales (Blokpoel 1976).

Lagomorphs are common inhabitants of airfields, probably in response to the availability of forage provided by the ground cover. Because of their small size, collisions with rabbits and hares are unlikely to cause direct structural damage to the aircraft fuselage, but, if ingested, they can damage jet engines (Faulkner 1966; Blokpoel 1976; Johnston 1978; Table 1).

Bats, because of their ability to fly, present a unique mammal hazard to aircraft. Collisions between bats and aircraft have been reported in the southern United States and Australia where bats occur in large numbers and tend to remain in dense concentrations during flight (Williams and Williams 1969; Ireland et al. 1975, 1976). In those circumstances, dense concentrations of bats flying to and from roosting areas could be avoided by a program of radar detection and active avoidance. In Canada, however, the principal source of collisions is likely to be diffusely distributed bats feeding within 300 m of the ground. The abundance of insects near runway lights appears to be one of the major attractants of bats (and some insectivorous birds) to airfields (van Tets et al. 1969).

3.2 MAMMALS AS ATTRACTANTS TO OTHER SPECIES OF WILDLIFE

Some species of mammals, when present at airports, may serve as attractants to birds and other species of mammals which, in turn, may

[a] Affiliation and details of communication are provided in Appendix I.

represent a hazard to aircraft. Old fields or areas of long grass adjacent to or on airport property can support large numbers of small rodents (e.g., Microtus sp.), which are preferred prey of some raptors and carnivores (Faulkner 1966; Lewis 1967; Saul 1967; Hild 1969a, 1969b; Solman 1969; Stortenbeker 1969; McNeil 1972; Brooks et al. 1976; Harrison 1976; Brough and Bridgman 1980; Mason 1980). Other small mammals such as ground squirrels (Spermophilus sp.), rabbits, hares, and marmots (Marmota sp.) also can attract predators. Furthermore, they can attract scavengers if carcasses from road kills, aircraft collisions, or removal programs are left exposed on airfields (Faulkner 1966; Kuhring 1973; Johnston 1978; M. Harrison, pers. comm.). Deer and other large game can attract birds, especially crows, by their excrement or by flushing insects from vegetation during grazing (Hild 1969b). Beaver, through damming of natural water courses or drainage systems, can create waterbodies which, in turn, can attract a variety of waterbirds (V. Solman, pers. comm.; W. Thompson, pers. comm.).

3.3 DAMAGE BY MAMMALS TO AIRPORT EQUIPMENT

Mammals have been documented to damage airport equipment, aircraft, and airport property. Ground squirrels, marmots, pocket gophers, and American badgers (Taxidea taxus), through excavation of burrows, can undermine runways, roadways, landing lights, fences and other equipment (Faulkner 1966; M. Harrison, pers. comm.; J. Seubert, pers. comm.). Resultant mounds of soil and burrow entrances can hamper mowing of the airfield and other maintenance practices. Beaver, through damming of the airfield, can flood portions of the airfield and result in damage to service roads, runways, taxiways, and equipment (V. Solman, pers. comm.). Mice, ground squirrels, gophers and canids (coyotes, foxes and wolves [Canis lupus]) have been known to chew electrical and communication cables at airports; in some cases this has resulted in the failure of landing lights and navigational equipment (H. Demer, pers. comm.; J. Seubert, pers. comm.). Research on cable coatings by the United States Fish and Wildlife Service suggests that chewing damage is associated with behavioural responses of canids and small rodents (e.g., territorial marking), teeth cutting by young canids or removal of a physical obstruction during burrowing by pocket gophers (K. LaVoie, pers. comm.).

4. AIRPORT VISITS

4.1 WINNIPEG INTERNATIONAL AIRPORT

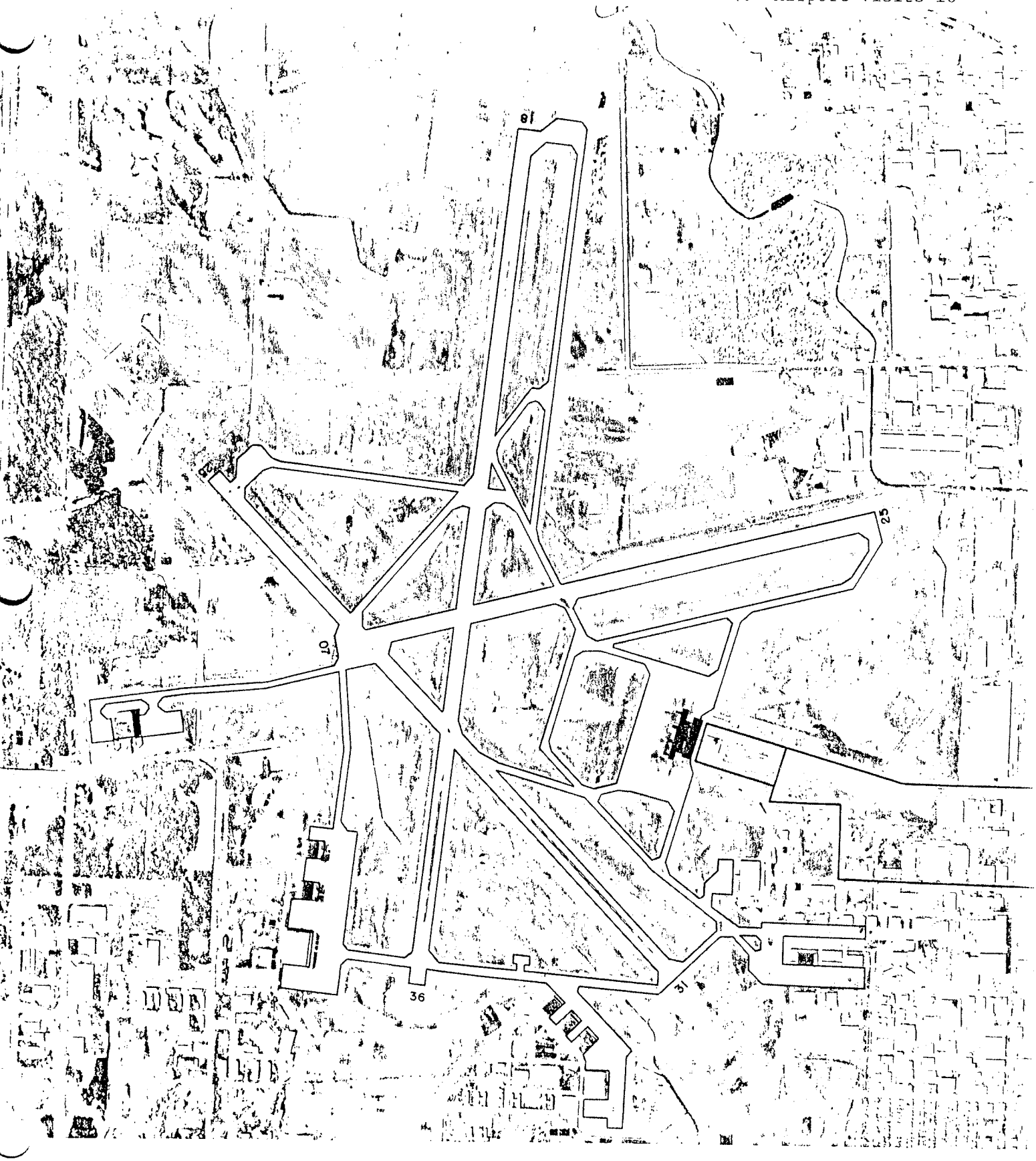
Winnipeg International Airport is located approximately 6 km west-northwest of the centre of Winnipeg. Residential and commercial developments abut the airport to the southwest, south, east and northeast, whereas farmland surrounds the airport to the north and west (Figure 1). Most of the northern portion of the airfield and some parts of the central airfield are, at present, leased for hay production. A small portion of the land within and adjacent to the west side of the airfield is covered by trembling aspen (Populus tremuloides) and bur oak (Quercus macrocarpa) woods. Several mammal problems, involving white-tailed deer (Odocoileus virginianus), red fox, snowshoe hares (Lepus americanus), and Richardson ground squirrels (Spermophilus richardsoni), were of concern.

4.1.1 White-tailed Deer

Prior to the early 1970's, deer were not a substantial problem at the Winnipeg airport. Increased residential and commercial development, in concert with existing land clearances for agriculture and the presence of the aspen-bur oak woods near the airport, are thought to have attracted deer to the area (G. Granberg, pers. comm.). White-tailed deer occur in low to moderate numbers in pockets throughout the region (G. Granberg, pers. comm.). Prior to implementation of a control program, approximately 40 deer were believed to utilize the woods and surrounding area on the airport property (D. Walsh, pers. comm.). During the early morning and late afternoon periods, deer frequently moved between the woods area and farm fields near Runways 25, 07, and 18. Storage of swathed grain in the northern area of the airport was a strong attractant to deer. Although no deer strikes had been (or have been) recorded, a number of near-strikes prompted a control program.

Control procedures that have been used (as of July 1981) to reduce deer numbers on airport property include habitat manipulation, fencing, a herding drive, a live trapping program, and a controlled hunting program.

Figure 1. Air Photo of the Winnipeg International Airport.



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Leased farmland within the airport property had been used for production of cereal crops. In cooperation with the lease holder, cereal crops production was terminated and hay crops were grown instead (D. Walsh, pers. comm.). Further development of hangers along the west perimeter will eventually eliminate the wooded area; this may, in turn, solve the existing deer problem.

Security fencing around the airport consists of 2.4 m (8 ft) chain-link fence with a 3-strand barbed wire overhang (as described by White [1977]). During the summer of 1981, the fence along the west perimeter of the airport was increased to a height of 3.0 m (10 ft). Problems with fence maintenance in the past (tears in the chain link, collapsed sections of fence in wet areas, erosion under the fence, and failure to close gates) have decreased the effectiveness of this control method.

Removal of deer using a drive, a controlled hunting program, and a trapping program was used to reduce deer numbers within the airport property. The drive, conducted during the winter of 1979, involved 35 military personnel as well as airport maintenance staff, the Royal Canadian Mounted Police (RCMP), airport firemen, and provincial Fish and Wildlife officers. The objective of the drive had been to herd all deer off the airport grounds, but as a result of panic responses by the deer and poor coverage of the airport grounds during the drive, the effort was unsuccessful (Airport Services and Security 1979). A continued program of controlled hunts and live trapping (when deer numbers and activity merit a control program) appears to have reduced the deer population to approximately 10 animals (D. Walsh, pers. comm.).

4.1.2 Red Fox

Three red fox dens, all of which are occupied, are known to occur within the airport (P. Bell, pers. comm.). Although red foxes have been reported on the runway on several occasions, this species does not appear to be a major problem to aircraft or to the operation of the airport.

4.1.3 Small Mammals

Two species of small mammals, snowshoe hares and Richardson ground squirrels, present a minor hazard to aircraft and airport maintenance. Both species are prey of several species of hawk and so serve as an attractant of hawks to the airport area. Richardson ground squirrels are very abundant within the airport grounds. Burrowing activity by this species interferes with mowing of grass near the main runways and taxiways. Because ground squirrels are attracted to areas of short grass (Faulkner 1966), and short grass length is required to inhibit use of the area by birds, a poisoning program using a strychnine bait is implemented each spring just prior to green-up to limit ground squirrel numbers (D. Walsh, pers. comm.). Although the poisoning program appears to eliminate most resident animals, immigration from surrounding areas has limited the overall success of the technique.

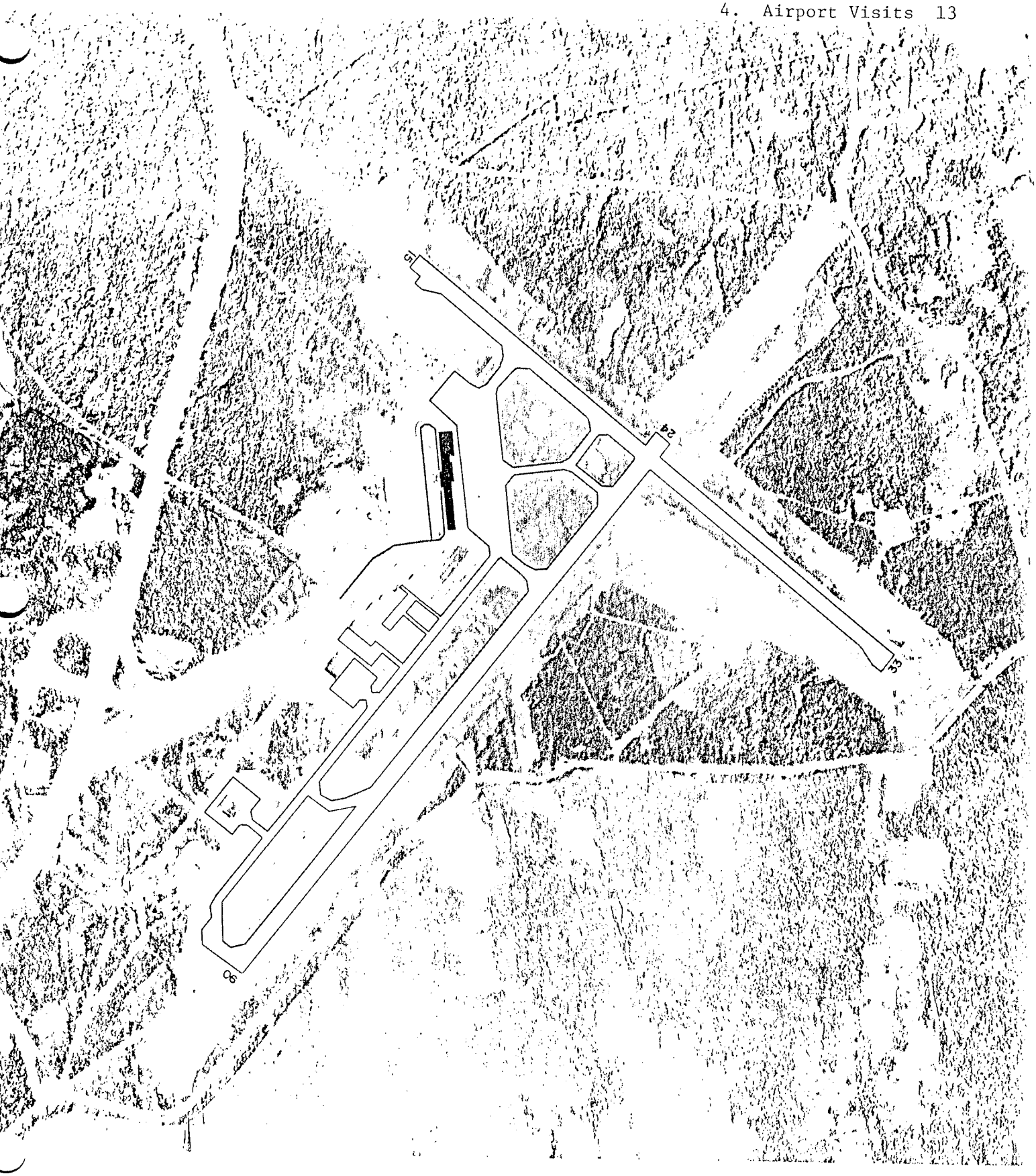
4.2 HALIFAX INTERNATIONAL AIRPORT

The Halifax International Airport is located 37 km north of the city of Halifax in the Atlantic Uplands area of the Acadian Forest region (Rowe 1972). With the exception of limited residential and commercial development to the southwest of the airport grounds, the airport is surrounded by sparse to moderately-dense forest consisting of black spruce (Picea mariana), tamarack (Larix laricina), red maple (Acer rubrum), black ash (Fraxinus nigra) and alder (Alnus sp.) scrub (Figure 2). Clearing of forest cover in the area is restricted by the easily erodable nature of the shale soils and the leaching of arsenic from exposed soil. The major wildlife problem at Halifax airport is the use of the area by white-tailed deer. Minor problems with red fox and porcupine (Erethizon dorsatum) also have been encountered.

4.2.1 White-tailed Deer

Deer range in the vicinity of the airport is of moderate quality and supports low to moderate numbers of deer (K. Dodsworth, pers. comm.). Mild winters during the past two years have resulted in improved survival of deer and increased numbers of animals. Deer appear to make greatest use of the airport during the spring when they feed predominantly on new grass along the

Figure 2. Air Photo of the Halifax International Airport.



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runways (G. Knox, pers. comm.). Urea, which is used to de-ice the runways during the winter, may promote earlier vigorous growth of grass in these areas. Deer numbers also increase during the fall, coincident with the rut and hunting season (G. Knox, pers. comm.). In contrast, very few deer and little deer sign have been observed within the airport during the winter. Two game sanctuaries, the Waverly and the Shubenacadie game sanctuaries are located within the airport region and may serve as a source area for deer near the airport (K. Dodsworth, pers. comm.). Most deer have been observed loafing or feeding in the areas of shrub regrowth off the ends of runways 15 and 24 (Figure 2) and along the edges of runway 15-33 (K. Dodsworth, pers. comm.; W. Dutchak, pers. comm.). Few near-strikes have been reported and only one direct strike, involving an Air Canada DC-8 during take-off on runway 06-24, has been documented. Runway 06-24 is situated such that its long axis crosses the crest of a small rise. A deer, presumably feeding along the runway edge, was obscured from the pilot's view by the rise. As the aircraft moved down the runway, the deer was frightened onto the runway and was struck by the landing gear (G. Knox, pers. comm.).

To date, measures to control the number of deer on the airport property have included fencing of the airport perimeter and a controlled hunt. During the early 1970's, the airport perimeter was fenced using a 2.4 m (8 ft) security fence (as described by White [1977]) except off the bottoms of runways 06 and 33 where a 2.4 m wooden fence was necessary to prevent interference with flight instruments. Frost and wind action, particularly in wet areas, have resulted in parts of the fence collapsing, thus reducing the effectiveness of the structure. Evidence suggests that deer crawl under the fence, rather than jump over it, to gain access to the airport (K. Dodsworth, pers. comm.; R. Johnston, pers. comm.).

A controlled hunt, conducted by the RCMP, has been used to reduce deer numbers within the airport. Following sightings of deer within the airport property, hunts were conducted during dawn or dusk using spotlights and high power rifles. During 1980, five deer were shot during controlled hunts (K. Dodsworth, pers. comm.). Because of the relatively large area of forest within the airport property and the difficulty of removing all animals in these areas, as well as immigration of new animals, the controlled hunt has

been only moderately successful in reducing deer numbers. Delays in removal of deer carcasses from the airport had previously resulted in the attraction of scavenging birds and a potential bird hazard to aircraft; carcasses presently are disposed of immediately.

4.2.2 Red Fox

Numbers of red foxes within the airport grounds and near the airport are low, probably because of heavy trapping effort in the area (K. Dodsworth, pers. comm.). Red foxes tend to hunt (presumably for small rodents) in the infield area between the runways and taxiways, and so present a potential strike hazard to aircraft (W. Dutchak, pers. comm.). Prior to 1970, some problems were encountered with red foxes chewing on the cables for runway lights. However, since the replacement of runway cables in the early 1970's, damage to cables has been extremely small (H. Wilson, pers. comm.). (The brands of cable used prior to and after 1970 were not known.)

4.2.3 Porcupine

Porcupines tend to frequent the area immediately adjacent to the runways, perhaps in response to the high urea concentrations from runway de-icing operations (G. Knox, pers. comm.). Several porcupine strikes have occurred but no damage to aircraft was reported (G. Knox, pers. comm.). No damage to airport equipment by porcupines has been reported.

4.3 CALGARY INTERNATIONAL AIRPORT

The Calgary International Airport is located approximately 8 km northeast of the city centre. Residential and commercial developments surround the airfield to the southeast, south and west, whereas farm land abuts the airport to the east and north (Figure 3). Major highways run parallel to the west, south, and east boundaries of the airport property. Nose Creek flows along the western boundary of the airport. The major mammal problems at the Calgary airport involve deer, red foxes, coyotes, white-tailed jack rabbits, Richardson ground squirrels, and American badgers.

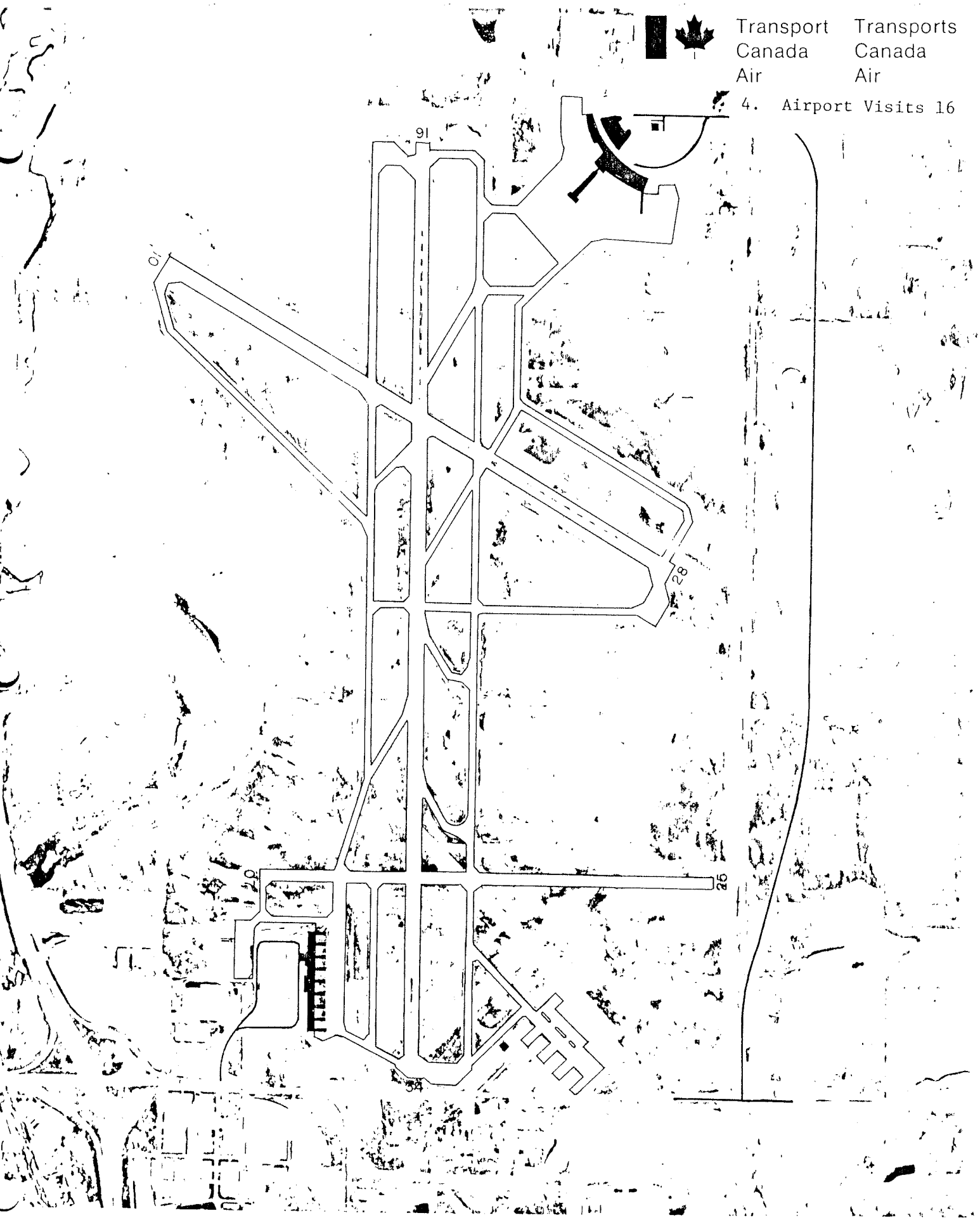

Figure 3. Air Photo of the Calgary International Airport.

4.3.1 Deer

Although deer probably have been present in the vicinity of the Calgary airfield since its construction, problems with potential deer strikes did not arise until the opening of the new airport terminal (H. Demers, pers. comm.). Within the region, deer densities are high (white-tailed deer are the predominant species, although some mule deer [Odocoileus hemionus] are present) (D. Eslinger, pers. comm.). It appears that, with increasing commercial and residential development to the north of the city, the Nose Creek valley tends to funnel deer down to the vicinity of the airport (H. Demers, pers. comm.). Dense growths of clover (Trifolium sp.), alfalfa (Medicago sativa), crested wheat grass (Agropyron cristatum), brome grass (Bromus sp.), and thistle (Cirsium sp.) within the airfield would provide abundant forage for deer. The abundance of food and lack of human disturbance within the airport grounds may attract deer to the area. No deer strikes have occurred at the airport to date.

Present control measures for deer include fencing of the airport perimeter and controlled hunts. The airport is presently surrounded by a 2.1 m (7 ft) security fence (White 1977). The fence is in good repair along the perimeter and it is thought that the main entry point for deer is through the west-side security gate, which is always open for vehicular traffic (H. Demers, pers. comm.). A controlled hunt, conducted by personnel of the Alberta Division of Fish and Wildlife, has been used to remove deer from the airport grounds. To date, a total of 15 animals have been removed (D. Eslinger, pers. comm.). The hazard of deer strikes at the airport presently is considered to be minimal.

4.3.2 Red Fox and Coyote

Numbers of red fox and coyote within the airport grounds are small. Chewing of electrical cables by these species has resulted in minimal damage once or twice a year (H. Demers, pers. comm.).

4.3.3 American Badger

American badgers, through their burrowing activities, create a minor problem by interfering with mowing of the airfield (H. Demers, pers. comm.). An abundance of Richardson ground squirrels in some areas of the airport appears to be the main attractant of American badgers; badger activity and numbers of sightings tend to be highest in areas with high numbers of ground squirrels. No direct control measures for American badgers have been implemented. Numbers of ground squirrels are being controlled, however, by an annual poisoning program (see below).

4.3.4 White-tailed Jack Rabbit

Numbers of white-tailed jack rabbits within the airport grounds have been increasing in recent years and were high during 1981. Although several jack rabbit strikes have occurred, as evidenced by carcasses on the runway, only one incident of aircraft damage has been reported (Table 1). In April 1981, the left engine of an Air Canada DC-9 was damaged, presumably by ingestion of a jack rabbit. Hunting of jack rabbits by coyotes and red foxes and harassment of jack rabbits by domestic dogs also create a potential strike hazard.

4.3.5 Richardson Ground Squirrel

Richardson ground squirrels are abundant throughout the vicinity of the airport. Although burrowing activity by this species presents a minor problem during mowing of the airfield, the major hazard associated with Richardson ground squirrels is that they attract American badgers and a variety of raptors. A poisoning program, using oats coated with Gopher-Cop (2% strychnine), is conducted each spring prior to green-up. Small portions of the poison bait are placed in burrows immediately adjacent to the major runways and taxiways. The poisoning program does reduce numbers of ground squirrels and jack rabbits, but results are only temporary because of the rapid reinvasion of animals from surrounding areas (H. Demers, pers. comm.). The fertilization effect of urea (a chemical used to de-ice runways) on forbs and grasses may attract ground squirrels to the areas adjacent to the runway pavement (V. Solman, pers. comm.).

5. QUESTIONNAIRE SURVEY OF MAMMAL CONTROL PROBLEMS AT AIRPORTS

Information on mammal control problems at airports was received for 22 airports (Abbotsford, Campbell River, Charlottetown, Cranbrook, Dorval, Edmonton, Fredericton, Gander, Kamloops, Mirabel, Muskoka, Penticton, Quebec City, Regina, Sandspit, Saskatoon, St. John's, Vancouver, Victoria, Whitehorse, Williams Lake, Yellowknife). Questionnaires were also sent to the Ottawa and Toronto airports but no reply was received. Although the questionnaire survey provided a broad view of the types and extent of mammal hazards at Canadian airports, causative factors generally were not substantiated. Until more detailed information on mammal hazards and their causes is available, information from questionnaires must be used with some discretion. The major problems described in the questionnaires are summarized by species in Table 2. No mammal problems were reported by the Quebec City, Vancouver, or Victoria airports.

5.1 UNGULATES

Deer and moose were the major species of ungulate that were considered to be a problem at airports. American elk were a potential hazard to aircraft at the Cranbrook airport. In all cases, the main problem with ungulates at airports was the danger of strikes with aircraft. None of the questionnaire respondents indicated that ungulate strikes had occurred. However, the Fredericton and St. John's airports reported several near-strikes between ungulates and aircraft; these incidents had necessitated aborted landings.

Few respondents reported temporal or seasonal variation in ungulate hazards at airports. Where seasonal variation was indicated, however, ungulate hazards usually were greatest during the fall and/or spring. At the Cranbrook airport, the elk hazard was most severe during the winter.

Ungulates appear to be attracted to airport property by the high availability of forage or browse, the lack of harassment by hunters, and minimal harassment by domestic dogs or predators. In some cases, forest cover at airports probably provides safe bedding areas for ungulates. The

Table 2. Summary of mammal control problems at selected Canadian airports. (Information is summarized for questionnaires received from a total of 19 airports.)

Group	Airport	Species	Nature of Problem	Temporal or Seasonal Variation	Probable Cause	Method of Control	Documented Strike Hazard
Ungulates	Campbell River	deer	- strike hazard	- year-round	- attracted to forage; minimal harassment by hunters or dogs	- scare techniques using vehicles; improved fencing (3 m security fence)	- no strikes; pilots report sightings to tower
	Cranbrook	deer elk	- strike hazard	- elk problem greatest during winter	- attracted to forage (airport on traditional elk winter range)	- scare techniques using vehicles or explosive shells; improved fencing	- none; serious potential
	Edmonton	deer	- strike hazard	- NI[a]	- NI	- security fencing with good maintenance	- none
	Fredericton	deer moose	- strike hazard	- NI	- NI	- clearing of forest cover on airport; scare techniques; improved fencing; controlled hunts	- several near misses
	Gander	moose	- strike hazard	- most severe during fall	- attracted to forage; minimal harassment by hunters	- improved security fencing and fence maintenance; drives	- none
	Muskoka	deer	- strike hazard	- NI	- attracted to forage	- scare techniques using vehicles	- none
	Sandspit	deer	- strike hazard	- NI	- attracted by browse and forest cover	- forest cover removed	- none
	St. John's	moose	- strike hazard	- April-May and Sept.-Oct.	- attracted by forage and minimal harassment by hunters	- improved security fencing 2.1 m (7')	- two aborted landings
	Williams Lake	deer moose	- strike hazard	- NI	- attracted by forage; moose migrate through area	- scare techniques using vehicles	- none
Bears	Gander	black bear	- strike hazard	- NI	- NI	- fencing	- none
	Williams Lake	black bear	- strike hazard	- NI	- migrate through area	- scare techniques using vehicles	- none
Canids	Abbotsford	coyote	- strike hazard	- NI	- attracted during the evening to radiant heat from runways	- poison bait program by Fish and Wildlife personnel	- none

...continued

Table 2. Continued.

Group	Airport	Species	Nature of Problem	Temporal or Seasonal Variation	Probable Cause	Method of Control	Documented Strike Hazard
Canids (cont'd)	Dorval	red fox	- strike hazard	- NI	- attracted by availability of prey (birds)	- fencing; clearing of shrubs; organized hunt	- one strike, no damage to aircraft
	Edmonton	coyote	- damage to cables, strike hazard	- NI	- NI	- chemical repellent on cables (Skoot)	- none
	Fredericton	red fox coyote	- damage to cables	- late fall and winter; animals most active at night	- NI	- chemical repellent on cables; trapping	
	Gander	red fox	- damage to cables	- NI	- NI	- use of BX cable sheathing; trapping and relocation	
	Kamloops	red fox coyote	- strike hazard	- NI	- attracted by high numbers of small rodents	- scare techniques using vehicles	- none
	Mirabel	red fox	- strike hazard	- greatest during spring to fall; present in winter	- attracted by birds and bird eggs	- use of electrical fence suggested	- several strikes; no damage to aircraft
	Muskoka	wolf red fox	- damage to cables; strike hazard	- NI	- NI	- use of BX cable sheathing; scare techniques using vehicles	- none
	Regina	red fox	- damage to cables	- NI	- NI	- chemical repellent on cables (Skoot)	
	Williams Lake	coyote	- strike hazard	- NI	- attracted by high numbers of snowshoe hares	- scare techniques using vehicles	- one strike of a young pup, no damage to aircraft
	Yellowknife	red fox	- damage to cables	- NI	- NI	- metal sheathing on above-ground cables	- several strikes, no damage to aircraft
Aquatic Mammals	Gander	beaver	- flooding and disruption of drainage system; attraction of waterfowl to impoundments	- NI	- NI	- fencing; destruction of dams and lodges; trapping and relocation	

Table 2. Continued.

Group	Airport	Species	Nature of Problem	Temporal or Seasonal Variation	Probable Cause	Method of Control	Documented Strike Hazard
Mustelids	Dorval	skunk	- strike hazard	- NI	- attractec by availability of birds' eggs	- fencing; elimination of wood areas	- none
	Edmonton	northern pocket gopher	- damage to cables, disturbance of airfield and lawns	- NI	- NI	- extermination program	- none
	Edmonton	Richardson ground squirrel	- disturbance of airfield and lawns	- NI	- NI	- extermination program in spring	- none
Small Mammals	Gander	rat	- damage to cables	- NI	- NI	- extermination program	
	Penticton	northern pocket gopher	- disturbance of airfield	- NI	- NI	- extermination program	
	Whitehorse	rodents (Arctic ground squirrel)	- damage to cables, disturbance of airfield	- NI	- NI	- extermination program	- none
Domestic Animals	Fredericton	dog	- strike hazard; damage to cables	- NI	- NI	- fencing; chemical repellent on cables	- none
	Muskoka	dog	- strike hazard	- NI	- NI	- fencing	- none
	Penticton	dog	- strike hazard	- NI	- NI	- scare techniques using vehicles	- none
	Saskatoon	dog livestock	- strike hazard	- NI	- NI	- improved fencing	- none
	St. John's	dog	- strike hazard	- NI	- NI	- improved fencing; removal program	- none

[a]NI=not indicated by respondent.

reported increase in numbers of deer and moose at some airports during the fall may be a response to increased hunter harassment in adjacent areas. The Cranbrook Airport presents a special case where the airport was constructed on a portion of a traditional elk wintering ground. Intensive cattle grazing in adjacent areas reduced winter forage for elk and, as a consequence, the airport was one of the few remaining areas with readily available forage.

According to the questionnaires, the most common methods of ungulate control were improved fencing of the airport area and scare techniques. Fencing had been installed at most airports (primarily as a security measure and, secondarily, as a method of ungulate control). Heights of fencing at various airports ranged from 2.1 m to 3 m. Because of the ability of some ungulates, particularly deer, to crawl under fences, several respondents stressed the necessity of good fence maintenance. Page wire with large openings did not prevent entry by deer. Only chain link fencing or small mesh page wire was considered suitable for exclusion of ungulates. Use of vehicles to scare ungulates from runways just prior to take-off or landing also was used for temporary control of ungulate hazards to aircraft. Explosive shells and propane cannons have been used with limited success at the Cranbrook airport to scare elk and deer. Other control methods that have been employed at other Canadian airports include clearing of forest cover on the airport grounds, controlled hunts, and drives.

5.2 BEARS

Black bears (Ursus americanus) were indicated as a potential strike hazard at the Gander and Williams Lake airports. No strikes or near-strikes were reported. Fencing and scaring techniques using vehicles prior to take-off and landing have been used to control bear hazards to aircraft.

5.3 CANIDS

Red fox, coyote and wolf have damaged cables at a number of airports and present a potential strike hazard in some locales. Most respondents did not indicate a seasonal variation in either problem, although damage to cables by red foxes and coyotes at the Fredericton airport was greatest during the fall

and winter. Availability of prey (small mammals and birds) at airports appeared to be the major attractant of canids to airports. Coyotes at the Abbotsford airport were observed sleeping on the runways, presumably in response to the warmth radiated by the tarmac. Although several strikes of canids were reported, no damage to aircraft was reported.

Use of chemical or physical barriers on electrical cable was a common method of deterring canid damage to cables. Products used included BX metal sheathing on the cables, and Skoot (an animal repellent containing thiram). The Fredericton respondent noted the use of a new repellent coating (Bio Met 12 Rodent Repellent) for cables at some airports in the United States. (The product is not registered for use in Canada and apparently is no longer available in the United States [K. LaVoie, pers. comm.].) Removal of animals using poison bait programs, organized hunts, and trapping programs also has been used to control the canid problem.

5.4 AQUATIC MAMMALS

The beaver (Castor canadensis) was the only species of aquatic mammal that appeared to be a problem at airports. At the Gander airport, damming of water courses and the drainage system by beavers resulted in flooding of some parts of the airfield. The resulting impoundment served as an attractant to waterfowl which, in turn, posed a potential strike hazard to aircraft. Animals were trapped and relocated and the lodges and dams were destroyed. Improved fence maintenance was used as another means of excluding this species from the airport.

5.5 MUSTELIDS

Striped skunks (Mephitis mephitis) were reported to be a minor strike hazard at the Dorval airport. It was suggested that this species may have been attracted by the availability of birds' eggs. Fencing and elimination of woodland habitat in adjacent areas appears to have reduced the problem to insignificant levels.

5.6 SMALL MAMMALS

Northern pocket gophers (Thamomys talpoides), Norway rats (Rattus norvegicus), Richardson ground squirrels (Spermophilus richardsoni), and Arctic ground squirrels (Spermophilus parryi) were indicated to be problems at several airports. Rats, northern pocket gophers, Richardson ground squirrels, and Arctic ground squirrels have damaged electrical cables, resulting in some equipment failures. Control measures employed included poisons at the Gander, Edmonton and Whitehorse airports, and animal repellent coatings (Skoot) on cables. Use of a Dexol Gasser to control northern pocket gophers in Edmonton was not overly successful. Northern pocket gophers, Richardson ground squirrels, and Arctic ground squirrels, as a result of their burrowing activity and the creation of mounds of excavated soil, have caused damage to grassed runways and have obstructed mowing operations at some airports. Annual poisoning programs were used to reduce numbers of these animals.

Small mammals such as mice and snowshoe hares were indicated to be indirect problems at the Dorval, Kamloops, and Williams Lake airports. Several species of canid presumably were attracted by the abundance of small mammal prey on airfields. Small mammals also have been identified as the main attractant of owls to airports (V. Solman, pers. comm.).

5.7 DOMESTIC ANIMALS

Among domestic animals, dogs were the major problem species at airports. Livestock (cattle and horses from surrounding farm areas) also was a problem at the Saskatoon airport. In all cases, domestic animals presented a potential strike hazard to aircraft. In addition, dogs had damaged cables at the Fredericton airport.

Fencing was the most commonly used method of controlling domestic animals. Scare techniques using vehicles and a removal program also were used to reduce problems with domestic dogs. Use of a chemcial repellent coating on cables was suggested as a means of reducing damage to cables by dogs.

6. METHODS TO CONTROL MAMMALS AT AIRPORTS

Based on information from the published literature, from interviews with airport personnel and other knowledgeable sources, and from responses to the questionnaire on mammal problems at airports, it is apparent that a number of mammal groups are hazards or potential hazards to aircraft safety and equipment at airports. The groups of mammals that present the greatest problems are ungulates (primarily deer and, to a lesser extent, elk and moose), canids (red fox, coyote and wolf), and small mammals (hares, rabbits, ground squirrels, pocket gophers, and moles).

Control of problem mammals at airports is a necessary component of air traffic safety. Methods employed may involve chemical toxicants, chemical repellents, physical barriers, scaring techniques and/or habitat manipulation. The present use and effectiveness of chemical, physical, and habitat manipulation measures to control mammal problems at airports are summarized in Tables 3, 4, and 5, respectively, and are described more fully in the text. Where practical, the intent of a control program should not be to destroy animals but rather to encourage them to avoid airports. (Destruction of animals is rarely a long-term solution because of rapid reinvasion from surrounding areas.) The types and combination of methods to be employed should be based on the specific requirements of the individual airport, and on the environmental factors unique to that situation. Because bird hazards to aircraft generally are more significant than mammal problems (see Blokpoel 1976 for a review), it is extremely important that methods used to decrease or control mammal problems do not increase the attractiveness of airports to birds.

Following is a brief discussion of methods of control for various groups of mammals. This discussion considers both past experience at airports and relevant experience in control of mammals in other settings. It is stressed that no one solution will be suitable for mammal problems at all airports. Prior to the formulation and implementation of a control program for problem mammals, the causative factors should be determined, and information on the regional ecology of the species and the relationship of the problem to other wildlife hazards at the airport should be obtained. The assistance of

Table 3. Use and effectiveness of chemicals in reducing mammal hazards at airports. (Only chemicals that have been accepted for registration under the Pest Control Products Act for Control of Vertebrate Pests are considered. Based on Peoples [1970], Gratz [1973], Lund [1975], Green [1978] and Agriculture Canada [1981]).

Problem Group	Problem or Hazard	Chemical or Product Name	Action	Recommended Use and Application	Effectiveness	Hazard to Man	Species For Which Treatment Effective
Ungulates	Strike hazard to aircraft	- Alphachlorohydrin	- repellent	- sprayed as a coating on ground cover to reduce foraging; supplemental treatment to physical barriers	- low to moderate	- low	- deer, elk
		- Hinder	- repellent	- same as above	- low to moderate	- low	- deer, elk
		- Thiram (Skoot)	- repellent	- same as above	- low to moderate	- low	- deer, elk
Canids	Strike hazard to aircraft	- Hydrogen cyanide	- acute poison	- poisoned bait; intensive extermination program	- high (if bait accepted)	- extreme	- wolves, coyote, red fox
		- Strychnine	- acute poison	- poisoned bait; intensive extermination program	- high (if bait accepted)	- extreme	- wolves, coyote, red fox
		- Sodium monofluoroacetate	- acute poison	- poisoned bait; intensive extermination program	- high (if bait accepted)	- extreme	- wolves, coyote, red fox
	Damage to cables[a]	- Napthalene	- repellent	- repellent coating	- not suitable	- low	- not suitable
		- Thiram (Skoot)	- repellent	- paint based mix applied to cables; reapplication at 1-2 yr intervals	- moderate	- low	- wolves, coyotes, red fox
Small Mammals	Damage to cables (poisons also may be used to reduce indirectly attraction of canids and birds to small mammal prey)	- Alphachlorohydrin	- repellent	- repellent coating on cables	- moderate	- low	- all small rodents, leporids
		- Aluminum phosphide	- acute poison	- tablets inserted into burrow; phosphine gas released	- moderate	- high	- ground squirrels, pocket gophers
		- Anthracene oil	- repellent	- repellent coating; short term application	- not suitable	- moderate	- not suitable
		- Chlorophacinone/ Diphacinone	- anticoagulant poison	- poisoned bait; multiple dose to be effective	- moderate to high (if bait accepted)	- moderate	- all small mammals
		- Fumarin	- anticoagulant poison	- poisoned bait; multiple dose to be effective	- moderate to high (if bait accepted)	- moderate	- all small mammals

...continued

Table 3. Continued.

Problem Group	Problem or Hazard	Chemical or Product Name	Action	Recommended Use and Application	Effectiveness	Hazard to Man	Species For Which Treatment Effective
Small Mammals (continued)		- Gophacide (phosacetim)	- acute poison (cholinesterase depression)	- poisoned bait placed in burrows	- high (if bait accepted)	- moderate to high	- ground squirrels, pocket gophers
		- Hydrogen cyanide	- acute poison	- dust pumped into burrows	- high	- high	- ground squirrels, pocket gophers
		- Orthodichlorobenzene	- repellent	- repellent spray	- not suitable	- low	- not suitable
		- Pindone	- anticoagulant poison	- poisoned bait; multiple dose to be effective	- moderate to high (if bait accepted	- moderate	- all small mammals
		- Red Squill	- acute poison	- poisoned bait	- low	- low	- all small mammals
		- Strychnine	- acute poison	- poisoned bait	- low (poor bait acceptance)	- high	- all small mammals
		- Sodium monofluoro-acetate	- acute poison	- poisoned bait	- high	- high	- all small mammals
		- Thiram (Skoot)	- repellent	- paint based mix applied to cables; reapplication at 1-2 yr intervals	- moderate	- low	- small rodents, leporids
		- Toxaphene	- acute poison/ repellent	- apply as a coating to cables	- moderate; not suitable	- moderate to high	- not suitable
		- Warfarin	- anticoagulant poison	- poisoned bait; multiple dose to be effective	- high (if bait accepted)	- moderate	- all small mammals
		- Zinc phosphide	- acute poison	- poisoned bait	- high	- moderate	- all small mammals

[a]Hydrogen cyanide, strychnine, and sodium monofluoroacetate also can be used to reduce damage to cables by directly reducing pest canid population.

Table 4. Use and effectiveness of physical barriers in controlling mammal hazards at airports. (See text for details of control methods. Based on information from airport visitations and interviews.)

Problem Group	Problem	Control Methods	Effectiveness	Species (For Which Treatment Effective)
Ungulates	Strike hazard to aircraft	- security fence (>2.4 m in height)	- good if fence constructed and maintained properly	- deer, elk, moose, pronghorn antelope
		- cattle guards (for use at open entry points to fenced airfields)	- good	- same as above
Canids	Strike hazard to aircraft	- security fence	- low	- coyote, red fox, wolves
	Damage to cables	- copper or bronze sheathing	- low to moderate	- coyote, red fox, wolves
		- stainless steel braid sheathing	- moderate to high	- coyote, red fox, wolves
Small Rodents	Damage to cables	- copper or bronze sheathing	- low to moderate	- mice, pocket gopher, ground squirrels
		- stainless steel braid sheathing	- moderate to high	- mice, pocket gopher, ground squirrels, tree squirrels
		- Turn Plate armour[a]	- moderate to high	- pocket gophers

[a]K. La Voie, pers. comm.

Table 5. Use and effectiveness of habitat manipulation in controlling mammal problems at airports. (Based on information obtained during airport visitations and interviews; additional references as noted.)

Problem Group	Habitat Components That Attract Group	Suggested Habitat Manipulation	Potential Conflicts with Other Uses
Ungulates	Ungulates attracted to airports by: 1) Protective cover (trees, shrubs, etc.) 2) Availability of browse and forage (legumes such as alfalfa and clover particularly attractive) 3) Minimal disturbance from people, particularly hunters 4) Shortage of cover and food in adjacent areas may force animals into airport	Ungulate use of airfields best reduced by: 1) Clearing of tree and shrub cover (note: new regrowth offers excellent browse to ungulates and must be cleared regularly) 2) Reduction of succulent ground covers such as legumes; increased use of grasses 3) Mowing of grassed areas to reduce availability of forage 4) Alteration of land use surrounding airports to minimize destruction of wildlife habitat	- may result in increased erosion and drifting of snow; reduction of sound barrier around airport - conflict with agricultural leases; grasses with large seed heads to be avoided (could result in attraction of birds to airport) - conflict with agricultural leases - conflict with commercial and residential developments
Canids	Canids attracted to airports by: 1) Availability of small mammal and bird prey 2) Availability of well-drained sites (e.g., gravel berms) for den sites 3) Minimal disturbance from people 4) Shortage of suitable habitat in areas adjacent to the airport	Canid use of airport best reduced by: 1) Reduce attractiveness of airports to small mammals (see below) and birds 2) Reduce populations of small mammals by extermination programs 3) Removal of suitable den sites 4) Alternation of land use surrounding airports to minimize destruction of wildlife habitat	- ensure habitat changes do not attract birds to airfields - potential for secondary poisoning problem - some sites such as road beds not removable - conflict with commerical and residential developments
Small Mammals	Small mammals attracted to airports by: 1) Availability of food; pocket gophers attracted (and dependent) on availability of forbs; ground squirrels and jack rabbits prefer short (i.e., mown) ground cover; mice prefer dense ground covers for protection from predators and grasses and legumes as food 2) Minimal disturbance from people attracts larger species such as badgers, ground squirrels, and leporids 3) Shortage of suitable habitat in areas adjacent to the airport	Small mammal use of airports best reduced by: 1) Reduction of forbs (particularly legumes) in the ground cover on airfields (pocket gophers cannot survive in areas devoid of forbs; legumes are one of the preferred foods of rodents and leporids) 2) Mowing of grassed areas (will reduce use of airfield by mice and some leporids) 3) Reduction of tree and shrub cover (will reduce use of airfield by some small rodents and leporids) 4) Elimination of suitable burrow sites (areas such as well-drained berms are preferred burrow sites of ground squirrels)	- ensure that changes in vegetation do not attract birds to airfield - may increase problem with ground squirrels and jack rabbits - may result in increased erosion and drifting of snow; reduction of sound barrier around airport - some sites such as road beds are not removable

personnel specially trained in the management of wildlife and the control of pest species should be solicited to ensure that the best means of control are employed and that the individual programs for the control of bird and mammal problems are fully integrated and compatible.

6.1 CONTROL OF UNGULATE HAZARDS

Economically and ecologically acceptable methods of controlling ungulate hazards at airports include the use of physical barriers, the use of chemical repellents, habitat manipulation, removal, and scaring techniques.

6.1.1 Physical Barriers

Although expensive, the use of a physical barrier such as a security fence to prevent access to an area by ungulates is the most effective method of controlling ungulate hazards at airports. However, as stressed by Airport Services and Security (1979) and a number of people interviewed during this study, fencing must be rigorously maintained and all entry points must be closed promptly after use. As an example, poor maintenance of some sections of the security fence and the failure to close some security gates at the Winnipeg International Airport probably are the major causes of the failure of fencing to eliminate the deer problem at this airport (Airport Services and Security 1979).

With slight modification, the standard 2.4 m (8 ft) high security fence with a barbed wire overhang, as recommended by Transport Canada (White 1977), should provide an effective barrier to ungulate movement. Studies by Fitzwater (1972) and Caslick (1980) indicate that a 2.4 m high fence will exclude deer in most instances. (Deer under stress apparently can jump as high as 3 m [Airport Services and Security 1979].) Because deer typically attempt to crawl under as opposed to jumping over fences, the lower half of the fence must be constructed of a tight mesh and must be firmly anchored to the ground (Caslick 1980). Ward et al. (1980) found that deer were capable of crawling through a 15 cm high gap under fences. Vertical gaps in fences near security gates also should not exceed 10 cm in width. At security gates

or other access points where ungulates may gain entry, use of cattle guards would be an effective means of permanently preventing access by ungulates.

If deer or other ungulates do jump over 2.4-3 m high fencing, existing security fencing could be modified (particularly in areas where deer most frequently gain entry) or new fencing installed as described by Jones and Longhurst (1958). They found that overhanging deer fences, with a 1-2 m overhang extending outward from a vertical fence at an angle of 25° above horizontal, were completely effective in excluding deer and sheep. However the construction cost for this type of fencing is high.

6.1.2 Chemical Repellents

A number of chemical substances have been used to deter ungulates and other mammals from consuming plant material (Table 3). Thiram (tetramethyl-thiuram disulphide) and ZAC (zinc dimethyldithio-carbamate) are commonly used commercial repellents that have been found to be effective in reducing ungulate browsing of young trees and shrubs (Dietz and Tigner 1968). Thiram suspended in a polymer base has been applied to ground cover at the Mid-State airport in Phillipsberg, Pennsylvania, and has substantially reduced deer problems along the three major runways (Anonymous 1977). Several new animal repellents, including Hinder and alphachlorohydrin, recently have been registered for use in Canada and are relatively effective in preventing deer from browsing on treated plants (G. Laidlaw, pers. comm.).

None of the studies reviewed, however, discussed the effects of repellents on ground cover plants. Because changes in ground cover composition may increase bird hazards or other mammal problems, or reduce soil stability, effects of repellents on ground cover should be investigated prior to any wide-scale application of the chemicals. Possibilities of poisoning non-target species or fouling domestic feed (e.g., haying operations on airfields) also should be considered.

Chemical repellents, by themselves, are not recommended for the control of ungulate hazards at airports. Chemical repellents may offer a supplementary means of control in conjunction with physical barriers or habitat

alteration but should not be used to compensate for poor maintenance of fencing or ground cover.

6.1.3 Habitat Manipulation

Reduction of shrub and tree cover and alteration of ground cover at airports also could be used to reduce ungulate hazards (Table 5). Airports commonly are located in areas where encroachment by residential, commercial and agricultural developments has resulted in a reduction of woodland and the availability of ungulate browse and forage. Ungulates consequently may be attracted to remaining wooded areas or forage within airport grounds. As an example, construction of the Cranbrook airport on a portion of a traditional elk winter range, together with increased cattle grazing in the remainder of the winter range, has resulted in elk moving onto the airport property each fall and winter. In addition, airports offer the advantage of minimal human disturbance (particularly by hunters) and limited harassment by predators. Reduction or removal of tree and shrub cover would remove protective cover for ungulates and would reduce the attractiveness of airfields to ungulates. However, if forest cover is removed, the new growth of some species of shrubs and trees will provide highly palatable browse for ungulates, and the new growth must be removed regularly. For example, such regrowth of shrubs along the approachways at the Halifax airport appear to attract deer from the surrounding area onto the airport property.

Ground covers such as legumes (e.g., alfalfa, clover) and agronomic grasses that are used presently at many airports also appear to attract ungulates to airfields. Although deer will consume both legumes and grasses, legumes appear to be the preferred forage (Mullen and Rongstad 1978; M. Dorrance, pers. comm.). For example, Mullen and Rongstad (1978) examined damage by white-tailed deer to hay crops consisting of a mixture of alfalfa and brome grass, and found that only the alfalfa portion of the hay was damaged. Elk similarly prefer forbs to grasses (Marcum 1980). Although deer and elk may still feed on agronomic grasses, it would appear that use of grass cover is preferable to grass/legume or legume covers. Where legumes are already present on airfields and deer present a hazard to aircraft, legumes should be replaced with grass covers, and use of legumes in on-site

haying operations should be prohibited. Mowing of areas of long grass that are frequented by ungulates (or regular cutting of hay) also would help to reduce the attractiveness of airfields to ungulates.

Habitat manipulation also may be used to draw ungulates away from airports. Establishment of wooded areas or foraging areas outside the airport may attract ungulates which would otherwise attempt to use the airport grounds. For example, establishment of an area of suitable elk winter range outside the Cranbrook airport might help to reduce ungulate hazards to aircraft. However, any plan to attract ungulates to areas of suitable habitat outside airports must be examined carefully; one possible consequence of this type of habitat manipulation is an increase--not a decrease--in the numbers of mammals using the airport.

6.1.4 Removal Programs

Following fencing of an airport or initiation of other measures to minimize the attractiveness of the airport to ungulates, it may be necessary to remove ungulates from the airport grounds. However, removal programs for ungulates require specialized knowledge and planning and, as a consequence, the authorization and assistance of provincial wildlife agencies should be solicited in planning and/or implementing any removal program. Live trapping programs, use of tranquillizer guns, and controlled hunts have all been used to remove deer at several Canadian airports. All three methods are highly manpower intensive but can be successful if conducted with care. Several methods of live-trapping and tranquillizing ungulates are reviewed by Taber and Cowan (1971). Drives to herd ungulates have been used by wildlife agencies to capture and census some species of ungulates, but drives demand considerable manpower, construction of drift fences and sound planning for success. The one known attempt to drive deer off airport property--at the Winnipeg International airport--was a failure because of panic responses by the animals and poor organization (Airport Security and Services 1979).

6.1.5 Scaring Techniques

Vehicles and noise-making devices have been used with some success to scare ungulates away from runways temporarily (Table 2). At several smaller

airports, vehicles are driven along the runway just prior to aircraft landings or take-offs in order to scare ungulates away from the runway area. Noise-making devices such as gas-powered cannons and cracker shells also can be used to scare ungulates (Anonymous 1979). However, such control of ungulate hazards to aircraft is at best temporary. The effectiveness of such methods also may decrease over time as ungulates habituate to the scaring technique (Anonymous 1977).

6.1.6 Recommendations

Installation of a security fence (as described by White [1977]), with added precautions to firmly anchor the base of the fence and to minimize vertical openings near gateways, appears to be the most effective permanent treatment for reducing ungulate problems at airports. The fence must be well-maintained and all entry points must be closed immediately following use if the effectiveness of the fence is to be maintained. If a permanent open entry is required, a cattle guard opening should be installed. Supplemental treatments of vegetation with chemical repellents or habitat manipulation may be useful in reducing the attractiveness of the airport to ungulates, and thus in reducing the incentive to cross the fence barrier. In particular, use of legumes as a ground cover should be discouraged.

6.2 CONTROL OF CANID PROBLEMS AT AIRPORTS

Canids did not appear to be a major problem at most airports. Minor problems involving damage to electrical and communication cables and strike hazards to aircraft were identified. However, because canids can reduce slightly the numbers of small mammals, there is some advantage to their presence at airports. Methods of controlling canid problems at airports include fencing, use of chemical repellents, habitat manipulation, scaring techniques, and direct removal.

6.2.1 Fencing

Because of the ability of canids to dig under fences, fence barriers are not overly effective in excluding canids (Fitzwater 1972). Fitzwater (1972) recommended that exclusion fences for coyotes and foxes be at least 1.3 m in

height, be topped with 1-2 strands of barbed wire, and be anchored firmly to the ground. Barbed wire (Fitzwater 1972) or electrical barriers (Shumake et al. 1978) strung along the bottom of the fence may discourage digging. Exclusion fences to reduce canid hazards at airports are likely best used in conjunction with other, more effective techniques.

6.2.2 Chemical and Physical Control of Cable Damage

Chemical repellents have proven useful in reducing damage by canids to electrical cables. Some types of coatings on electrical cables appear to be less susceptible to damage. It has been suggested but not substantiated that variation in the salt content of the coatings may account for these differences. A study of the vulnerability of cable coatings to damage by canids should be conducted and the least susceptible coatings should be used at airports where the problem is most severe. Skoot, a coating product containing the general animal repellent Thiram, has been used successfully at the Regina International airport to reduce canid damage to cables (reapplication is necessary approximately once every two years). Bio Met 12 Rodent Repellent, which contains 15.85% of the active ingredient tri-n-butylin chloride, has been used successfully in the United States to reduce canid damage to cables but is not yet registered for use in Canada. Chemical means of reducing canid damage to cables are summarized in Table 3.

Metal sheathing, such as BX sheathing for electrical cables, can be used to protect electrical wires physically from canid damage (Table 4). Use of stainless steel sheathing or products such as Turn Plate armour (K. LaVoie, pers. comm.) appears to provide moderate to good protection from canid damage.

6.2.3 Habitat Manipulation

High numbers of prey species such as small mammals and birds appear to be a major attractant of canids to airports. A lack of direct human disturbance, availability of well-drained areas suitable for denning, and destruction of suitable habitat in areas adjacent to the airport (as a result of commercial and residential developments) also would attract canids to

airfields. Although habitat manipulation is not an effective means to reduce numbers of canids directly, alteration of the airport environment to decrease the numbers of prey (see Section 6.3) would appear to be the most effective means of manipulating the airport environs to reduce its attractiveness to canids.

6.2.4 Scaring Techniques

Explosive shells and chasing with vehicles have been used to scare canids away from runways temporarily prior to landings or take-offs of aircraft. Little is known of the success of scaring techniques to reduce canid problems at airports (Balser 1974).

6.2.5 Removal

Trapping programs or controlled hunts can be used to remove canids from airports. The success of trapping programs, however, is limited by the wariness of most canids to entering traps (Baumgartner 1978). As a result of the secretive nature of most canids, controlled hunts would be prohibitively manpower-intensive in most areas.

6.2.6 Recommendations

Assuming that canids are attracted to most airports by the abundance of small mammals and birds, reduction of prey populations would be the most effective method of reducing canid problems. Canid damage to cables is best controlled through use of less palatable or more rigid cable coatings and/or chemical repellents.

6.3 CONTROL OF SMALL MAMMAL PROBLEMS AT AIRPORTS

The major problems with small mammals at airports are (1) the attraction of larger mammals and birds that prey upon these species, (2) damage to airport equipment such as electrical cables, and (3) interference with airport maintenance (e.g., burrowing activities interfere with mowing of the airfield). Means of controlling small mammal problems at airports include chemical toxicants, chemical repellents, and habitat manipulation.

6.3.1 Chemical Toxicants

A wide variety of lethal chemical compounds that exhibit a broad range of mechanisms of action are currently in use or have been used in the past to control small mammal populations (see Clark [1975] and Green [1978] for reviews) (Table 3). Several manuals describing the use of chemical toxicants to control small mammal populations are available (e.g., Clark 1975; Baumgartner 1978). Chemical toxicants can be classified as either acute (single-dose) poisons or chronic (multiple-dose) poisons. The effectiveness of a poison control program depends largely on the toxicity and the specificity of the compound and on its acceptance by the target species. A brief review of the effectiveness of acute and chronic poisons follows. Chemical toxicant programs to control small mammals should be planned and implemented only by knowledgeable and trained staff; problems with the use of chemical toxicants are discussed later.

6.3.1.1 Acute poisons. The effectiveness of an acute poison depends on the target species consuming sufficient poison in a single dose to result in its death. The time lapse between the first intake of the poison and the onset of poisoning symptoms is extremely important in determining effectiveness. If symptoms occur before a lethal dose is consumed, bait shyness invariably occurs (Lund 1975).

Also important are the persistence of the poison in the bait (i.e. whether poison remains potent during the period of baiting that is required for control) and the solubility, cost, availability and ease of use. Poor bait acceptance or reacceptance can sometimes be overcome by prebaiting (i.e. bait without poison is provided to the 'pest' population; once the animals freely accept the non-poisoned bait, poisoned bait is substituted).

6.3.1.2 Multiple-dose poisons. Multiple-dose rodenticides must be consumed by the target species over a period of several days to be effective. Because symptoms of poisoning are delayed, bait shyness is not as likely to occur (Lund 1975). Prebaiting is not necessary; control campaigns using multiple-dose rodenticides are, as a result, less manpower intensive. Anticoagulants are currently the most commonly used multiple-dose poisons for small mammals.

Warfarin was one of the first anticoagulants developed and was widely used for the control of rats and mice in urban areas. Its use is now more restricted due to the resistance of some populations of small mammals (especially rats) to Warfarin (Brooks and Bowerman 1973; Greaves et al. 1976) and the development of more effective anticoagulants, such as the oil-soluble indandiones. Chlorophacinone, diphacinone and bromadiolone are several of the more commonly used indandione anticoagulants; these are highly effective against small rodents (Rowe and Redfern 1968; Giban 1974; Horsfall et al. 1974; Palmateer 1974; Marsh et al. 1980). A strike hazard problem at the Hayward Municipal airport in Almeda County, California, involving black-tailed jack rabbits (Lepus californicus), was controlled successfully using the anticoagulant diphacinone (0.005%) (Johnston 1978).

6.3.1.3 Problems of using toxic chemicals. Although a number of studies have shown that acute and multiple-dose programs can reduce numbers of small mammals, effects are often only temporary. Reinvasion of small mammals from adjacent areas often leads to rapid increases in the number of animals in treated areas and, therefore, can negate the effects of the treatment (Myllymaki 1975).

Continuous provision of poison baits has been used to solve the problem of reinvasion of treated areas. For example, Radvanyi (1974) and Martell and Radvanyi (1974) established poison bait feeders containing a whole oat bait coated with Rozol (an anticoagulant) throughout their treatment areas. In both studies, numbers of small rodents on the treatment areas were reduced and were maintained at low levels for at least one year.

Prospective users of poisons also must consider the risk of secondary poisoning; that is, the poisoning of other species of vertebrates through direct consumption of the poison or through consumption of carcasses of the target species. Risk of secondary poisoning of rare, endangered, and threatened species of mammals or birds must be considered prior to use of any toxic chemical. Risks of secondary poisoning can be reduced, however, by regular removal of the carcasses of the target species (Johnston 1978). In some cases the 'secondary' reduction in numbers of other species also may be beneficial. For example, the strychnine bait used to control Richardson

ground squirrels at the Calgary airport also killed moderately high numbers of white-tailed jack rabbits (H. Demers, pers. comm.).

6.3.2 Chemical Repellents

Chemical repellents would be most useful in controlling small mammal damage to airport equipment (e.g., chewing of electrical cables). Means of chemically (and physically) controlling small rodent damage to cables and other equipment are identical to those methods already described for canids (Section 6.2.2) and are summarized in Table 3.

6.3.3 Habitat Manipulation

Manipulation of environmental factors to reduce the carrying capacity of an area for a species can be an effective means of controlling some small mammal populations (Hansson 1975) (Table 5). The primary effect of habitat manipulation is to shift populations away from the treatment area but it may also result in secondary effects such as increased mortality associated with increased susceptibility to predation, increases in social stress, and reduction in suitable foods (Green 1978).

The removal or reduction of ground cover is probably one of the easiest and most effective methods of reducing the numbers of some species of small mammals. Clean cultivation (mowing of entire areas or clearing ground cover) has been used with success in orchards and tree plantations to reduce numbers of small rodents (Eadie 1953; Jokela and Lorenz 1959; Howard 1967b). Because regular mowing of areas adjacent to runways is required to reduce bird hazards to aircraft, this technique would be an economical means of reducing some small mammal populations, such as microtine rodents. If areas of long grass are mowed, grass cuttings should be removed because they also provide shelter to small mammals. However, some species of small mammals such as ground squirrels and jack rabbits are attracted to areas of short vegetation. In areas where these species are apt to present a problem, chemical toxicant programs probably are the only economically acceptable method of control.

6.3.4 Recommendations

Control of small mammal populations at airports to reduce damage to equipment such as electrical cables is best accomplished using chemical repellents or coatings that are unpalatable to small mammals. Reductions in numbers of small mammals may be necessary to reduce the attractiveness of airports to large mammals and birds that prey on these species. Depending on the type of small mammal to be controlled, a poisoning program or habitat manipulation may be the best means of control. For species, such as microtine rodents, that depend on dense ground cover, mowing of the vegetation and subsequent removal of the cuttings will substantially reduce the carrying capacity for those species. In contrast, mowing can increase the suitability of airports for species such as ground squirrels and jack rabbits; poisoning programs have been used to reduce numbers of these species.

Manipulation of the type and length of ground cover at a particular airport should take into account the probable responses of birds and other mammals if both mammal problems and bird problems are to be minimized. The optimal approach would have to be determined on an airport-by-airport basis.

7. RECOMMENDATIONS AND SUGGESTED RESEARCH

Based on all available information concerning mammal problems at airports, it is apparent that quantitative information on mammal problems and causative factors is lacking. In most cases, the numbers of animals involved, the economic costs, seasonal variation, and the relationship of the problem to land use and wildlife distributions in surrounding areas are poorly understood. Part of the lack of information is attributed to the failure of individual airports to report mammal problems. It is recommended that a reporting system, similar to the system used for bird strikes by Transport Canada and the Department of National Defence, be established for documentation of (1) mammal strikes or near-strikes with aircraft, and (2) major damage to airport equipment by mammals (e.g., chewing of cables that results in failure of landing lights).

Methods of control of mammal problems at airports also are poorly documented and further study is required for some methods of control. Suggested areas for study include the following:

1. Develop alternative types of ground cover that (a) are less attractive to ungulates and/or small mammals, and (b), at the same time, do not result in increased bird hazards to aircraft.

2. Assess the effectiveness of animal repellents in minimizing use of airfields by ungulates and small mammals.

3. Determine the susceptibility of different types of cables to damage by mammals and the effectiveness of repellent coatings in reducing damage.

4. Examine the usefulness of physical (particularly electrical) barriers in excluding canids and small mammals from airfields.

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Appendix I. List of persons contacted for information on mammal problems at airports (Affiliation, and the date and type of communication, are indicated.)

J. Allison	Airport Manager, Calgary, Alberta	27/07/81	Interview
P. Bell	Airport Maintenance, Transport Canada, Winnipeg, Manitoba	16/07/81	Interview
R. Boonstra	Associate Professor, Scarborough College, Toronto, Ontario	23/07/81	Interview
F. Caudle	RCMP, Halifax, Nova Scotia	20/07/81	Interview
P. Chan	Canadian Pacific Airlines, Vancouver, British Columbia	29/07/81	Telephone
J. Danch	Security Operation, Transport Canada, Halifax, Nova Scotia	27/07/81	Interview
H. Demers	Airport Maintenance, Transport Canada, Calgary, Alberta	27/07/81	Interview
K. Dodsworth	Department of Lands and Forests, Halifax, Nova Scotia	29/07/81	Interview
M. Dorrance	Problem Wildlife Section, Alberta Environment, Vegreville, Alberta	30/09/81	Telephone
A. Druette	Airport Manager, Transport Canada, Winnipeg, Manitoba	9/07/81	Telephone
F. Dupin	Duty Manager, Pittsburg Airport, Pittsburg, PA	Multiple discussions	Telephone

Continued...

APPENDIX I (Continued).

W. Dutchak	Duty Manager, Transport Canada, Halifax, N.S.	20/07/81	Interview
D. Eslinger	Alberta Fish and Wildlife, Calgary, Alberta	27/07/81	Interview
K. Franzbergen	Operations, Pacific Western Airlines, Calgary, Alberta	Multiple discussions	Telephone
G. Granberg	Manitoba Dept. of Natural Resources, Winnipeg, Manitoba	16/07/81	Interview
W. Gunn	LGL Limited, Edmonton, Alberta	Multiple discussions	Interview
J. Gunson	Alberta Fish and Wildlife, Edmonton, Alberta	30/09/81	Telephone
R. Hagill	Airport Maintenance, Transport Canada, Halifax, Nova Scotia	20/07/81	Interview
M. Harrison	Office of Airport Standards, Federal Aviation Administration, Washington D.C.	27/08/81	Telephone
R. Johnston	RCMP, Halifax, Nova Scotia	20/07/81	Interview
G. Knox	Airport Manager, Transport Canada, Halifax, Nova Scotia	20/07/81	Interview
G. Laidlaw	Agriculture Canada, Ottawa, Ontario	21/07/81	Interview

Continued...

APPENDIX I (Continued).

K. LaVoie	United States Department of the Interior, Denver Wildlife Research Unit, Denver, Colorado	Multiple discussions	Telephone
P. McDonald	Airport Facilities, Transport Canada, Ottawa, Ontario	Multiple discussions	Interview/ Telephone
K. Orser	Airport Maintenance, Transport Canada, Halifax, Nova Scotia	20/07/81	Interview
J. Richardson	LGL Limited, Toronto, Ontario	Multiple discussions	Interview
J. Seubert	United States Department of the Interior, Denver Wildlife Research Unit, Denver, CO	Multiple discussions	Telephone
V. Solman	Formerly with Canadian Wildlife Service, Ottawa, Ontario	21/07/81	Interview
F. Stanislow	Air Traffic Control, Halifax, Nova Scotia	20/07/81	Interview
W. Thompson	Department of National Defence, Ottawa, Ontario	21/07/81	Interview
W. Tucker	Transport Canada, Halifax, Nova Scotia	20/07/81	Interview
D. Walsh	Duty Manager, Transport Canada, Winnipeg, Manitoba	16/07/81	Interview
P. White	Airport Facilities, Transport Canada, Ottawa, Ontario	Multiple discussions	Telephone

Continued...

APPENDIX I (Concluded).

G. Wilson	Air Canada, Dorval, Quebec	27/07/81	Telephone
H. Wilson	Transport Canada, Halifax, Nova Scotia	20/07/81	Interview

Appendix II. Example of wildlife control problem questionnaire.

MEMORANDUM NOTE DE SERVICE

TO / A: APM - Gander

FROM / DE: KFE/A - Ottawa
K1A 0N8

SECURITY CLASSIFICATION / DE SÉCURITÉ

OUR FILE NOTRE RÉFÉRENCE: 5150-31 (KFE/A)

YOUR FILE VOTRE RÉFÉRENCE

DATE: May 19, 1981

SUBJECT / OBJET: Control of Wildlife on Airport Property

We are in the early stages of developing a policy, standards and guidelines manual on the subject of control of wildlife (excluding birds) on airport property.

Inasmuch as your airport staff have had experience with a wide range of wildlife problems (e.g. collisions with aircraft, destruction of electrical cables, etc.) and in the application of various techniques and methods to reduce and control these problems, it would be greatly appreciated if you could have your most knowledgeable staff member complete the attached request for information and return it to this office with a copy to the Regional Manager, Airports by June 30, 1981. For your information, the Regional Manager, Airports has given me his approval to send the attached request for information directly to you.

The proposed solutions to problems of wildlife control may have national application and can be considered as entries to the CATA Suggestion Award Program. If your staff is interested in having the proposals considered for a Suggestion Award, please have them fill out one copy of Treasury Board Form TB/CT 370-10 and attach it to the attached form entitled "Request for Information on Wildlife Control Problems and Proposed Solutions."

Thank you in advance for your assistance and cooperation.

R.B Campbell

R.B. (Bob) Campbell
Chief, Environment Division
Airport Facilities Branch

Attach.

REQUEST FOR INFORMATION ON WILDLIFE CONTROL PROBLEMS AND PROPOSED SOLUTIONS

Re: Wildlife Hazards - Reduction and Control

Airport Name:

Name and Title of
Person Answering
this Questionnaire:

Mailing Address:

Telephone Number:

1. Could you describe from your experience at your own airport or other airports where you have worked, what wildlife (other than birds) are causing problems at CATA airports and also the nature of the problems?

   Example: Wolves eating through electrical cables causing unserviceability of runway lighting units, power failures, etc...

2. If possible please identify:

(a) The cause of each problem described in question one above:

Example: Wolves are attracted to electrical cables due to saline content in protective coating/cable covering.

(b) A possible solution to each of the problems described in question one above:

Example: Physical control such as an airport boundary fence; a hunting and/or trapping program; chemical control such as coating cables with repellents; providing "salt licks" in locations away from operational areas.

3. Could you briefly describe the circumstances and impact of the most serious wildlife incident on your airport or in your experience? If an incident report exists a photocopy would be helpful.

PLEASE RETURN QUESTIONNAIRE TO:

Mr. W. Paul McDonald (KFEI/A)
20th Floor, Area F
Transport Canada Building
Place de Ville
Ottawa, Ontario
K1A 0N8