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Wildlife management practices at western Canadian airports

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A B S T R A C T

A survey of 38 airports in British Columbia, Alberta and Saskatchewan, Canada, is used to document and explore differences in use of Airport Wildlife Management Plans; common wildlife attractants; wildlife countermeasure usage and outcomes; and animal strike record keeping systems. Hazardous activities and practices for managing waste and agricultural crops commonly occurred within 8 km of airports, but also occasionally airside or groundside. Maintaining long grass was the most routinely used countermeasure, but there are conflicting responses regarding the most appropriate grass length to deter wildlife. Removal of diverse habitat had the highest success ranking among listed countermeasures. Over 75% of airports kept strike records, but less than 7% used them to measure the outcomes of countermeasure implementation.

1. Introduction

The risk of aircraft collisions with wildlife (animal strikes) is increasing as air traffic grows. Contributing factors include increases in high hazard bird populations, increases in air traffic volumes, the use of quiet two-engine aircraft, plus the restriction of open space environments suitable for birds outside of airports due to urban encroachment. Highly publicized events, such as the crash of US Airways Flight 1549 into the Hudson River when departing LaGuardia Airport, New York City because of a goose strike in January 2009, have added to the public concern. To ensure that airports are prepared to recognize and mitigate wildlife hazards at airports, the *Canadian Aviation Regulations* (2006), require the development, implementation and maintenance of Airport Wildlife Management Plans (AWMPs) at Canadian airports that meet the criteria contained in the amended regulations.

2. Background

A variety of countermeasures (CMs) have been used in an attempt to reduce the risk of animal strikes. CMs are grouped into active (both non-lethal and lethal) and passive techniques. Active techniques involve excluding, dispersing, or removing animals (either dead or alive) while passive techniques generally employ some form of habitat modification. Many active, non-lethal countermeasures intended to harass and disperse animals have been tested, including the use of dogs; pyrotechnics, noisemakers, bioacoustics, bird distress and alarm calls; sonic and ultra sonic devices; predator urines and other odor based repellents; hand held Class II and III laser devices; live trapping; live capture and relocation of deer; raptor relocation; nest removal; and restriction of nesting sites.

Fences are the most important tool to control mammals at airports with recommended heights between 3.0 m and 3.7 m, and configurations employing barbed wire, razor wire, outriggers, and Electrobraid deer fencing. A successful integrated approach to animal management includes lethal control. However, airport managers must ensure that animal suffering is minimized and concurrently eliminate attractants while implementing lethal control measures in order to provide a long-term solution. Culling remains an immediate but short term animal management technique. A zero tolerance policy for deer and other large mammals in airport operating areas has been recommended by Cleary and Dolbeer (2005). Lethal control has also been used to curtail populations of coyotes (which chew electrical lines), rodents (which attract predators) and bird populations. Although expensive and with some operational limitations, falconry can be effective for controlling birds. The Falco Robot GBRS, a natural looking, remote controlled flying device, has also been tested with some success (Iori et al., 2009).

The management of habitat on and adjacent to airports is an effective, long-term passive control countermeasure. Rendering habitat unattractive to animals and reducing habitat diversity leads to reduced animal populations thereby reducing risk. The

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importance of habitat management is widely recognized and it is incumbent upon airport management to ensure that government leaders make appropriate and informed zoning and construction approval decisions on lands adjacent to airports (Gallaher, 2003).

Some examples of habitat management include planting unpalatable vegetation and managing wetlands on or adjacent to airport lands to render them inaccessible or unattractive to animals. Wetland management strategies include eliminating water bodies; clearing water bodies of vegetation and maintaining a 4:1 bank slope; erecting physical barriers to reduce access to water; maximizing water dispersal; and controlling water depth.

The management of landfills, sewage lagoons, waste transfer stations and waste disposal sites on and adjacent to airport property is critical. Recommendations include fully enclosed buildings; installation of perching deterrents; frequent inspections for loose debris; minimizing odor; the removal of waste disposal sites on airport grounds and conducting any disposal activities at night; prohibiting animal and bird feeding at airports; and education programs for cab drivers to reduce gull feeding. Currently, waste disposal clauses are attached to zoning regulations at 55 airports in Canada (Transport Canada, 2004).

Agricultural crops and practices on or adjacent to airports can pose significant risk to airport operations. Transport Canada (2008) recommends that airport managers work with landowners to reduce the risk, and that any leased agricultural land on airport property be managed carefully. A risk analysis carried out for Ohio State University Airport recommended that agricultural practices on airport lands be terminated (US Department of Agriculture, 2002).

Efforts to assess the height at which to maintain airport grassed environments has produced conflicting results. Transport Canada (2006) concluded that long grass programs could be implemented to reduce gull populations; however, rodent populations could increase, leading to an increased raptor presence. However, short grass seems to discourage Canada goose nesting and reduces rodent populations and therefore raptor populations. Beason (2004) indicates that birds show a species-specific response towards vegetation height. Ultimately, Transport Canada recommends that each airport conduct site-specific studies to determine optimal grass heights, depending upon which hazard species are present.

Developing record keeping systems for animal strikes, animal monitoring and animal control activity monitoring has been discussed by the US Department of Agriculture (2002), Transport Canada (2006), European countries (Dekker and Buurma, 2005), and Australia (Eschenfelder, 2003). All concluded that animal strike records should be kept and maintained by airport authorities. Additionally, there is a need for increased and more detailed reporting because less than 20% of animal strikes are reported to aviation authorities, leading to a poor understanding of wildlife threats (Wright and Dolbeer, 2005).

As part of a larger, long-term animal-airport interaction study involving Prince George Airport (YXS), we found a lack of data on how airports were implementing the various recommendations found in the professional literature on controlling wildlife risk. We therefore conducted a study to document practices and procedures at airports in western Canada regarding AWMPs and animal strike record keeping; attractants commonly found on and adjacent to airport grounds; animal control countermeasure use and efficacy; and animal strike trends.

3. Method

We conducted an online survey of airports in western Canada to determine the use of AWMPs; animal attractants; usage and outcomes of animal control countermeasures; and animal strike recording systems. The survey was designed only to document and explore the responses of airport professionals to the topics. We made no initial assumptions or hypotheses about these topics or any causal relationships that might exist among them. We followed the guidelines and recommendations of American Association for Public Opinion Research (2008) and Johnson and Owens (2003) for survey procedures, response rate calculations, and data analysis.

We used an electronic survey website to collect, sort and summarize survey responses. Both open-format questions, which required narrative-style answers in point form or sentences, and closed-format questions, which included dichotomous answers, multiple choice, free choice, ranked and rated choices were posed.

The survey comprised three sections: the introduction contained navigational instructions, free and informed consent information, and definitions of survey terms; the main body contained questions on specific airport management practices; and the concluding section asked for referrals to other airport animal management experts, and contact information if the respondent wished to be provided with the survey and research project results. To assess the user-friendliness of the electronic survey website, and the clarity of instructions and questions, we conducted a survey pretest.

The air transportation industry commonly uses the word wildlife in such terms as wildlife strike, wildlife hazard, wildlife control, and Airport Wildlife Management Plan. However, strikes, near misses, hazards, control activities and sightings at airports can involve both wild and domestic birds and mammals, as well as reptiles and amphibians. Therefore, in our survey we used the term animal, defined in the survey introduction as any wild or domestic terrestrial vertebrate. This included birds, mammals, reptiles or amphibians. We used the term animal strike to refer to both bird and mammal strikes, and we used the term animal control instead of wildlife control.

We followed Transport Canada (2004) conventions in defining a hazard as "the conditions or circumstances that could lead to damage or destruction of an aircraft, or to loss of life as a result of aircraft operations. Risk is defined as the consequence of a hazard, measured in terms of likelihood and severity".

During May and June 2007, we conducted an Internet search and developed a preliminary list of airports in British Columbia, Alberta and Saskatchewan to form the target population. Where possible, we contacted each airport by email. If no airport contact information was found, we emailed the corresponding municipal administration office with a request to forward the message to appropriate airport staff. We asked airport staff if they had encountered any issues with animal strikes or with animals interfering with runways and if they would be willing to remain in contact with us. We made phone calls and emails between June 26 and July 26, 2007.

We prescreened and classified airports based on this initial contact. We defined airports as eligible and included them in the target population even if their initial emails were returned due to email delivery failure or there was no readily available contact information. Airports with less than 12 flights per year, used solely for training activities, or private airports, were defined as ineligible and excluded from the target population. The final sample consisted of 76 British Columbia, 31 Alberta, and 17 Saskatchewan airports.

From January 14 to 28, 2008, we phoned or emailed each airport and asked the contact person to identify the staff expert in animal management issues. We advised the staff expert of our research project on airport animal management practices and invited them to participate in an online survey. If the person agreed to participate, we defined the airport as eligible, and asked the animal expert

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to complete the survey online via a link. If the person we were speaking to was not the animal expert, then we asked them to forward the survey to the person in their organization who was most knowledgeable in animal control at airports. If the contact person declined to participate, we still defined the airport as eligible and it remained in the sample population. We sent one follow-up email on February 22, 2008 and the online site closed on February 29, 2008.

The responses to each question were summarized as the number or percentage of respondents that selected each option or category. The percentages were calculated as the number of responses per category divided by the number of respondents to that question. Percentages given for different questions may be based on different totals if the number of respondents per question differed. Also, several questions allowed more than one response, resulting in the sum of the percentages in the categories adding up to more than 100%. We defined the most effective CMs to reduce animal strikes as those where over 70% of users had ranked the treatment outcome as successful or very successful.

We calculated the response rate according to the American Association for Public Opinion Research guidelines that define the eligible sample population to include the number of airports that were contacted and did not wish to participate, plus the number of airports for which contact information was not readily available, plus several other additional categories.

4. Results

Of 124 eligible airports, 40 declined to participate, and 26 airports had either invalid or missing email addresses. Of the 58 airports with whom we made direct contact, 65.5% accessed the online survey and submitted eligible data. There were 19 participating airports from British Columbia, 10 from Alberta and 10 from Saskatchewan. The RR4 response rate according to American Association for Public Opinion Research (2008) was 30.6%. Some airports did not answer all the questions, or did not answer all parts of the questions, resulting in variable sample sizes within and between questions.

Based on the responses, 21.1% of the airports self identified as national, 42.1% as regional and 36.8% as small airports. There were no remote or satellite airports. Of the respondents, over 70% replied that the airport did have an AWMP, 26.3% that they did not, with the remainder uncertain. By airport classification, all national airports, over 80% of regional airports, and 42.9% of small airports had an AWMP.

Airports were asked to identify which wildlife attractants were present airside, groundside, or within 8 km of the airport boundary (Fig. 1). Natural food sources were the most common attractant found, followed by ditches, ground cover, and nesting areas.

No landfills and waste transfer sites were located either airside or groundside, but 50% of airports reported waste transfer sites and 65.8% reported landfills within 8 km of the airport. Airports also identified open waste-water treatment sites airside, groundside, and within 8 km. Sewage lagoons were found on airport property and within 8 km of the airport. Waste storage sites were found airside, groundside, and within 8 km of the airport.

Airport respondents were asked to identify which listed animal control countermeasures had ever been implemented at their airport. Both passive and active CM techniques were employed by the 35 responding airports (Table 1). The most frequently used CMs were: special mowing regimes to keep grass length over 15 cm high; noise harassment to disperse birds; sharp shooting to remove pest animals or birds; and removal of diverse habitat to discourage animal use. CMs least employed were erecting electric fencing, falconry, and placing grates over streams or ponds.

Those surveyed were asked to rank the outcomes of CM treatments employed at their airports (Table 2). CMs where 100% of users ranked the outcome as successful or very successful were the use of dogs and influencing water management with 8 km of the airport, which had been employed by 5 and 2 respondents,

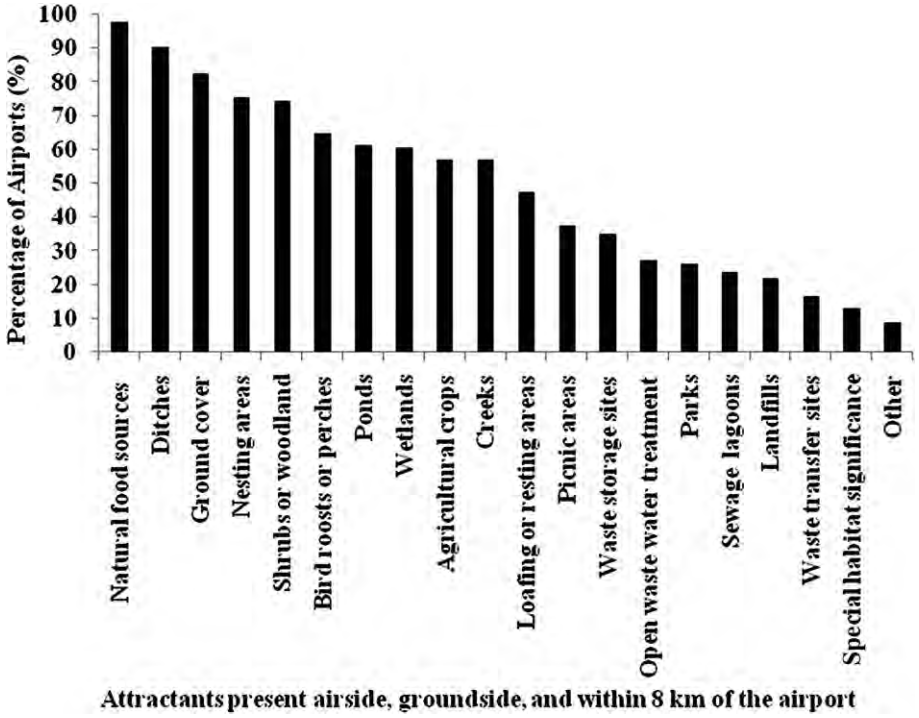

Fig. 1. Percentages of western Canadian airports indicating the presence of animal attractants either airside, groundside, or within 8 km of the airport boundary, February 2008. Note: the data covers 14 small airports, 16 regional airports, 8 national airports. Respondents could select more than one attractant.

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Table 1
Percentages of western Canadian airports that reported using various CMs at their airports, February 2008.

Countermeasure	Percentage of Airports Using Each Countermeasure		
	Yes (%)	No (%)	Don't Know (%)
Use of Active Non-Lethal Control Methods			
Noise harassment	65.7[a]	34.3	0
Erecting non electric fencing	48.6	51.4	0
Light harassment	42.9	54.3	2.9
Nest removal	34.3	65.7	0
Live trapping	22.9	74.3	2.9
Chemical repellents on vegetation	18.2	81.8	0
Dogs	17.1	82.9	0
Chemicals on perching, nesting or roosting areas	11.4	88.6	0
Adding additional buried apron fencing	2.9	94.3	2.9
Erecting electric fencing	2.9	97.1[a]	0
Use of Active Lethal Control Methods			
Sharp shooting	54.3[a]	45.7	0
Poisoning	40.0	57.1	2.9
Trapping	22.9	77.1	0
Falconry	2.9	97.1[a,b]	0
Use of Passive Control Methods			
Maintaining long grass	68.6[a]	28.6	2.9
Removing shrubs, brush or diverse habitat	54.3[a]	42.9	2.9
Managing waste products	42.9	57.1	0
Removal of perching, nesting or roosting areas[b]	41.2	57.1	0
Draining water accumulations	37.1	60.0	2.9
Removing entry points to buildings	25.7	65.7	8.6
Sweeping runways for worms	25.7	68.9	5.7
Influencing agricultural practices within 8 km	22.9	77.1	0
Restricting access to water (grates, wire grids etc)	22.9	74.3	2.9
Preventing visible run off[b]	20.6	73.5	5.9
Influencing landfill practices within 8 km	17.1	82.9	0
Influencing water management within 8 km[b]	5.9	88.2	2.9
Planting unpalatable vegetation[b]	5.9	94.1	0
Placing grates over streams or ponds	2.9	97.1[a]	0

[a] Highest percentage responses.
[b] Countermeasures with 34 users; all other countermeasures were used by 35 respondents.

respectively. CMs where outcomes were indicated as successful or very successful by over 70% of users included removing shrubs, brush or other diverse habitat, managing waste products, and removing perching, nesting or roosting areas, employed by 19, 14 and 15 users. The following CMs were ranked by only one respondent as having unsuccessful or very unsuccessful outcomes: influencing agricultural crop practices within 8 km; trapping; light harassment; erecting non electric fencing; and noise harassment. About one respondent per CM answered that they did not know the outcome of the implemented CM.

Airport respondents were asked to state how they determined if CMs implemented at their airport were successful. CM outcomes were assessed 271 times by the airports (Fig. 2). CM implementation outcomes over all airport classifications were assessed using record keeping systems 6.6% of the time, using reports from pilots and staff 34.7% of the time, and using past experience over 40% of the time.

Based on 34 survey responses, over 80% of airports implement specific grass management practices. None of the responding 8 small airports left their grass long as a method to discourage animal or bird use, while 50% of the six national airports and 14.3% of the 14 regional airports did leave their grass long, primarily intending to discourage gull and goose usage. The two most common grass mowing practices, each reported by 32.1% of respondents, were: all practical areas were mowed regularly, but the height to which they were mowed was not specified; and the grass was kept short, either to reduce nesting or reduce rodent populations. One small and 2 regional airports only cut their grass once per year.

When asked if their airport kept records of animal strikes or near misses, 76.3% replied that they did keep records. All national airports reported keeping records. The vast majority of regional airports but less than half of small airports reported keeping records. The airports that did not keep records did provide some explanatory comments. Four small airports reported not keeping a system as they had no reported strikes. One regional airport reported that they "Do not have a system in place". Another small airport respondent replied that they had a "Lack of information about implementing a strike reporting system".

Airports were asked to describe the reporting and recording method used for animal strikes or near misses. Eleven airports used only the Transport Canada record keeping system (Form #51-0272); nearly half used both the Transport Canada system and an alternate system; and less than 10% used a system other than the Transport Canada system. One regional and five small airports stated that they did not use an animal strike record keeping system at all.

When asked to describe animal strikes or near miss trends over the past five years, 7.9% of airports replied that the number of strikes or near misses were increasing; over 20% responded that the numbers were decreasing; 47.4% responded that the numbers were staying the same; and 23.7% did not know.

5. Discussion

Eight regional airports and two small airports stated that they did not have a draft or approved AWMP in place. However, depending upon the level of risk at each airport, this may not be needed if a risk assessment has determined that low risk conditions exist (based on the criteria of *Canadian Aviation Regulations Section Sec 302.302(1)*). It is not known whether the ten airports had carried out the appropriate assessment.

One national airport respondent described the airport environment as "An island within an urban landscape. The area provides habitat, food and water and is virtually predator free." Mitigating the hazard caused by attractants most often involves manipulating the habitat and restricting access to the attractant, but can also mean changing land use patterns, activities and practices. Mitigating attractants and management of animals on airports is an ongoing activity. As one respondent replied "Wildlife management itself is an oxymoron. The exercise is one of due diligence and resource allocation. Expectations must also be managed, particularly those of the regulator and user. The risks can only be dealt with, not eliminated".

Airside or groundside attractants are under the jurisdiction of the airport, and more easily managed than attractants located outside airport boundaries. Onsite animal management can be rendered ineffective by off-airport attractants. For example, one airport manager reported as their biggest issue a Ducks Unlimited pond managed for habitat within 8 km of the airport. The manager noted "At this point in time, I don't mind them being there, if they don't mind me doing very aggressive bird control on my side of the fence".

The *Aeronautics Act*, *Section 5.4(2),* provides the authority to enact airport zoning regulations that prohibit land uses adjacent to airports deemed hazardous to aircraft operations, including land uses that increase bird hazard. Transport Canada has identified bird hazard zones within radii of 8 km and 3.2 km of specified airport reference points and within these zones specific activities and practices that attract animals are designated as extremely or moderately hazardous and are not recommended.

The recommendations have not solved wildlife management issues. Waste management areas, for example, are classed as extremely hazardous and are not recommended within 8 km of the

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Table 2
Percentages of western Canadian airports ranking the success of CMs used at their airports, February 2008.

Countermeasure	Respondents Using Countermeasure	Success Ranking					
		Very Successful and Successful	Somewhat Successful	Neutral	Somewhat Unsuccessful	Unsuccessful and Very Unsuccessful	Don't Know
Active Non-Lethal Control Methods							
Noise harassment	22	59.1	22.7	9.1	0	4.5	4.5
Erecting non electric fencing	17	52.9	29.4	0	5.9	5.9	5.9
Light harassment	16	50.1	31.3	6.3	0	6.3	6.3
Nest removal	11	45.5	45.5	9.1	0	0	0
Live trapping	8	37.5	25	12.5	12.5	0	12.5
Chemical repellents on vegetation	6	33.3	33.3	16.7	0	0	16.7
Dogs[a]	5	100	0	0	0	0	0
Chemicals on perching, nesting or roosting areas	4	25	25	0	25	0	25
Adding additional buried apron fencing	2	0	50	0	0	0	50
Erecting electric fencing	2	0	50	0	0	0	50
Active Lethal Control Methods							
Sharp shooting	17	64.7	23.5	11.8	0	0	0
Poisoning	15	40	60	0	0	0	0
Trapping	9	66.7	11.1	0	0	11.1	11.1
Falconry	2	50	0	0	0	0	50
Passive Control Methods							
Maintaining long grass	23	60.9	21.7	8.7	0	0	8.7
Removing shrubs, brush or diverse habitat[a]	19	89.4	5.3	0	0	0	5.3
Removal of perching, nesting or roosting areas[a]	15	73.3	20	0	0	0	6.7
Managing waste products[a]	14	85.7	7.1	0	0	0	7.1
Draining water accumulations	13	53.9	15.4	7.7	0	0	23.1
Removing entry points to buildings	9	66.6	22.2	0	0	0	11.1
Restricting access to water (grates, wire grids etc)	9	66.6	11.1	0	0	0	22.2
Sweeping runways for worms	9	55.5	22.2	11.1	0	0	11.1
Influencing agricultural crop practices within 8 km	9	33.3	44.4	0	0	11.1	11.1
Preventing visible run off	6	56.7	16.7	0	0	0	16.7
Influencing landfill practices within 8 km	5	20	20	20	0	0	40
Planting unpalatable vegetation	4	25	50	0	0	0	25
Influencing water management within 8 km	2	100	0	0	0	0	0
Placing grates over streams or ponds	2	50	0	0	0	0	50

[a] Indicates more than 70% of respondents reported very successful or successful outcomes for the selected countermeasures.

airport reference point, yet waste storage sites, waste transfer sites and landfills were all reported within such a radius. Sewage lagoons are classified as moderately hazardous and yet 52.6% of responding airports reported one within 8 km of their reference point. Airports reporting waste management sites, sewage lagoons and ponds on or nearby should be addressing their risk and attempting to influence these land use practices, but only 17.1% of respondents have been active in land use discussions about nearby landfill practices.

Airports often make poor land use choices. Lands inside and outside of airports can be leased for agricultural production as a source of revenue for the airport authority. Respondents noted

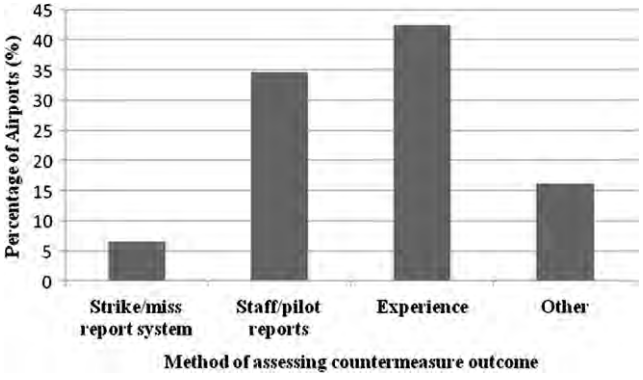

Fig. 2. Percentages of western Canadian airports indicating method of assessing CM outcome, February 2008. Note: Countermeasures were assessed 271 times by 36 respondents.

agricultural crops airside at 50% of airports, groundside at 39.5% and within 8 km of the airport reference point at 81.6%. Despite the possibility of extreme risk, depending upon the specific crop, less than a quarter of airports have attempted to influence adjacent agricultural crop management. Because agricultural crops can vary in the hazards posed to aircraft operations, depending on the type of crop, agricultural practices implemented, and distance from the airport, the airport needs to address the specific risks posed by the agricultural crops present.

The most commonly used CMs reported were maintaining long grass, noise harassment, removing shrubs, brush and other diverse habitat, sharp shooting, and erecting non electric fencing. Some CMs continue to be used year after year, while others are a onetime effort entailing only annual checks or maintenance. Of the most commonly used CMs reported in the survey, maintaining long grass, noise harassment and sharp shooting require repetition. Removing diverse habitat and erecting non electric fencing are onetime efforts. However, as one respondent from a national airport noted "Wildlife control is an ongoing problem and conditions have to be continually monitored and your program has to be changed to adapt to these changes. There is not a single answer to wildlife control. Each site is different and each individual site changes from year to year".

Airport environments usually contain large grassed areas, and while functional and easy to maintain, Transport Canada (2004) states that "grass is likely the dominant bird-attracting feature at airports." Our findings show a discrepancy between responses to two separate questions about grass maintenance. The first asked "Has your airport maintained long grass?" Of 35 responses, over two-

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thirds of responses were yes. In contrast, in reply to the second question, "Does your airport carry out any specific grass mowing practices intended to discourage animal or bird use of grassed areas?" of 28 responses, only less than 20% responded that they left their grass long, primarily to discourage gulls and geese. Based on our responses, the CM with the combination of 19 users and a high success ranking was removing shrubs, brush and other diverse habitat. Maintaining long grass and noise harassment, although used by more respondents, 23 and 22 respectively, had lower success rankings than removing diverse habitat. When airports were asked to state the method by which they assessed the outcomes of their CM, anecdotal methods such as reports from staff and past experience were used more often than referring to a strike reporting system.

Bird Strike Committee Canada adopted a bird strike definition which is contained within *CARs 302.303(1)* and *(2)*. Strikes involving other animal types (in Canada, primarily mammals) are interpreted less formally, but follow the intent of the *CARs 302.303(1)* and *(2)* definitions (Transport Canada, 2004). *CARs 302.303(1)* requires that all airport operators keep records of all animal strikes and *CARs 302.303(3)* further requires airport operators to either report each strike within 30 days of occurrence, or report all strikes annually. Transport Canada does not possess the regulatory authority to compel strike reporting, but can assess financial penalties if reporting is not carried out in accordance with *CARs 302.303(3)*.

Although the majority of airports did keep strike records, eight small and one regional airport did not. We did not determine if this lack of animal strike record keeping at small airports is due to airport managers being unaware of the regulatory requirements and reporting procedures, or if it is the result of having no strikes to report and the subsequent perception that there is no need for a record keeping system.

All national airports were able to describe trends in strikes or near misses. Of the small and regional airports who stated that they did not know if animal strikes or near misses were increasing or not, two regional airports had previously responded to survey questions indicating that they did keep records of strikes or near misses; therefore it is not known why they would be unable to answer this question. Without this basic knowledge of strike trends, airports are unable to assess if *CARs 302.302(1)* criteria apply to them; carry out risk assessments and analysis; or identify and manage hazard species appropriately.

When asked how the change in strike trends was determined, all the national airports relied on past records while small airports appear to be relying on their best estimates and experiences. The use of experience rather than record keeping is also demonstrated by the responses to the question on CM outcomes, when the results of animal control projects were determined, by all airport categories, largely by anecdotal methods based on experience, rather than supported by data from record keeping systems. This suggests that there is a significant gap in accurate data that could lead to poorly informed practices as well as to a false sense of security on the part of many small and regional facilities.

Of further concern are the management consequences of incomplete or poorly maintained records. Records of strikes, animal activity monitoring and animal control activity logs should be maintained at *CARS* mandated airports. Responses to questions regarding CM outcomes and strike records and trends suggest that appropriate records may not always be maintained.

6. Conclusions

Our findings suggest that airports in western Canada are working hard to uphold high standards in animal management planning, but that still more can be done to increase safety. Canada has been a world leader in contributing to the understanding of airport and animal interactions, and the development of management techniques to address these challenging issues. Continued diligence in research, animal monitoring, meticulous record keeping, and relevant, site-specific countermeasure implementation as well as adaptive management will ensure safer airports for pilots, air travelers and animals alike, both now and in the future.

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References

American Association for Public Opinion Research, 2008. Standard Definitions: Final Disposition Codes and Outcome Rates for Surveys, fifth ed. AAPOR, Lenexa.

Beason, R., 2004. New Technologies to Deter Wildlife from Airports and Aircraft. US Department of Agriculture. Animal and Plant Health Inspection Service. Wildlife Services, Columbus.

Cleary, E.C., Dolbeer, R.A., 2005. Wildlife Hazard Management at Airports. A Manual for Airport Personnel. 2nd edition. Federal Aviation Administration. U.S. Department of Transportation.

Dekker, A., Buurma, L., 2005. Mandatory Reporting of Bird Strikes in Europe Who Will Report What to Who? In: Proceedings of the International Bird Strike Committee. 27th Annual Meeting. 23–27 May, 2005, Athens, Greece.

Eschenfelder, P., 2003. Mandatory reporting – the time has come. In: Proceedings of the International Bird Strike Committee, 26th Annual Meeting, 5–9 May, 2003, Warsaw, Poland.

Gallaher, P.A., 2003. The Airport Environment and Its Effect on Wildlife Damage to Aircraft. Thesis. Embrey-Riddle University.

Iori, P.A., Montemaggiori, E., Fernandez-Juricic, 2009. Responses of Gulls to a Remote Control Operated Hawk Model: implications for Bird Strikes. In: Bird Strike Committee-USA/Canada 11th Joint Meeting, 14–17 September, 2009, Victoria, British Columbia, Canada.

Johnson, T., Owens, L., 2003. Survey Response Rate Reporting in the Professional Literature. In: 58th Annual Meeting of the American Association for Public Opinion Research, Nashville.

Transport Canada, 2004. Sharing the Skies: an Aviation Industry Guide to the Management of Wildlife Hazards (TP13549E). Ottawa.

Transport Canada, 2006. Airport Wildlife Management. Bulletin No. 37. Airport Wildlife Management, Ottawa.

Transport Canada website, 2008. Template for the Development of an Airport Wildlife Management Plan. http://www.tc.gc.ca/CivilAviation/AerodromeAirNav/Standards/WildlifeControl/menu.htm Transport Canada, Standards Branch, Aerodromes and Air Navigation Division, (accessed 25.08. 08.).

US Department of Agriculture, 2002. Wildlife Hazard Assessment for Ohio State University Airport, Columbus, Ohio (February 2001–January 2002). Animal Plant Health Inspection Service, Wildlife Services. Cooperative Service Agreement No. 01-72-39-3113-TF.

Wright, S.E., Dolbeer, R.A., 2005. Percentage of Wildlife Strikes Reported and Species Identified under a Voluntary Reporting System. In: Bird Strike Committee-USA/Canada 7th Annual Meeting, Vancouver, British Columbia.

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