ECONOMIC TOOLS FOR MANAGING IMPACTS OF URBAN CANADA GEESE

NICOLE H. MCCOY

Abstract: Management of urban Canada geese impacts can be assisted by the use of economic analyses of both the problem and the proposed solution. Management of a species that is both geographically mobile and stationary, protected by the Migratory Bird Act of 1918, and loved by much of the public while posing a significant risk of damage to both private and public property is a difficult task. The issue is further complicated by the scope and scale of urban goose impacts. While the presence of urban Canada geese results in both positive and negative impacts, this paper will focus primarily on the management problems involving overabundance and concentrated populations. The many negative impacts caused by Canada geese may occur at a "lawn" level, or be aggregated into a "community" level. Management actions that solely focus on the "lawn" level may shift the problem to other parts of the community. Economic analysis provides a venue for management strategies, either individually or in aggregate, to be evaluated in a common time frame that accounts for their real costs and resulting benefits. Three economic techniques can be used to evaluate management strategies at any geographic level: economic feasibility, economic efficiency, and cost-effectiveness analysis.

Key words: Canada goose management, cost-effectiveness, efficiency, feasibility, wildlife economics.

Since the 1960s and 1970s, Canada goose (*Branta canadensis*) populations have increased substantially throughout North America (Conover and Chasko 1985, Trost and Maleki 1985, Smith et al. 1999). Canada geese have been found in each of the 50 states and throughout Canada and Mexico (Cleary et al. 2000). Sauer et al. (2000) estimates that between 1966 and 1999, resident Canada goose populations in the United States increased at a mean annual rate of 13 %. In 1998 there were over 2 million resident Canada geese in the United States (Alge 1999). As these populations have grown, their impacts on urban and suburban communities have likewise increased (Laycock 1982, Conover and Chasko 1985).

Managing Canada geese is, by any estimation, a difficult task. While geese fall under the jurisdiction of the U.S. Fish and Wildlife Service, their mobility, protection under the Migratory Bird Treaty Act (MBTA) of 1918, and use of a variety of private, state, and federally owned natural and artificial habitats results in both a breadth and depth of impacts that are difficult to mitigate at an effective level. Economic analysis of urban goose management strategies can assist resource agencies, local governments, and public interests in achieving an optimal or desired level of control. This paper will address the scope and scale of the goose management problem and will demonstrate how management programs can be evaluated on the basis of their economic feasibility, efficiency, and effectiveness.

It is important to recognize that Canada geese are not inherently economically or environmentally bad. Although many of the impacts resulting from geese are detrimental, the birds themselves are not undesirable, and in fact, are recognized as providing a significant number of public benefits. The benefits of geese in urban areas include the aesthetic value of the presence of wildlife in an urban area, public enjoyment from viewing and feeding geese, the role geese play as a component of the urban ecosystem, and the food they may provide to some human residents, other wildlife, and domestic pets.

Because Canada geese provide a significant benefit, economic analyses of management strategies should address reducing the damages caused by geese while simultaneously maintaining healthy and viable populations that allow the beneficial impacts of the geese to continue. Nevertheless, because the current principal concern for managing existing goose populations relates primarily to their negative impacts, this paper focuses on managing those impacts under the implicit assumption that the benefits of Canada goose presence are maintained under any management strategy (economic efficiency analysis, discussed later in this paper, expects that these benefits will be included in the analysis).

IMPACTS OF URBAN CANADA GEESE

The negative impacts of goose presence in urban/suburban areas have been addressed by numerous authors and are presented in syntheses in a number of documents. However, as this paper does address managing these impacts, a brief discussion of the problem is included. Management issues regarding Canada geese are further divided into two groups, the scope of the impacts and the scale of the problem.

Canada geese adapt easily to urban environments, often moving into urbanized areas because the grassy, open, park-like spaces with plenty of water are excellent goose habitat (USDA 1999). Additionally, human presence provides protection from many natural predators. Some goose populations have become so

comfortable in urban environments that they are year-long residents of the area and no longer migrate with the change in seasons. As a result, parks, golf courses, lawns, and gardens may become inundated with geese.

Scope

Negative impacts of goose overabundance include threats to human health from high fecal coliform (e.g., *Escherichia coli*) levels and other pathogens including *Crpytosporidium parvum*, *Giardia lambia*, and *Salmonella* spp. (USDA 1999). These threats have resulted in the closing of some public beaches during times of elevated levels of these disease-causing agents. High nutrient levels from fecal droppings in or near water have contributed to the eutrophication of fresh water areas (Manny et al. 1994). Impacts of Canada geese also include injuries to humans from goose attacks and from slipping in goose fecal matter.

Property damage, in the form of overgrazed lawns and landscaped areas, is a significant problem with geese as is the resultant soil erosion. Many of these impacts may have secondary ramifications, including public avoidance of parks, golf courses, and beaches, and the resulting potential for public overuse of non-goose infested areas.

One of the most significant and worrisome negative impacts of goose presence in urban areas is the threat of bird strikes to aircraft. The use of increasing numbers of aircraft combined with expanding Canada goose populations results in significant risks to human safety and property. Bird strikes cause an estimated 7 fatalities and US$245 million damage to civilian and military aircraft each year (Linnell et al. 1996). From 1988-1998, a total of 117,000 hours of aircraft downtime and over US$80 million in damages were caused by bird strikes to civil aircraft in the United States (Cleary et al. 2000). Of these strikes, approximately 6 % were attributed to geese. While this represents a relatively small amount of total bird strikes to aircraft, the large size of Canada geese (8-15 lb) results in their being responsible for 27% of aircraft downtime, 24% of direct damage costs, and 43% of total related costs (Cleary et al. 2000). One of the most frequently cited cases of damage and loss of human life resulting from Canada geese was in 1995 when a U.S. Air Force Boeing 707 E-38 AWACS jet ingested at least 13 geese upon takeoff. The US$184 million aircraft crashed, killing the entire 24-person crew (Smith et al. 1999).

Finally, concentrated Canada geese populations may threaten the health of other wildlife, especially waterfowl. For example, Influenza A viruses and avian tuberculosis outbreaks are exacerbated by dense populations of waterfowl (including Canada geese) (USDA 1999).

Scale

A problem somewhat unique to the management of Canada geese is the scale at which the above-listed impacts occur (Aguilera et al. 1991). While many of the impacts caused by geese occur at a small geographic scale, or "lawn" level, the aggregation of these impacts occurs at a larger scale, such as a "community" or even "regional" level. Using an appropriate scale of management is critical for an accurate economic analysis so that all relevant costs and benefits of a given action are incorporated into the evaluation. For example, while city park ponds may be experiencing high fecal coliform levels from a concentrated population of Canada geese, a nearby airport may be at risk of goose strikes to aircraft. Management activities that are designed to discourage geese from using the city park may, in fact, encourage a higher goose presence at the airport. An economic analysis that evaluates only the costs and resulting benefits of a management action at a city park could ignore a significant external cost that is being borne by the airport.

Problem urban waterfowl task forces have had some success in managing Canada goose populations at the community level. A task force in Reno, Nevada, worked to both resolve airport problems and to decrease other urban impacts associated with Canada geese (Smith et al. 1999). However, the success of such task forces requires both the active participation of all affected parties and the legal and budgetary authority to carry out the program. Because multiple jurisdictions impacted by geese may have different levels of involvement and varying commitments to the program, coordinated management at a large scale may be prohibitively difficult. As a result, many urban Canada goose management actions occur at smaller scales. Even though broader impacts should be evaluated whenever possible, this paper recognizes the operational constraints inherent in Canada goose management and presents economic tools that can be applied at any geographic scale (although they will be best applied at a scale that appropriately accounts for all relevant costs and benefits).

REQUIRED INFORMATION

To complete any economic analysis of a management action, several pieces of information are required: (1) project costs, (2) project benefits, and (3) value of the benefits.

Project Costs

The costs of a Canada goose management program will include any relevant capital and labor expenditures made to complete the project. These costs

include both initial investments and operating costs incurred over the life of the project. Costs will be problem-, goal-, and program-specific. For example, if a manager identifies a problem of goose overabundance on a golf course, feasible courses of action may differ than if the problem is goose overabundance on an airfield. Costs will also be goal-specific. Is the goal to reduce a resident goose population by 20 %, to minimize the risk of disease transmission to humans, or to minimize the costs of damage and the expenditures made to mitigate that damage? Once the goal is established, there will likely be a number of ways a management program could seek to achieve its objectives. For example, managers with a goal of reducing a Canada goose population might employ one or more strategies to achieve this goal, including, habitat modifications, hazing, repellents, contraceptives, and lethal control.

Other relevant costs which may be more difficult to dollar-quantify but should be addressed are secondary impacts such as the loss of other wildlife species due to hazing techniques or habitat changes designed to discourage geese. An additional significant cost which should be considered is the expense of both time and money spent managing public response to a management action. Given the visibility of Canada geese, their near demise in the early twentieth century, and public affinity for the species, managers must consider the social, political and legal costs of any management action. Lawsuits, bad press, and loss of public support can turn an economical alternative into a prohibitively expensive endeavor.

Project Benefits

Because most urban Canada geese problems are caused by their overabundance, the benefits of a management program can be measured in terms of damage averted. This measurement is different from many wildlife projects in which benefits may be calculated in terms of improved habitat or more robust populations. Damage averted is a reduction in an undesirable impact resulting from a management action. Damage averted is calculated by subtracting the undesirable impacts in the presence of the management action from the undesirable impacts without the management action. This calculation recognizes that while geese will cause damage if no action is taken, there will also be damage during and after the action. Damage averted allows the incorporation of harmful effects that may be caused by the management action, such as the loss of nontarget wildlife species or a loss of aesthetic values. If a management action greatly reduces the damage caused by geese but causes other detrimental effects, total damage averted is reduced (and could be negative).

As with project costs, benefits will vary depending on the problem, goal, and program employed in the management action. Problem identification will play a major role in deciding how benefits are measured. For example, if there is a problem with goose strikes to aircraft, a management action to reduce the goose population might also lower fecal coliform counts. However, if the goal were to reduce the potential for bird strikes to aircraft, measuring benefits in terms of fecal coliform would not be appropriate.

Every economic analysis requires that the benefits of a management action be enumerated on a scale relevant to the problem, whether that be a percentage reduction in population numbers, fewer goose strikes to aircraft, a reduction in fecal coliform counts, or an increase in visitor-use days along a section of beach, etc.

Value of Benefits

The next step in an economic analysis is to assign a dollar value (where possible) to the benefits quantified in the previous section (relevant costs that were not dollar-quantified in the project costs section should also be calculated).

Assigning a dollar value to the benefits of a management action will likely be more difficult than determining costs. A manager might wonder, what is the dollar value of a reduction in coliform counts, or how much is it worth to reduce the number of goose strikes to aircraft at an airport. Economics can use market and nonmarket valuation to convert the quantified impacts previously discussed into dollar measures.

Impacts that have been or could be quantified using standard market valuation techniques include the revenues lost to private recreation areas (such as golf courses) from customer avoidance, medical costs resulting from injury or disease, repair costs and lost revenues from bird strikes to aircraft, and the costs to landowners of repairing property damage.

Market valuation can account for only a portion of the impacts caused by the presence of geese in urban areas. Impacts that could be identified using nonmarket valuation techniques include the loss of leisure opportunities and reduction in leisure enjoyment resulting from either an overabundance or underabundance of geese. Other nonmarket techniques can be used to determine the relative impact geese have on the value of parklands and beaches. For both techniques, sensitivity analysis can be used to determine how changes in the number of geese affect public enjoyment and/or public land values.

ADDITIONAL CONSIDERATIONS

Project Life

Alternative methods employed to achieve a specific goal may result in different project lives. For example, the life of a single hazing treatment will likely differ from the life of a single lethal treatment. While

it is likely that neither of the 2 treatments would occur only once, managers should recognize that even when treatments appear equal in their costs and benefits, differing project lives may yield a different result. This discrepancy will be further explained under economic efficiency. Additionally, because expenditures and benefits of proposed solutions may accrue in different years, it is necessary that all costs and benefits for each solution are compared in a common year. Usually that year is the present, resulting in a net present value (NPV) comparison.

Risk and Uncertainty

Inherent in the management of Canada geese is the uncertainty regarding both their impacts and in the success of the management actions made to address those impacts. Not every goose at an airport will strike an aircraft, not every aircraft strike will result in damage, and, some strikes will cause a small amount of damage whereas other strikes may completely debilitate a plane. High fecal coliform counts on beaches may sicken some people and have no effect on others. Some geese are aggressive and have been known to attack people; others are tolerant of human presence. Furthermore, the success of a given management action can be highly variable. For example, migrant geese are more prone to scaring than are resident birds (Blokpoel 1976). Also, the presence of geese surrounding an abatement device may detract from its effectiveness in deterring the arrival of additional geese (Heinrich and Craven 1990). Habitat modification techniques alone will not usually prevent geese from using an area (Smith et al. 1999).

Because of risk and uncertainty, the results of a management action may be difficult to define; how can a manager determine an appropriate level of control when the results of such control may be ambiguous?

Expected value (EV) analysis can assist managers in determining both the likely value of a management action or the costs of no-action. EV analysis involves specifying a set of contingencies that are comprehensive and mutually exclusive (Boardman et al. 1996). Contingencies are possible outcomes such that only one of these outcomes will actually occur. EV analysis can best be illustrated by example:

Suppose managers are concerned about the danger of bird strikes to aircraft at a given airport. Currently losses from bird strikes at the airport cost US$1,000,000 per year. Problem identification has led to selection of a management action that includes US$100,000 in habitat modifications on the landscape surrounding the airstrips. Managers recognize that the success of habitat modification is dependent upon a number of variables and

have therefore identified 4 comprehensive outcomes (1 of these results will occur) of the management action that include (1) no reduction in aircraft strikes, (2) a 20 % reduction in aircraft strikes, (3) a 50 % reduction in aircraft strikes, and (4) a 100 % reduction in aircraft strikes. Each of these alternatives is mutually exclusive; that is, 1 management action could not result in both no reduction and a 50 % reduction in aircraft strikes.

Managers have also identified the beneficial results of each of the 4 contingencies. Outcome (1) results in no beneficial results, (2) reduces the losses from bird strikes to US$650,000, (3) reduces losses to US$500,000, and (4) reduces losses to zero. Given these costs and benefits, if (1) occurs, the resulting net benefit (NB) will be negative, -US$100,000, in the case of (2) the NB is US$250,000, for (3) the NB is US$500,000, and (4) the NB is US$1,000,000.

Once a representative set of contingencies is determined, we can then assign the probability of occurrence to each of them; the sum of all probabilities must equal 1. It may be that the probability of (1) is 10 %, (2) is 60 %, (3) is 25 %, and (4) is 5 %. Equation (1) shows that the expected value of a management action will be the sum of the probabilities of each action multiplied by the net benefit of that action

$$EV = p_1 (B_1-C_1) +\ldots+ p_n (B_n-C_n) \qquad (1)$$

Or, in this case

$$EV= .1(US\$0-US\$100,000) + \qquad (2)$$
$$.6(US\$350,000-US\$100,000) +$$
$$.25(US\$600,000-US\$100,000) +$$
$$.05(US\$1,100,000-US\$100,000)$$

$$EV = US\$315,000 \qquad (3)$$

Some may wonder how the dollar benefits (the reduction in losses) in the above example were determined. For the example, they were simply assumed. However, expected value analysis could also be used to determine the possible benefits of a management action when the potential impacts (damage averted) may be highly variable.

In addition to EV analysis, sensitivity analysis can be used to determine how sensitive the predicted net benefits are to changes in assumptions (Boardman et al.

1996). If net benefits remain positive when we consider the range of reasonable assumptions, then there will be more confidence in the results of the analysis.

ECONOMIC ANALYSIS TOOLS

Economic analysis of urban goose management can be accomplished using 3 techniques, (1) economic feasibility, and (2) economic efficiency, and (3) cost-effectiveness.

Economic Feasibility

Economic feasibility is a very basic level of economic analysis. It seeks to answer the question, "Are the benefits of an action greater than its costs?" A project that yields a net present value (NPV) that is greater than zero is economically feasible. In the above example, the benefits of the project are greater than the costs, yielding a NPV that is the same as the EV of US$315,000; the proposed action is feasible.

Economic Efficiency

Economic efficiency is used to determine the most productive use of capital and labor inputs. While economic feasibility requires only that the benefits of an action are greater than its costs. It cannot tell us what is the most efficient solution. Economic efficiency not only results in a positive NPV but also results in the maximum NPV possible while holding available inputs constant (Workman and Tanaka 1991). Referring again to the example above, we see that US$100,000 in management costs yields a benefit of US$415,000, resulting in a NPV of US$315,000. However, suppose that same US$100,000 could be used to reduce bird strikes in a number of different ways, including habitat changes, hazing, and repelling (or some combination of each). The hazing option results in a benefit of US$300,000, the repelling option results in a benefit of US$450,000, and hazing+repelling results in a benefit of US$500,000. Because each alternative cost exactly US$100,000, alternative (4) yields the greatest NPV (US$400,000). Economic feasibility would say that any of the alternatives is acceptable; however, an economic efficiency analysis would select (4) because it offers the "biggest bang for the buck."

Economic efficiency also requires that the benefits lost from a management action be included in the analysis. For example, if a management strategy would in fact, reduce the enjoyment the public receives from the presence of geese, this loss should be calculated. Fortunately, because most of these benefits may in fact be maximized at lower population densities, management actions addressing a problem resulting from over-abundance may not significantly reduce these benefits.

Project life, discussed earlier in this paper, acknowledges that different solutions may have differing expected lives. Economic efficiency analysis requires that all alternative solutions be compared in a common time frame. Therefore, if the life of 1 solution is 1 year, another solution is 2 years, and a third solution lasts 4 years, all solutions must be compared as if they were each carried out for 4 years.

Cost Effectiveness

Cost-effectiveness Analysis (CEA) recognizes that dollar-quantifying the benefits of a proposed action may not be possible. This may be especially true in urban Canada goose management where assigning dollar values to many of the impacts of geese may be prohibitively difficult. CEA requires only that the costs of an action be known and that the benefits of an action be quantified on some scale (not monetary). CEA does not find the most efficient solution but instead enables managers to achieve a specified goal at a minimum cost, or alternatively, spend a fixed amount to maximize a goal. This analysis may be most useful at smaller geographic scales such as a golf course where managers may seek only to reduce Canada goose populations by a certain number, or at a city park where managers may have a fixed budget allocation that can be spent on controlling geese. CEA allows managers to evaluate a set of alternatives according to their costs and corresponding effectiveness. From this analysis, managers can select the alternative that best meets their goal or budgetary constraints. An example of a CEA follows below. Fig. 1 illustrates the results of the CEA.

Suppose managers wish to reduce goose populations at a local golf course. Five alternatives have been identified (all benefits and costs compared in a common year and common project life):

1. Hazing. Cost: US$10,000. Effectiveness: 10% population reduction.

2. Repellent. Cost: US$20,000. Effectiveness: 10% population reduction

3. Habitat modification. Cost: US$20,000. Effectiveness: 20% population reduction

4. Habitat modification and hazing. Cost: US$25,000. Effectiveness: 25% population reduction

5. Habitat modification and repellent. Cost: US$30,000 Effectiveness: 35% population reduction

Once all alternatives are evaluated, it is apparent that any alternative except 2 could be a cost-effective choice, depending upon the desired result or budgetary restrictions. Alternative 2 would never be selected because at the same level of effectiveness, alternative 1
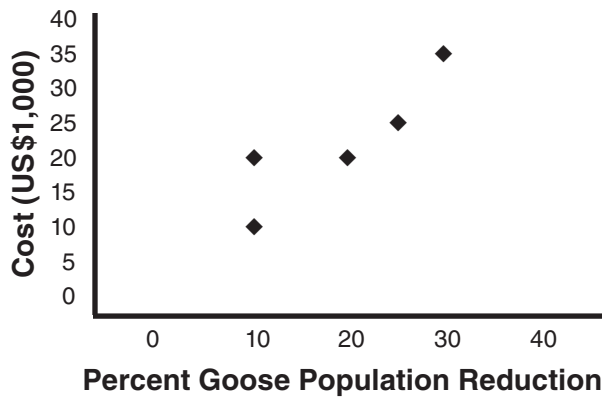
Fig. 1. A hypothetical example of a cost-effective analysis for Canada goose management strategies.

would require less cost. Additionally, for the same cost, alternative 3 would result in a higher level of effectiveness. In this example alternatives 1, 3, 4, and 5 make up what is known as a cost-effectiveness frontier any point found interior (i.e., left and above) to the frontier should not be selected.

DISCUSSION

Economic analysis can offer valuable insight into the effectiveness and efficiency of urban Canada goose management programs. Management of a species that is both despised and venerated by the public is a difficult task that is further complicated by the scope and scale of urban goose impacts and the variety of management strategies available to address these impacts. Economic analysis provides a venue for these management strategies, either individually or in aggregate, to be evaluated in a common time frame that accounts for their geographic extent and according to their real costs and resulting benefits. Economic analysis may seem to be an unnecessary or even impossible step when applied to wildlife management decisions, but it in fact can provide a common framework for managers to evaluate management actions while also addressing the uncertainty that is especially pervasive in Canada goose management.

LITERATURE CITED

AGUILERA. E., R. L. KNIGHT, AND J. L. CUMMINGS. 1991. An evaluation of two hazing methods for urban Canada geese. Wildlife Society Bulletin 19:32-35.

ALGE, T. L. 1999. Airport bird threat in North America from large flocking birds, (geese) as viewed by an engine manufacture. Pages 11-12 *in* Proceedings of the Joint Birdstrike Committee – USA/Canada meeting, Vancouver, British Columbia, Canada.

BLOKPOEL, H. 1976. Bird hazards to aircraft. Books Canada. Buffalo, New York, USA.

BOARDMAN, A. E., D. H. GREENBERG, A. R. VINING, AND D. L. WEIMER.1996. Cost-benefit analysis: concepts and practice. Prentice Hall, Upper Saddle River, New Jersey, USA.

CLEARY, E. C., S. E. WRIGHT, AND R. A. DOLBEER. 2000. Federal Aviation Administration National Wildlife Strike Database. Serial Report No. 6. Washington, D.C., USA.

CONOVER, M. R., AND G. C. CHASKO. 1985. Nuisance Canada goose problems in the eastern United States. Wildlife Society Bulletin 13:228-233.

HEINRICH, J. W., AND S. R. CRAVEN. 1990. Evaluation of three damage abatement techniques for Canada geese. Wildlife Society Bulletin 18:405-410.

LAYCOCK, G. 1982. Urban goose. Audubon. 84:44-47.

LINNELL, M. A., M. R. CONOVER, AND T. J. OHASHI. 1996. Analysis of bird strikes at a tropical airport. Journal of Wildlife Management 60:935-945.

MANNY, B. A., W. C. JOHNSON, AND R.G. WETZEL. 1994. Nutrient additives by waterfowl to lakes and reservoirs: predicting their effects on productivity and water quality. Hydrobiologia. 279:121-132.

SAUER, J. R., J. E. HINES, I. THOMAS, J. FALLON, AND G. GOUGH. 2000. The North American Breeding Bird Survey, results and analysis 1966-1999. Version 98.1, U. S. Geological Survey Patuxent Wildlife Research Center, Laurel Maryland, USA.

SMITH, A. E., S. R. CRAVEN, AND P. D. CURTIS. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16 and Cornell University Cooperative Extension, Ithaca, New York, USA.

TROST, R. E., AND R. A. MALECKI. 1985. Population trends in Atlantic flyway Canada geese: implications for management. Wildlife Society Bulletin 13:502-508.

USDA. 1999. United States Department of Agriculture. Management of conflicts associated with non-migratory (resident) Canada geese in the Puget Sound area. Environmental Assessment.

WORKMAN, J. P., AND J. A. TANAKA. 1991. Economic feasibility and management considerations in range revegetation. Journal of Range Management 44:566-573.