Journal of Wildlife Management 74(4):843–848; 2010; DOI: 10.2193/2008-470

Human Dimensions of Wildlife Management Note

Using a Cost-Effectiveness Model to Determine the Applicability of OvoControl G to Manage Nuisance Canada Geese

JOE N. CAUDELL,[1] *United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, 901 W State Street, West Lafayette, IN 47907, USA*

STEPHANIE A. SHWIFF, *United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins, CO 80521, USA*

MICHAEL T. SLATER, *United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Eastern Oregon District Office, 60015 Smith Loop, LaGrande, OR 97850, USA*

ABSTRACT OvoControl G is a relatively new product that reduces hatchability of Canada goose (*Branta canadensis*) eggs, and few data are available on its cost effectiveness. Variables such as presence of nontargets, alternative foods, and public support can affect cost efficacy. We present a model that uses these and other factors to estimate the cost of application of OvoControl G for managing nuisance Canada geese. We found that at low goose densities (<35 pairs of geese), fixed labor was a significant portion of costs. As goose densities increase, OvoControl G becomes more cost effective than other methods, such as egg oiling or addling. Managers can use this model to determine whether OvoControl G will provide a successful and cost-effective treatment for population control of Canada geese in specific management areas.

KEY WORDS biocontrol, *Branta canadensis*, Canada geese, cost analysis, OvoControl, population control.

During the past 20 years, many resident Canada goose (*Branta canadensis*) populations have increased dramatically and become problematic for city managers, golf course operators, urban residents, and farmers (Conover and Chasko 1985). Resident Canada geese are defined as nonmigratory geese that nest and reside year-round, predominantly within the United States. Overabundant, resident goose populations create numerous problems, including fecal contamination, bird strikes to aircraft, disease transmission to other wildlife, aggressive behavior near nesting sites, and damage to property, natural resources, and quality of life (U.S. Department of Agriculture [USDA] 1999).

Common approaches to controlling overabundant goose populations include both lethal (e.g., capture and euthanasia, hunting) and nonlethal methods (e.g., capture and translocation, hazing, repellents; Smith et al. 1999). A nonlethal control product for Canada geese, OvoControl G (Innolytics, Rancho Santa Fe, CA), reduces the hatchability of eggs and is based on the chemical nicarbazin. Nicarbazin has been used since the 1950s as an anticoccidial agent in broiler chickens. It was determined that feeding nicarbazin to breeding poultry reduces the hatchability of eggs (Jones et al. 1990). Nicarbazin interferes with the formation of the vitelline membrane, which allows the yolk to intermix with the albumen of the egg. This intermixing prevents further development of the fertilized egg. The National Wildlife Research Center has conducted laboratory and field trials with a nicarbazin-based product to control nuisance waterfowl (Johnston et al. 2001, Bynum et al. 2005). In 2005, Innolytics obtained approval from the U.S. Environmental Protection Agency to produce OvoControl G for the control of nuisance Canada goose populations. At the time of this study, wildlife fertility control was a relatively new application for nicarbazin, and few data were available on its cost effectiveness compared to that of other control methods.

The potential biological efficacy of this product is similar to other egg–nest destruction techniques. If all the nests are found during nest searches, egg oiling or addling can lead to a near 100% reduction in production (Cooper and Keefe 1997). Likewise, if waterfowl receive the proper dose of nicarbazin, egg hatchability of the nest can be near zero (Jones et al. 1990, Bynum et al. 2007). At low goose densities, Caudell and Shwiff (2007) showed that using OvoControl was expensive because of high fixed costs. As goose densities increased from 6 to 56 pairs of geese, the price per egg dropped considerably. Wildlife managers may be faced with controlling geese within these densities. The objective of this study was to determine, using cost-effectiveness modeling and sensitivity analysis, the density threshold at which it would become cost efficient to use OvoControl G compared to egg addling, oiling, or other nest-destruction techniques. Assuming that the biological effects of egg oiling, addling, and nest-destruction techniques and that of OvoControl G are similar, we used a cost-effectiveness analysis (CEA) to evaluate the costs associated with the different methods and to determine which method minimizes costs.

STUDY AREA

Wildlife Services personnel applied OvoControl G (2006 label) from 21 February 2007 through 11 May 2007 at 2 locations in Oregon, USA: Bend Metro Parks and

[1] *E-mail: joe.n.caudell@aphis.usda.gov*

Recreation District (BMPRD) and Black Butte Ranch (BBR). The BMPRD manages 961 ha (2,375 acres; 71 properties) of regional parks ($n = 63$) and open spaces ($n = 8$). The BMPRD has been in conflict with Canada geese since the early 1900s, and the severity of the conflict has increased with goose numbers. The conflict areas are located in parks along the Deschutes River in Bend, Oregon. Geese at BMPRD use lawn areas heavily for feeding and loafing. Based on reports from park personnel, there were approximately 150 geese at these locations during the winter months, although the population can swell to >800 in the juvenile-rearing and molt season in June and July. Wildlife Services personnel treated Canada geese with OvoControl G on 5 of 63 parks (8%; Brooks, Drake, Farewell Bend, Pacific, and Pioneer parks), using the procedures outlined on the OvoControl G 2006 label. This was not a researched-based application, but an actual management application of this product to reduce damage by geese. We used the experience gained in that OvoControl G application, including the anecdotal information on the observed limitations of the application procedures and feedback from the cooperators, to assist the end user to refine the model for a specific situation. In 2008, Innolytics revised the OvoControl label (label version 04-09-2008A, referred to hereafter as the OvoControl 2008 label), which resulted in significant changes to the application procedures and requirements.

Wildlife Services personnel administered OvoControl G to resident Canada geese at 4 areas within the BBR, located west of Sisters, Oregon. Black Butte Ranch is a full-service, private resort area that includes almost 1,200 homes and covers approximately 1,012 ha (2,500 acres) of meadows and forest land, ponds, and lakes. Included within BBR boundaries are 2 18-hole golf courses and other grassy recreational areas. These areas, along with the meadows, are attractive to both resident and migratory Canada geese. Based on observations from park personnel, winter goose aggregations comprise approximately 250 birds. During the spring and fall migrations and during the summer breeding season, goose numbers can exceed 1,000 birds because of immigration.

METHODS

Caudell and Shwiff (2007) presented a theoretical model for determining costs associated with applying OvoControl G based on the OvoControl 2006 label (Innolytics, label version 11-7-2006; referred to hereafter as the OvoControl 2006 label), previous research, and theoretical application practices. They developed the model to predict the total costs per egg (TC_E) associated with the use of OvoControl G. In the model, $TC_E = f(L_A, L_B, W, M_A, M_B, P_O, E_S)$, where L represents labor hours in the acclimation (A) and baiting (B) periods, W represents the wage rate, M represents materials (in pounds) used during the acclimation and baiting periods, P represents the price per pound of the material, and E equals 5.1 eggs per pair times the number of pairs. The TC_E equation can be represented by equation 1:

$$TC_E = \frac{(L_A + L_B)W + (M_A + M_B)P_O}{E_s} \quad (1)$$

where total costs associated with labor (L_T) are represented by $L_T = (L_A + L_B)W$, and similarly for materials, the total costs (M_T) are represented $M_T = (M_A + M_B)P_O$. Substituting this into equation 1 provides the simplified version of the equation:

$$TC_E = \frac{L_T + M_T}{E_s} \quad (2)$$

Therefore, the total costs per egg associated with the use of OvoControl G can be determined by factoring in wages for labor and the price of OvoControl G as well as determining the need for different requirements of labor and materials in the acclimation and baiting periods. Caudell and Shwiff (2007) used equation 2 to determine that OvoControl G can be a cost-effective method for reducing the fecundity of larger goose populations; however, because of the high, fixed labor costs associated with an OvoControl G application, treating small populations (1–20 pairs of geese) may not be cost effective. Given the limited time this product has been on the market, our previous model lacked any refinements based on actual field applications.

Details about the application process using the OvoControl 2006 label can be found on the 2006 label or in Caudell and Shwiff (2007), but we describe the process here briefly. To ensure that geese readily accepted the bait and nontarget animals were not affected by the application, we conducted a 21-day acclimation and observation period. We located the site in late winter or early spring, before the nesting season (the period when the birds begin pairing off and laying eggs). We then fed the birds a small amount of OvoControl G (initially 25% of the full dosage) to acclimate them to feeding in the area, to assess bait acceptance and presentation, and to determine which nontargets (if any) were also in the area. This acclimation period lasted for 21 days, before the start of the nesting season. This practice is similar to the prebaiting period used in other toxicant applications (e.g., DRC-1339; USDA 2001); however, there was no untreated prebait. We used the OvoControl G product throughout the project. During the acclimation period, we slowly increased the amount of OvoControl G (increase of 25%/week) until the end of the acclimation period, when the birds were all on the full-treatment dosage of 28.3 g per goose per day (Caudell and Shwiff 2007). After the acclimation period, we baited geese daily (usually for approx. 1 hr) for the duration of the breeding season (8–10 weeks). We conducted an additional observation period of 2 hours per week for nontarget animals. We distributed bait by hand to geese or placed it in bait pans. We applied bait by hand in BMPRD and BBR in accordance with the requirement of the OvoControl G 2006 label. Because of the sparse and dispersed nesting at BBR, we did not know how many of the geese accepting OvoControl G were breeding birds.

There are fixed or density-independent costs and variable or density-dependent costs associated with the application of most wildlife management techniques, such as OvoCon-

Table 1. Qualitative factors affecting bait uptake and their estimated direction of effect on field efficacy of OvoControl G (Innolytics, Rancho Santa Fe, CA) for controlling nuisance populations of Canada geese, based on the application experiences with OvoControl G in the Bend Metro Parks and Recreation District, Bend, Oregon, USA, and at the Black Butte Ranch, Sisters, Oregon, from 21 February 2007 through 11 May 2007.

Factor	Positive	Negative	Neutral
Public opinion	Encourage project	Discourage project	No opinion of project
Recreational feeding	Reduced acclimation period		
Domestic animals		Interference,[a] bait consumption	
Nontarget species		Interference,[a] bait consumption	
Weather		Inclement conditions	Moderate conditions
Treatment area	Small area	Large area	Moderately sized area
Population size	Small population	Large population	Moderate population
Population distribution	Closely distributed	Widely distributed	Moderately distributed
Alternative foods	Few	Many	
Bait acceptance	High	Low	

[a] Interference affects the goose's ability to access the food.

trol G and egg–nest destruction techniques. For OvoControl G, the primary fixed cost is the amount of the minimum time spent prebaiting and conducting initial observations. As the number of geese increases, these fixed costs remain unchanged. Variable costs, such as the amount of bait, labor, and other materials associated with both OvoControl G and egg–nest destruction, increase. We did not identify any significant fixed costs associated with egg–nest destruction techniques.

Because of the presence of variable costs with OvoControl G, it is possible to achieve economies of scale (a reduction in the average cost per unit) as the number of treated geese increases. With egg–nest destruction techniques, this is not necessarily the case; there is no efficiency gained by treating a large number of birds or a higher density because the application or labor and the material time are static per egg. Search time can be diminished but not application time. In the application of OvoControl G, bait and labor costs increase with density; however, labor costs increase at a decreasing rate. Because OvoControl G achieves economies of scale at higher densities, it is likely that OvoControl G would have a higher per-egg cost at lower goose densities and a lower per-egg cost at higher goose densities.

Our objective was to determine the density threshold at which it would become cost efficient to use OvoControl G, as opposed to egg addling, oiling, or other nest-destruction techniques. Many factors affect the determination of this threshold, including several assumptions that were based on the OvoControl G label, the manufacturer, and previous research. Therefore, we conducted a sensitivity analysis to examine the effects of changes in certain variables on the costs associated with an OvoControl G application.

Through our experiences with applying OvoControl G at BMPRD and BBR, we identified several factors that can affect the threshold level of cost efficiency (Table 1). Some factors may have a positive influence on bait uptake. For example, there may be few alternate food sources available, causing the birds to more readily take the OvoControl G. Other variables, such as interference from a variety of sources, may have a negative influence. Examination of the effects of all these factors is beyond the scope of this analysis. We constructed the CEA in terms of a range of conservative bait and labor costs to attempt to reduce uncertainty about the values assigned to them and the magnitude of the predicted effect. The initial analysis incorporated this uncertainty by using the most plausible estimates of these unknown quantities. The sensitivity analysis acknowledged this uncertainty in the model and examined how sensitive the results of the CEA were to a change in one of the variables (bait and labor costs).

Our limited-sensitivity analysis sought to determine the minimum effect of labor and bait cost changes on the threshold level of cost efficiency. To illustrate the effects of a hypothetical 50% reduction in price, we reduced the bait cost from US$10.01/kg (US$4.55/lb) to US$5.01/kg (US$2.28/lb). We also examined a potential modification of the acclimation period. Birds fed nicarbazin typically reach the peak levels of active ingredient in their blood 6–8 days after feeding (Yoder et al. 2005). Recent changes to the label have reduced the acclimation period and removed much of the required observation period, requiring that the acclimation period last only as long as it takes for the geese to become habituated to the product and receive an effective dose. Therefore, we modeled a reduction in the acclimation and observation period from 14 days to 5 days (1 hr/day for baiting) to determine the effect on cost effectiveness.

Egg–nest destruction methods (e.g., egg oiling, egg addling, and nest destruction) are common techniques for reducing the number of chicks hatched in the population (similar to using OvoControl G). Cooper and Keefe (1997) provided an estimate of US$14.31 per hour for labor and materials for nest–egg destruction. We removed the cost of labor and used the estimate for materials and equipment of US$3.95 in addition to the cost of equivalent labor (i.e., labor + 35% benefits) of a federal wildlife biologist or technician applying OvoControl G to provide a method of comparison with other techniques in 2007 United States dollars. We used a range of 2007 hourly rates for a general schedule (GS)-5 (US$16.58), GS-7 (US$20.53), and GS-9 (US$25.11) level (step 1 base hourly rate + 35% for benefits) federal wildlife biologist or technician (Office of Personnel Management 2007) to provide a range of labor costs for OvoControl G application comparison. We then used the Cooper and Keefe (1997) estimate of 1.7 eggs per hour to determine the cost per egg at the aforementioned labor rates.

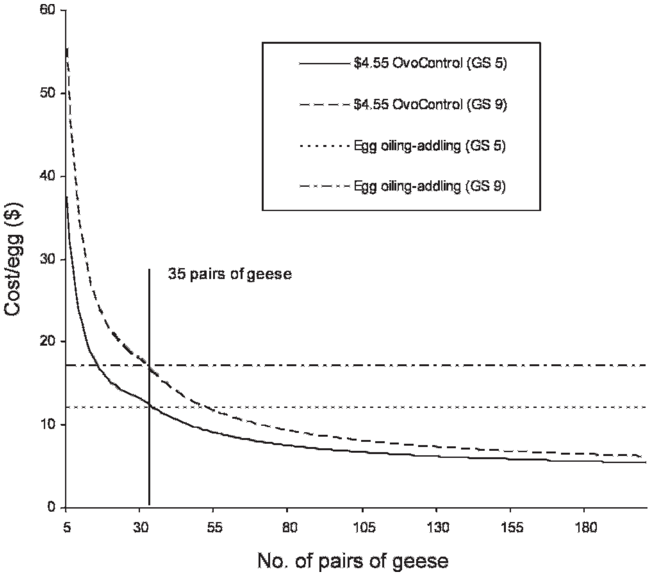

Figure 1. Effect of changing the labor rate from a general schedule (GS)-5 pay rate to a GS-9 rate, using an OvoControl G (Innolytics, Rancho Santa Fe, CA) application (2008 label) to control nuisance Canada geese populations at the 2008 price of US$10.01/kg (US$4.55/lb) for the bait and a 7-day acclimation period.

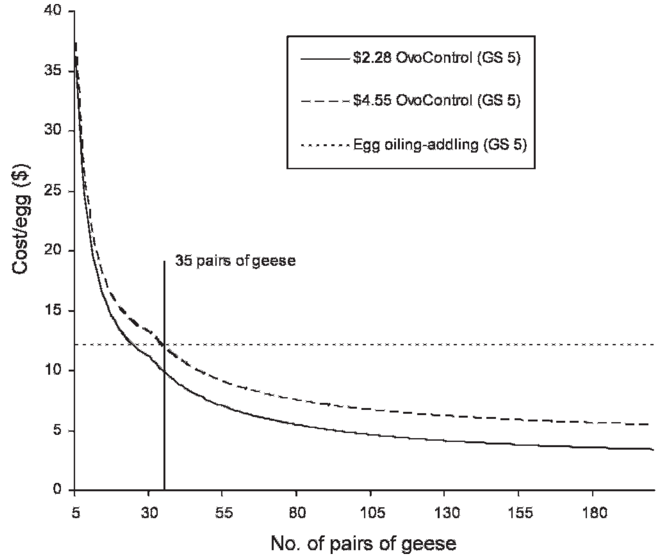

Figure 2. Effect of changing the price of OvoControl G (Innolytics, Rancho Santa Fe, CA; 2008 label), used for controlling nuisance Canada geese populations, from the 2008 price of US$10.01/kg (US$4.55/lb) to a hypothetical low price of US$2.28/lb for bait, with an application labor rate at the general schedule (GS)-5 pay rate and a 7-day acclimation period.

RESULTS

In general, BMPRD park managers commented that the number of goslings at the treated BMPRD parks appeared to be less than in past seasons and compared with nontreatment areas (i.e., nearby untreated private business parks). Park managers were pleased with the results of the project and contracted with Wildlife Services (USDA, Animal and Plant Health Inspection Service [APHIS], Washington, D.C.) to use OvoControl G in 2008.

Comments from BBR employees indicated that a relatively large number of goslings remained present near the main lodge following treatment with the bait, although there appeared to be a reduction of perhaps 25% during past years. Wildlife Services applicators felt that the lack of recreational goose feeding, combined with dispersed nesting, resulted in poor application efficiency. However, even with the application problems and the apparent contraceptive effect being relatively low, BBR managers thought they had observed enough of a reduction in gosling numbers to justify use of OvoControl G again in 2008.

A graphical representation of the sensitivity analysis results indicated that OvoControl G would become a more cost-effective treatment at approximately 35 pairs of birds at any wage rate (Fig. 1), assuming that the wage rate is the same for OvoControl G and the nest–egg destruction techniques and a 7-day acclimation period is achieved. At the 2008 level of product costs, US$10.01/kg (US$4.55/lb), OvoControl G again would become the most cost-effective method at approximately 35 pairs of birds (Fig. 2), assuming a 7-day acclimation period. Decreasing the cost of OvoControl G to US$5.01/kg (US$2.28/lb) would decrease the number of pairs needed for cost effectiveness to approximately 23. It is important to note that this lower cost was chosen to show the effect of a hypothetical 50% reduction in price and is not an expected future cost of the product. Reducing the acclimation period for an OvoControl G application from 14 days to 5 days would result in OvoControl G becoming a more cost-effective method (compared to egg oiling or addling) at 42 and 22 pairs of birds, respectively (Fig. 3).

Many factors can affect the likelihood of bait uptake and therefore cost per egg (Table 1). Calculating the effect of a

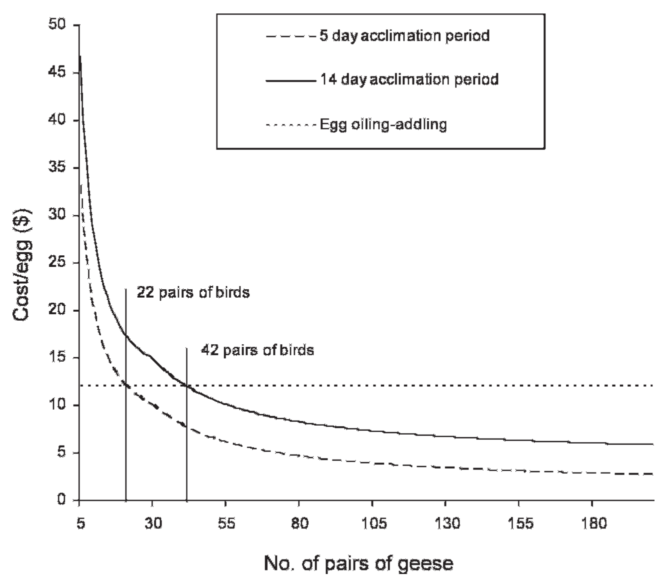

Figure 3. Effect on the cost per egg of reducing the acclimation period from 14 days to 5 days at the general schedule (GS)-5 pay rate for labor using the 2008 price of OvoControl G (Innolytics, Rancho Santa Fe, CA) of US$10.01/kg (US$4.55 lb) and the 2008 label methods for controlling nuisance Canada geese populations. The breakeven point in comparison with egg oiling or addling is 42 pairs (14 days) and 22 pairs (5 days), respectively.

change of each of the variables listed in Table 1, however, is outside the scope of this article. Instead, we listed the variables likely to affect bait uptake, based on the experiences of the Wildlife Services applicators on the BBR and BMPRD project and the label requirements. Variables having a positive influence on bait uptake would have a negative effect on cost per egg, and vice versa for those factors having a negative influence on bait uptake. For the factors having a neutral influence on bait uptake, the effect on cost per egg is uncertain.

DISCUSSION

The results of this analysis indicate that, at the current market price, OvoControl G becomes more cost efficient than nest–egg destruction at ≥ 35 pairs of birds, regardless of the cost of labor (assuming a 7-day acclimation period). As the number of treated pairs of birds increases from 5 to 30 (Fig. 1), the cost of an OvoControl G application drops rapidly. In the range between 5 and 35 pairs of geese, other inputs (e.g., applicators time availability) may play a role in the choice to use OvoControl G or egg oiling or addling.

We sought to conservatively estimate the costs associated with a field application of OvoControl G in Oregon. Incorporation of the factors that can affect the application from Table 1 as sources of potential cost would undoubtedly have affected the projected efficiency of the program. Cost efficiency of the application of OvoControl G is affected primarily by product cost and length of acclimation period. For example, reductions in the product price by 50% would drop the breakeven point to 25 pairs. This could be achieved by increasing the active ingredient with no associated price increases, which happened in 2006 when the active ingredient was increased from 0.25% to 0.5%, without an associated price increase.

Changes in acclimation-period requirements occurred between 2006 and 2008. Caudell and Shwiff (2007) found that, with small numbers of geese (e.g., 10 pairs of birds), OvoControl G use (2006 label) was relatively expensive (approx. US$33/egg at the GS-5 labor rate). However, because of the changes to the acclimation period requirement in the 2008 label, the cost of treating 10 pairs of birds dropped to approximately US$22 (at the 2007 GS-5 rate with a 7-day acclimation period). Although this cost is still greater than the cost of egg oiling or addling, it is approaching a point at which the difference in cost may not be prohibitive to the cooperator. The breakeven point between egg oiling and addling and OvoControl G dropped from 55 pairs of geese (based on the 2006 label) to a potential low of 22 pairs of geese (assuming a 5-day acclimation period on the 2008 label), making OvoControl G feasible at a lower bird numbers.

In experimental, simulated field treatments, Bynum et al. (2007) showed that there is a reduction in goslings when OvoControl G is used. Even though we did not collect any additional quantitative data in our case study of the BBR and BMPRD, the qualitative reactions of both the applicators and cooperators add another dimension to consider. Wildlife Services applicators did not feel that at BBR geese were treated with optimal efficiency. This not only causes costs to increase because of the additional time trying to get the geese treated, but the efficacy of the treatment can also be diminished. Not all of the geese could be located and treated, and some geese consumed bait on an irregular basis. Even with these apparent problems, the cooperators expressed satisfaction with the outcome of the product and expressed an interested in additional applications in 2008 (M. Slater and A. Darr, USDA, APHIS, Wildlife Services, unpublished report). A next step in the research of this product or similar applications to reduce gosling production is to quantitatively determine an average threshold for perceived success of projects by cooperators.

Economic efficiency is one of many factors that play a role in determining the usefulness of a wildlife management program. The study reported here revealed important factors that affect the decision to implement a contraceptive program in several regions, even though many unknowns were involved in the original decision. The analysis of costs associated with the OvoControl G program identified key economic variables and procedures that will improve analyses and decision-making in future contraceptive program planning.

Management Implications

Wildlife managers can use this analysis to incorporate the threshold of cost effectiveness for OvoControl G use into their decisions about methods used to control nuisance Canada geese of varying flock size. Additionally, this study identified variables that will likely change the field efficacy of OvoControl G, potentially affecting the threshold of cost effectiveness in comparison to other methods. The method we used can also be employed to conduct similar cost-effectiveness analyses for existing wildlife-damage management strategies.

Acknowledgments

We thank J. Loven and D. Williams, Wildlife Services state directors in Indiana and Oregon, USA, respectively, for the time to work on this manuscript. We also thank S. Munoz-Eifler, R. Sterner, and K. Kirkpatrick for their helpful comments in preparing this manuscript.

LITERATURE CITED

Bynum, K. S., J. D. Eisemann, G. C. Weaver, C. A. Yoder, K. A. Fagerstone, and L. A. Miller. 2007. Nicarbazin OvoControl G bait reduces hatchability of eggs laid by resident Canada geese in Oregon. Journal of Wildlife Management 71:135–143.

Bynum, K. S., C. A. Yoder, J. D. Eisemann, J. J. Johnston, and L. A. Miller. 2005. Development of nicarbazin as a reproductive inhibitor for resident Canada geese. Proceedings of the Wildlife Damage Management Conference 11:179–189.

Caudell, J. N., and S. A. Shwiff. 2007. Modeling costs of using OvoControl G for managing nuisance Canada goose (*Branta canadensis*) populations. Proceedings of the Wildlife Damage Management Conference 12:42–49.

Conover, M. R., and G. G. Chasko. 1985. Nuisance Canada goose problems in the eastern United States. Wildlife Society Bulletin 13:228–233.

Cooper, J. A. and T. Keefe. 1997. Urban Canada goose management: policies and procedures. Transactions of the North American Wildlife and Natural Resources Conference 62:412–430.

Johnston, J. J., W. M. Britton, A. MacDonald, T. M. Primus, M. J. Goodal, C. A. Yoder, L. A. Miller, and K. A. Fagerstone. 2001. Quantification of plasma and egg 4,4′-dinitrocarbanilide (DNC) residues for the efficient development of a nicarbazin-based contraceptive for pest waterfowl. Pest Management Science 58:197–202.

Jones, J. E., J. Solis, B. L. Hughes, D. J. Castaldo, and J. E. Toler. 1990. Production and egg quality responses of white leghorn layers to anti-coccidial agents. Poultry Science 69:378–387.

Office of Personnel Management. 2007. OPM Web site. <http://www.opm.gov/oca/07tables/html/gs_h.asp>. Accessed 1 Jan 2007.

Smith, A. E., S. R. Craven, and P. D. Curtis. 1999. Managing Canada geese in urban environments. Cornell University Cooperative Extension Service Jack Berryman Institute Publication 16, Ithaca, New York, USA.

U.S. Department of Agriculture [USDA]. 1999. Final environmental assessment and finding of no significant impact and decision for management of conflicts associated with non-migratory (resident) Canada geese in the Puget Sound area: environmental assessment. Animal and Plant Health Inspection Service, Washington, D.C., USA.

U.S. Department of Agriculture [USDA]. 2001. Compound DRC-1339 concentrate feedlots. Technical Note, 1 April 2001. Animal and Plant Health Inspection Service, Wildlife Services, Washington, D.C., USA.

Yoder, C. A., L. A. Miller, K. S. Bynum. 2005. Comparison of nicarbazin absorption in chickens, mallards, and Canada geese. Poultry Science 84:1491–1494.

Associate Editor: Grado.