Vulnerability of nontarget goose species to hunting with electronic snow goose calls

Jason H. Caswell, Alan D. Afton, and F. Dale Caswell

Abstract  Since 1999, use of electronic calls has been legal for hunting lesser snow geese (Chen caerulescens caerulescens; hereafter snow geese) during special seasons or times of day when other waterfowl species could not be hunted in prairie Canada. Prior to expanding the use of electronic calls for hunting snow geese during fall hunting seasons, effects of these calls on nontarget goose species must be examined. Accordingly, we examined the vulnerability of Canada (Branta canadensis) and white-fronted goose (Anser albirostris) (dark geese) to electronic snow goose calls and 3 goose decoy sets (dark, mixed, and white) during the 1999 fall hunting seasons in Manitoba and Saskatchewan. Canada geese were 2.3 times more likely to fly within gun range (P<0.001) and the mean number killed/hour/hunter was 2.5 times greater (P=0.043) during control periods when hunters were silent or used traditional calling methods (i.e., hand-held and voice calls) than when hunters used electronic snow goose calls. Flock response and kill rate for Canada geese declined as proportions of white decoys increased in decoy sets (P<0.001). White-fronted geese were 1.8 times more likely to fly within gun range (P=0.050) and the mean number killed/hour/hunter was 5.0 times greater (P=0.022) during control periods than during periods when electronic snow goose calls were used. Flock response for white-fronted geese also declined as the proportion of white decoys increased in decoy sets (P<0.001). The legalization of electronic snow goose calls during fall hunting seasons in prairie Canada should not result in increased harvest of nontarget dark geese.

Key words  Anser albirostris, Branta canadensis, Canada geese, Chen caerulescens, decoys, electronic call, flock response, hunting, Manitoba, Saskatchewan, snow geese, white-fronted geese

Olsen and Afton (2000) found that lesser snow geese (Chen caerulescens caerulescens; hereafter snow geese) were more vulnerable to hunting with electronic snow goose calls than to traditional calling methods (i.e., hand-held and voice calls) and concluded that legalization of electronic snow goose calls for hunting could help reduce midcontinent snow goose numbers to meet population goals (Batt 1997). In 1999 the Canadian Wildlife Service (CWS) authorized the use of electronic snow goose calls for hunting snow geese in prairie Canada during special seasons or times of day (afternoon) when species of geese other than snow geese could not be hunted. In the fall of 1998,
Saskatchewan Environment requested approval from the CWS to allow use of electronic snow goose calls during the regular goose season when other species could be hunted (D. Nieman, Canadian Wildlife Service, personal communication). This request originally was denied by CWS because of concern that unrestricted use of electronic snow goose calls might increase harvest of nontarget species such as Canada (Branta canadensis) and white-fronted geese (Anser albifrons) (dark geese).

Canada and white-fronted goose populations are managed cooperatively throughout North America, with most populations managed by regulating harvest (Hindman et al. 1998). Of particular concern was the Eastern Prairie Population (EPP) of Canada goose (B. c. interior) that nests in northern Manitoba and winters in Missouri (Malecki et al. 1980, Babcock et al. 1990). The 1999 EPP estimate was below population objectives prescribed in the management plan (Bataille and Humburg 1999, Humburg et al. 1999). Regulations attempting to reduce harvest rate of EPP birds continued through the 2002 Manitoba fall hunting season.

Midcontinent greater white-fronted geese, which until recently were considered as separate eastern and western populations, are now combined for management purposes (Central, Mississippi, and Pacific Flyway Councils 1998). One group of white-fronted geese that breeds in the interior portion of Alaska, migrates through prairie Canada, and winters in Texas and Mexico (Miller et al. 1968) currently is at a level that cannot support increased harvest (Ely and Schmutz 1999, Spindler et al. 1999).

Given interest in expanding the use of electronic snow goose calls and the fact that both populations of concern migrate through prairie Canada, we examined the vulnerability of Canada and white-fronted geese to these calls and 3 goose decoy sets (i.e., dark, mixed, and white) during the 1999 fall goose seasons in Manitoba and Saskatchewan. We investigated the vulnerability of Canada and white-fronted geese to various decoy sets so that waterfowl managers could restrict the use of electronic snow goose calls to certain decoy sets that did not increase harvest of nontarget goose species. Our objectives were to determine whether: 1) vulnerability of Canada and white-fronted goose flocks differed between the use of electronic snow goose calls and traditional calling methods, and 2) vulnerability of Canada and white-fronted geese to electronic snow goose calls varied with composition of decoy sets.

Under objective 1, we predicted that proportions of observed flocks of nontarget dark geese that flew within gun range (<50 m), numbers of geese killed/hour/hunter, and ages of harvested geese would decline with use of electronic snow goose calls. We also predicted that Canada and white-fronted geese killed by hunters using electronic calls would exhibit relatively worse body condition (Olsen and Afton 2000). Under objective 2, we predicted that vulnerabilities of Canada and white-fronted geese would decline as the proportion of white decoys increased in the decoy set.

**Study area**

We conducted experimental hunts in Manitoba and Saskatchewan at locations where high densities of staging geese were known to occur (Bellrose 1976)—specifically, near Last Mountain Lake (51°24′N, 105°14′W) and the town of Kindersley (51°28′N, 109°10′W) in Saskatchewan and north and southwest of the city of Winnipeg (49°53′N, 97°08′W) in Manitoba (Figure 1). In Saskatchewan, 67%, 23%, 6%, and 4% of experimental hunts were in harvested pea, barley, lentil, and wheat fields, respectively. In Manitoba, 34%, 27%, 13%, 11%, and 9% of experimental hunts were in harvested barley, fallow, wheat, oats, and corn fields, respectively.

**Methods**

Before initiating experimental hunts, we spent 3 days (8-10 September 1999) training and
subsequently testing 2 field crews of observers. Upon completion of training, we compared measurements of crews using a 1-way analysis of variance (PROC GLM; SAS Institute 1990) for each of 4 measurements. We determined that there was little observer variation ($P > 0.05$) and that distance estimation between crews was consistently within ±5 m.

Prior to each hunt, we located harvested agricultural fields containing ≥500 Canada or white-fronted goose or both (in the evening [1600 hours] and late morning [1000–1200 hours]). When a suitable field was located, we sought permission from the landowner to conduct hunts. Once permission was secured, we used several methods to solicit volunteer hunters, selecting them ($n = 114$) through suggestions from landowners and by directly contacting hunters in the field. We attempted to select different hunters for each hunt, to help ensure a broad range of experience and hunting skills, and assumed that volunteer hunters were representative of those in the areas where we hunted.

We conducted experimental hunts from 11 September–16 October 1999. We provided hay-bale blinds (Cabela’s, Sydney, Nebr., Model #22-2491) and goose chairs (Cabela’s, Model #22-2434) to hunters and allowed them to select and set up blinds as they would under normal hunting conditions; a few hunters (5%) concealed themselves by using white coveralls or in natural vegetation.

We conducted experimental hunts using 3 goose decoy sets: 1) dark (3 dozen 107-cm-long Canada goose decoys, Flambeau super magnum, Middlefield, Oh.), 2) mixed (10 dozen 56-cm-long snow goose decoys, G&H standard snow, Henryetta, Okla., and 3 dozen super magnum Canada goose decoys), and 3) white (10 dozen standard snow goose decoys). We rotated decoy sets among hunts so that similar numbers of hunts were conducted with each decoy set.

We compared 2 calling methods within each hunt: 1) electronic (recorded) lesser snow goose calls and 2) traditional goose calling methods (silence, or hand-held and voice calls) used by hunters. We used a commercially available snow goose tape (Johnny Stewart Wildlife Calls, Waco, Tex., Model #CT306A), Johnny Stewart Wildlife playback sound system, and “LDR-1” amplifier. We replaced original tapes if a reduction in sound quality occurred. For each hunt, we alternated calling methods during 15-minute sampling periods (Olsen and Afton 2000). We randomized the start order for calling methods for each hunt.

An observer and an assistant recorded data for each hunt. We kept the portable calling device and speaker near the observer or assistant to facilitate its operation and ensure that the speaker was directed toward approaching flocks. We played the electronic call continuously during the calling period. If no goose flocks were visible, we pointed the speaker in a direction in which geese previously had been observed. We set the initial volume at one-eighth turn less than maximum on the volume control knob. We reduced the volume an additional one-eighth turn on the knob when flocks approached to 200 m (Olsen and Afton 2000). If approaching flocks changed direction after the volume had been reduced, we turned the volume back to the initial setting. Traditional calling was allowed only during control periods and was at the discretion of volunteer hunters.

For each hunt we recorded the following data: location, field type, decoy set used, and number of shots taken (Caswell 2001). The initial treatment period for each hunt began when the first flock of geese was observed. We included in the experiment all flocks of geese (≥1 goose) observed within 400 m of hunters (Olsen and Afton 2000). For each 15-minute sampling period we recorded species, flock size, and minimum distance that each flock approached hunters (±5 m). We estimated distances using laser rangefinders (Bushnell Yardage Pro 800 or 400, Overland Park, Kans.) and conspicuous landmarks of known distance.

We encouraged hunters to shoot geese as they would under ordinary hunting circumstances. A 3-minute buffer period, during which we allowed no calling, separated each sampling period to ensure that geese were not influenced by previous calling methods (Olsen and Afton 2000). We continued observing flocks at the end of sampling periods until they could be recorded. We neither directed nor influenced hunter shooting selection, but we did not allow shooting during the buffer period.

Harvested geese were identified with respect to sample periods during which they were shot. We ensured that hunters had all necessary federal and provincial hunting permits and instructed them to adhere to all federal and provincial waterfowl regulations during the study, except for those permitted by our scientific collection permit. The permit issued by CWS allowed use of electronic snow goose calls and hunting in afternoons, when goose hunting otherwise was closed, to increase our sample of hunts. The permit also exempted us from

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daily and possession bag limits, allowing us to extend duration of hunts and obtain larger samples of geese when necessary (i.e., permitted hunters to exceed the daily bag limit before a minimum of 2 experimental and control periods had elapsed).

After each hunt, we sexed and aged (hatch-year [HY] and after hatch-year [AHY]) all harvested geese by cloacal and rectrix examination (Hochbaum 1942). We measured mass (±0.05 kg) with a spring scale (Pesola) and culmen, head, and total tarsal length (±0.05 mm) with dial calipers (Dzubin and Cooch 1992).

**Statistical analysis**

**Flock response.** We used logistic regression (PROC LOGISTIC; SAS Institute 1990) to test whether flock response (whether each flock flew within 50 m of hunters) differed between time of day (categorical; a.m. or p.m.), calling method (categorical; electronic or traditional), decoy sets (categorical; white, mixed, or dark), log-transformed flock size (continuous), and all associated 2-way interactions. We recorded flock response as “1” if an observed flock flew within 50 m and as “0” otherwise. We assessed fit of our final model using Hosmer and Lemeshow’s (1989) goodness-of-fit test (PROC LOGISTIC; SAS Institute 1990). Because populations of Canada and white-fronted geese are managed separately and their ranges do not completely overlap, we analyzed flock response and other response variables (kill rate, body condition, and ages of harvested geese) separately for each species.

**Kill rate.** Because only one white-fronted goose was shot in Manitoba and only one Canada goose was shot in western Saskatchewan, our kill-rate analysis for white-fronted geese was restricted to Saskatchewan hunts and that for Canada goose was restricted to Manitoba and eastern Saskatchewan hunts. We used a 3-way analysis of variance (PROC GLM; SAS Institute 1990) to test whether kill rates differed between time of day, calling method, and among decoy sets. For each hunt we calculated a kill/hour/hunter for each calling method as the response variable (Olsen and Afton 2000). We square root-transformed kill/hour/hunter to meet normality assumptions. Kill rates are presented as square-root back-transformed least-square means (±SE).

**Body condition.** For each species, we indexed body size using principal component analysis (PROC PRINCOMP; SAS Institute 1990) of the correlation matrix of the 3 morphometric measurements taken from harvested geese (Olsen and Afton 2000). We used the first principal component (PC1) as a measure of body size for each goose (Alisauskas and Ankney 1987). PC1 explained 95% and 69% of variation in morphometric measurements for Canada and white-fronted goose, respectively. We then regressed body mass (PROC GLM; SAS Institute 1990) on PC1 and adjusted each bird’s body mass for its size by adding the overall mean body mass of the species to the individual’s residual from regression (Ankney and Afton 1988, Olsen and Afton 2000). We then used size-adjusted body mass as a measure of body condition (Dufour et al. 1993). We detected a positive linear trend between body mass and PC1 for Canada goose (Caswell 2001), suggesting that size classes of Canada goose did not differ in body condition or require separate analysis. We then used 4-way analysis of variance (PROC GLM; SAS Institute 1990) to determine whether body condition differed between call method, age, and sex, or among decoy sets. Body condition values are presented as least-square means (±SE).

**Ages of harvested geese.** We used logistic regression (PROC LOGISTIC; SAS Institute 1990) to test whether age of harvested Canada and white-fronted goose differed between time of day, calling method, decoy set, sex (categorical; male or female) and all 2-way interactions. For analysis we scored AHY geese as “1” and HY geese as “0”.

**Results**

We conducted 92 experimental hunts, 44 in Manitoba and 48 in Saskatchewan. A total of 114 volunteer hunters contributed 170 hunter-days to our study. Of the 114 volunteers, 15 (13%) used traditional calls during control sample periods. Most hunts (89 of 92; 97%) were comprised of 2 hunters, whereas 1 hunt was comprised of 3 hunters and 2 hunts were comprised of 1 hunter each. On 13 occasions we conducted hunts with the same hunters during the morning and afternoon of the same day.

We conducted equal numbers (n=276 each) of sample periods for electronic and traditional calling methods (n=68.8 hour each) during the study, with numbers of sample periods within a hunt ranging from 4–12 (mean±SE = 5.54±1.92). We observed 2,774 flocks of Canada goose and 2,441 flocks of white-fronted goose (n=36,600 and 47,191 goose, respectively). Volunteer hunters killed 214 Canada
and 154 white-fronted geese during our experiments (Table 1).

**Flock response**

**Canada geese.** Our final model (Hosmer and Lemeshow’s goodness-of-fit test = 5.08, \( P = 0.749 \)) indicated that flock response differed between calling methods and among decoy sets; log flock size and time of day-by-call method interaction also influenced the model (\( P < 0.05 \)). The odds ratio indicated that Canada geese were 2.3 times more likely to fly within gun range (< 50 m) when using traditional calling methods than when using electronic snow goose calls (Wald \( \chi^2_{12} = 16.86, P < 0.001 \)). Canada geese were 12.3 times more likely to fly within gun range when hunters used dark decoy sets than when white decoy sets were used (Wald \( \chi^2_{12} = 50.94, P < 0.001 \)) and 6.7 times more likely to fly within gun range to mixed decoy sets than to white decoy sets (Wald \( \chi^2_{12} = 28.59, P < 0.001 \)). Canada geese were more likely to fly within gun range as flock size decreased (odds ratio = 0.61; Wald \( \chi^2_{12} = 108.35, P < 0.001 \)). The time of day-by-call method interaction (Wald \( \chi^2_{12} = 4.35, P = 0.037 \)) was significant because the difference in flock response between call methods was less in the morning than in the afternoon; however, flock response to electronic snow goose calls always was lower than that to traditional calls (Table 2).

**White-fronted geese.** Our final model (Hosmer and Lemeshow’s goodness-of-fit test = 2.52, \( P = 0.961 \)) indicated that flock response differed between call methods and among decoy sets; log flock size and the time of day-by-decoy set interaction also were significant. The odds ratio indicated that white-fronted geese were 1.8 times more likely to fly within gun range under traditional calling methods than when electronic snow goose calls were used (Wald \( \chi^2_{12} = 3.84, P = 0.050 \)) and 3.5 times more likely to fly within gun range toward dark decoy sets than white decoy sets (Wald \( \chi^2_{12} = 12.47, P < 0.001 \)). Flocks were more likely to fly within gun range as flock size decreased (odds ratio=0.65; Wald \( \chi^2_{12} = 77.04, P < 0.001 \)). The time of day-by-decoy set interaction (Wald \( \chi^2_{12} = 9.13, P = 0.010 \)) was significant because flock response was highest in the afternoon when dark decoys were used but highest in morning when other decoy sets were used (Table 3).

**Kill rate**

**Canada geese.** Our final model indicated that kill rate differed between call methods (\( F_{3, 127} = 4.19, n = 131, P = 0.043 \)) and among decoy sets (\( F_{3, 127} = 18.06, n = 131, P < 0.001 \)). Kill rate averaged 2.5 times greater for traditional calls (\( \bar{x} = 0.0367 \pm 0.0006 \)) than for electronic snow goose calls (\( \bar{x} = 0.0149 \pm 0.0006 \)). Kill rate declined as the proportion of white decoys

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### Table 1. Numbers of Canada and white-fronted geese harvested during experimental hunts by decoy set, call method, age, and sex, 11 September–16 October 1999 in Manitoba and Saskatchewan, Canada.

<table>
<thead>
<tr>
<th>Species</th>
<th>Decoy set</th>
<th>Call method</th>
<th>AHY Male</th>
<th>AHY Female</th>
<th>HY Male</th>
<th>HY Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada geese</td>
<td>Dark</td>
<td>Traditional</td>
<td>39</td>
<td>25</td>
<td>11</td>
<td>19</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>11</td>
<td>16</td>
<td>6</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>Traditional</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>12</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>13</td>
<td>12</td>
<td>3</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>Traditional</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>78</td>
<td>65</td>
<td>31</td>
<td>40</td>
<td>214</td>
</tr>
<tr>
<td>White-fronted geese</td>
<td>Dark</td>
<td>Traditional</td>
<td>5</td>
<td>8</td>
<td>15</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>Traditional</td>
<td>14</td>
<td>11</td>
<td>18</td>
<td>11</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>Traditional</td>
<td>1</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>23</td>
<td>40</td>
<td>50</td>
<td>41</td>
<td>154</td>
</tr>
</tbody>
</table>

### Table 2. Total flocks observed and number of flocks (%) of Canada geese that approached to within 50 m of volunteer hunters by decoy set, time of day (a.m./p.m.), and call method, 11 September–16 October 1999 in Manitoba and Saskatchewan, Canada.

<table>
<thead>
<tr>
<th>Decoy set</th>
<th>Call method</th>
<th>Total flocks</th>
<th>Flocks ≤50 m (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark</td>
<td>AM</td>
<td>Traditional</td>
<td>567</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>317</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Traditional</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>132</td>
</tr>
<tr>
<td>Mixed</td>
<td>AM</td>
<td>Traditional</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>295</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Traditional</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>131</td>
</tr>
<tr>
<td>White</td>
<td>AM</td>
<td>Traditional</td>
<td>306</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Traditional</td>
<td>173</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>133</td>
</tr>
<tr>
<td>Total</td>
<td>AM</td>
<td>Traditional</td>
<td>1,213</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>703</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Traditional</td>
<td>462</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>396</td>
</tr>
</tbody>
</table>
increased in decoy sets (for dark, mixed, and white decoy sets: \(\bar{x}=0.0746 \pm 0.0008, 0.0308 \pm 0.0008, \) and \(0.0004 \pm 0.0009,\) respectively).

**White-fronted geese.** Our final model indicated that kill rate differed between call methods \((F_{1,84}=5.42, n=86, P=0.022)\). Kill rate averaged 5.0x greater for traditional calling methods \((\bar{x}=0.0438 \pm 0.0012)\) than for electronic snow goose calls \((\bar{x}=0.0088 \pm 0.0013)\).

**Body condition**

**Canada geese.** Our final model indicated that body condition of harvested Canada geese differed between ages \((F_{2,211}=78.94, n=214, P<0.001)\) and sexes \((F_{2,211}=8.98, n=214, P=0.003)\). AHY geese \((\bar{x}=3.69 \text{ kg} \pm 0.023)\) were in better condition than were HY geese \((\bar{x}=3.33 \text{ kg} \pm 0.033)\), and males \((\bar{x}=3.57 \text{ kg} \pm 0.028)\) were in better condition than females \((\bar{x}=3.46 \text{ kg} \pm 0.028)\). Body condition of Canada geese harvested with the call on \((\bar{x}=3.61 \text{ kg} \pm 0.041)\) was similar to those harvested while the call was off \((\bar{x}=3.56 \text{ kg} \pm 0.028)\). Body condition of white-fronted geese harvested with the call on \((\bar{x}=2.37 \text{ kg} \pm 0.046)\) was similar to those harvested while the call was off \((\bar{x}=2.43 \text{ kg} \pm 0.027)\).

**Ages of harvested geese**

**Canada geese.** None of the explanatory variables we considered contributed to the variation of ages of harvested Canada geese \((P>0.05)\).

**White-fronted geese.** Our final model (Hosmer and Lemeshow's goodness-of-fit test \(=1.23, P = 0.873\)) indicated that ages of harvested white-fronted geese differed among decoy sets and between sexes. The odds ratio indicated that the probability of a white-fronted goose being shot over dark decoys when compared to white decoys was 6.3 times greater for HY than AHY birds \((\chi^2_1 = 11.47, P<0.001)\) (Table 1). The odds ratio \((0.48)\) indicated that the probability of a harvested white-fronted goose being female was 2.1 times greater for AHY than HY birds \((\chi^2_1 = 4.28, P=0.039)\) (Table 1).

**Discussion**

**Vulnerability to electronic calls**

Olsen and Afton (2000) found that flock responses, kill rates, and sizes of responding snow goose flocks were higher while hunting with electronic snow goose calls than with traditional calling methods. In contrast to their results and consistent with our prediction, we found that flock responses and kill rates of Canada and white-fronted geese were lower when using electronic snow goose calls than when using traditional calling methods. Olsen and Afton (2000) also reported that body condition and ages of harvested snow goose differed between calling methods. Contrary to our prediction, we found that body condition and ages of harvested Canada and white-fronted geese were not affected by calling methods, although harvested AHY Canada and white-fronted geese were in better condition than were HY geese, and male Canada geese were in better condition than females.

Schmutz and Ely (1999) previously reported that survival of adult female white-fronted geese was lower than that of adult males during fall hunting seasons. Similarly, our experimental hunts indicated that the probability of a harvested white-fronted being female was twice as great for adults as for hatch-year birds. As with lesser snow geese (Olsen and Afton 2000) and several duck species (Stott and
Olson 1972, Hochbaum and Walters 1984), larger flocks of Canada and white-fronted goose were less likely to fly within gun range than were smaller flocks, regardless of calling method or decoy set used.

For Canada geese, we found that flock response generally was low when electronic snow goose calls were used, but was even lower in afternoon compared to morning hunts. Hunting in afternoons under the authority of our scientific permit, a time when taking nontarget geese was not permitted, possibly affected these results. Our exclusive access to fields containing large flocks of feeding goose resulted in productive experimental hunts in the afternoon when using traditional calls. Accordingly, our flock-response and kill-rate estimates in the afternoon may be higher for traditional calling methods than in situations where all hunters were allowed to hunt in the afternoon.

**Decoy arrangement**

As expected, we found that vulnerability of Canada and white-fronted goose to hunting varied among decoy sets typically used in prairie Canada. Flock responses of Canada and white-fronted goose and kill rate of Canada goose declined as the proportion of white decoys increased in the set. The age ratio of harvested white-fronted goose was lower for dark than white decoys, and flock response of white-fronted goose was highest in afternoon hunts when dark decoys were used, where it was highest in morning hunts when other decoys were used. These differential responses by both species to varying decoy sets could be useful in managing harvest of nontarget dark goose species through restrictions on decoy types used with electronic calls.

**Management Implications**

Our results indicated that use of electronic snow goose calls will not increase kill rates of dark goose species in prairie Canada. Moreover, when electronic snow goose calls were used, kill rates of
Canada and white-fronted geese were further reduced by using white decoys. These results present waterfowl managers with a cautious approach to prevent increasing the harvest of dark goose species by permitting use of electronic snow goose calls during the general hunting season only in combination with white decoy sets. Based on our results, CWS legalized electronic snow goose calls when used with white decoys for the fall 2002 hunting season in Manitoba, Saskatchewan, and Quebec (Canadian Wildlife Service Waterfowl Committee 2002).

Rockwell and Ankney (2000) estimated for the period 1998–2004 that a fixed annual harvest of 1.41 million snow geese was necessary to reduce the midcontinent population to a desired level of 3 million. With implementation of special provisions and the conservation order in 1998, the estimated annual snow goose harvest has increased (Figure 2). Our results indicated that legalizing electronic snow goose calls during regular fall hunting seasons in prairie Canada would complement existing special provisions and the conservation order and increase the likelihood of achieving the desired annual harvest of snow geese.

With the rise in popularity of electronic calls, numerous snow goose recordings have been produced by different companies and are available to hunters. We believe the content of recorded calls used must be closely monitored and regulated by enforcement agencies to ensure that harvest of nontarget geese does not increase. In particular recordings should be screened to ensure that nontarget goose species are not included on tapes or compact discs used for hunting snow geese.

Finally, Olsen and Afton (2000) noted geographic variation in vulnerability of snow goose to electronic snow goose calls, and we suggest that nontarget species also might exhibit geographic variation in their response to electronic calls. Our study was confined to the Canadian prairies, where most fall migrant geese first encounter considerable numbers of hunters (i.e., they are relatively naïve and therefore should be most susceptible to harvest). Our results could therefore be considered conservative because geese become less vulnerable to harvest as the season progresses and they gain experience (Lindberg and Malecki 1994). Further research investigating the effects of electronic snow goose calls on nontarget species may be needed before electronic snow goose calls are legalized during general waterfowl seasons at other locations.

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Jason H. Caswell (left) is a Ph.D. student at the University of Saskatchewan. He received a B.S. in environmental science (1998) from the University of Manitoba and an M.S. in forestry, wildlife, and fisheries (2001) from Louisiana State University. Jason’s current research focuses on the population ecology of eastern arctic-nesting Ross’s geese, and mallard vulnerability to hunting with spinning-wing decoys in prairie Canada. Alan D. (Al) Afton (center) is Assistant Leader-Wildlife of the USGS-Louisiana Cooperative Fish and Wildlife Research Unit and adjunct associate professor of wildlife in the School of Renewable Natural Resources at LSU. Al holds a B.S. in wildlife biology (1973) from Kansas State University, an M.S. in wildlife ecology (1977) from the University of Minnesota, and a Ph.D. in biology-behavioral ecology (1983) from the University of North Dakota. He and his graduate students focus their research on basic and applied questions concerning waterfowl ecology and the conservation and management of wetland habitats. F. Dale Caswell (right) is chief of waterfowl management in the prairie and northern region for the Canadian Wildlife Service. He received a B.S. from the University of Manitoba and an M.S. in biology from the University of North Dakota. Dale’s current work focuses on the cooperative management of arctic nesting geese and prairie ducks.

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