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Tools and Technology

Evaluation of a Clutch-Containment Method During Hatch in Geese: Using Resident Canada Geese as an Example

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ABSTRACT Disruption associated with nest visits during the hatch period of waterfowl can cause partial abandonment of hatchlings, potentially causing bias in the survival of marked birds. We evaluated the use of a mesh clutch-containment bag to capture and mark entire broods of 151 resident Canada goose (*Branta canadensis*) nests, prior to hatch, while minimizing observer-caused disruption during brooding. The study was conducted in New Jersey, USA, from April to June 2010. No differences were found in hatch success or the number of hatchlings marked between contained clutches and the control group. Although this technique was not beneficial in studying gosling survival in temperate nesting populations, it may be effective in sub-Arctic nesting conditions where nest visits are conducted using a more invasive approach such as a helicopter.

KEY WORDS *Branta canadensis*, Canada goose, clutch, gosling, New Jersey, survival.

Measuring survival of Canada geese (*Branta canadensis*) goslings through fledging has been shown to be very challenging, primarily due to their small size and the habitats in which they live (Stolley et al. 1999). Most gosling mortality occurs in the first 2 weeks following hatching (Steel et al. 1957, Brakhage 1965, Zicus 1981, Eberhardt et al. 1989), making this stage a critical component in estimating gosling survival. However, gosling survival rates can vary drastically across populations, habitats, techniques, and/or level of effort (Stolley et al. 1999).

Several approaches are used to estimate gosling survival including comparing total hatchling counts to total gosling counts at a later date, as well as the comparison of mean number of hatchlings per nest to mean brood size at a later date (Stolley et al. 1999). Unfortunately, both inherently overestimate survival due to the inability to account for total brood loss, brood mixing, or emigration (Zicus 1981). Mark–resight–recapture can improve estimates, particularly when using a combination of individually marked hatchlings and marked adults (Stolley et al. 1999).

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Hatching usually occurs during the early hours of the day, followed by brooding of hatchlings in the nest bowl for about 24 hr (Brakhage 1965). Brooding allows for drying of feathers, thermoregulation, and absorption of the remaining nutrients from yolk lipids (Batt et al. 1992). The initial brooding period is followed by a permanent departure from the nest site for brood rearing. Disturbance caused by nest visits during the brooding period can cause older hatchlings to depart the nest site with the adults prematurely; leaving the newly hatched birds unprotected, not fully brooded, and possibly abandoned (Livezey 1980, Esler and Grand 1993, Verboven et al. 2001). Additionally, repeated nest visits are often required during the last 3–5 days in order to verify the exact hatch date. This added disruption can increase the likelihood that adults will flee the nest site with only a partial brood during subsequent visits (Livezey 1980).

To address problems of partial clutch abandonment in Canada geese and increase the capture of hatchlings, we evaluate a method that uses a mesh clutch-containment bag during the hatch period. Containment of the clutch allows for marking of complete broods with the intent of minimizing disruption of natural brooding activities and reducing abandonment of newly hatched birds by parents.

STUDY AREA

We conducted Canada goose nest searches at 11 locations across 6 counties and 4 physiographic strata in New Jersey, USA, that were known nesting and brood-rearing sites.

Locations included state-owned wildlife management areas and fish hatcheries, municipal parks with associated lakes, a closed municipal landfill, and a privately owned youth camp. Study sites ranged in size from 6 ha to 135 ha. The mean high temperature for April and May 2010 was 20° C (69° F) and 24° C (76° F), respectively. The four primary physiographic strata covered within these plots included Highlands, Northern Piedmont, Coastal Plain, and Salt Marsh habitats. The Highlands region had recently experienced tremendous human development; however, this stratum offered breeding waterfowl habitat primarily in areas dominated by freshwater wetlands, rivers, farm ponds, and reservoirs. Northern Piedmont was a sediment-filled rift basin bound by the Blue Ridge Mountains and the eastern side of the Appalachians. Low rolling hills and poorly drained soil held natural streams and water bodies that proved beneficial for waterfowl. While part of the Coastal Plain offered moist, poorly drained soil, much of this stratum in New Jersey consisted of sandy, infertile soil. Primary breeding waterfowl habitat included palustrine wetlands and manmade sandwash ponds. The salt marsh region was tidal wetland primarily consisted of cordgrass (*Spartina* spp.), and offered both wintering and breeding habitat for many waterbirds. This stratum was located along the tributaries of the Atlantic coast and Delaware Bay.

METHODS

We conducted nest searches by foot and boat during the peak laying period from 1 to 30 April 2010. We aged embryos utilizing both field-candler (modified from Weller 1956, Cooper and Batt 1972) and egg-floating (USDA 2009) techniques to estimate the incubation stage and hatch date. We averaged the results from both methods to gain the most accurate estimate of hatch date (Reiter and Andersen 2008). We randomly assigned each nest to either a clutch-bag treatment or no-clutch-bag control group prior to hatch. We stratified the sample by location to reduce bias associated with other variables affecting hatch success.

We used vocalizations of young, or "peeping," as an indication that the nest would hatch in about 2 days (Kossack 1950, Cooper 1978). We used the presence of egg pipping, evident by a star-shaped crack on the surface of the shell, as an indication that the nest would hatch within 1 day. On the evening prior to hatch, we contained the clutch of all nests within the treatment group with a 35.5-cm × 71.0-cm (12″ × 24″) green, plastic, expandable-mesh, clutch-containment bag (Big Apple Packaging onion sack; US$ 0.14/bag; Fig. 1). The mesh size was 4.8 mm × 4.8 mm, which offered limited potential for legs or wings to become entangled. We contained a maximum of 5 eggs within each bag, and we used 2 bags if clutch sizes were >5 eggs. We left as much open space as possible within the bags to facilitate movement of hatching goslings and space for egg remains and closed bags with an overhand knot to ensure containment of the clutch. After treatment, we covered each bag with down and materials from the nest bowl to help prevent avian predation (Rearden 1951). We also visited nests within the control group just prior to estimated hatch date to verify the exact hatch date.

We revisited all treatment clutches <18 hr after containment and all control nests on the morning of the predicted hatch date. We recorded the number of hatched goslings within each clutch on their hatch date. We removed goslings, as well as pipped and unpipped eggs, from the nest bag in treatment clutches. We determined the number of eggs that hatched from nests within the control group by counting the number of 1) goslings within the nest bowl, 2) eggshells with intact membranes in the nest bowl, and/or 3) goslings associated with the adult near the nest. We applied Monel size no. 1005-1 web tags (Alliston 1975) to the center of the outside web of the right foot of hatchlings and birds within star-pipped eggs, as part of a separate study of gosling survival. New Jersey Division of Fish and Wildlife staff recaptured marked goslings during annual molt banding efforts in late June 2010. This study was conducted under a banding permit from the Bird Banding Laboratory/U.S.

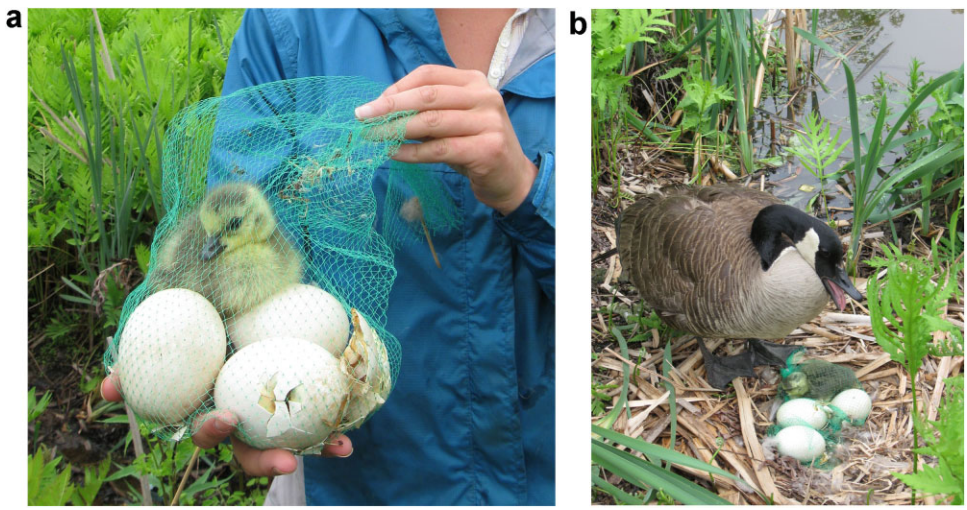

Figure 1. a: Clutch-containment bag with hatchling and 3 pipping eggs used during 2010 resident Canada goose nesting season in New Jersey, USA. b: Nest site with adult protecting clutch and young during hatch period.

Geological Survey Patuxent Wildlife Research Center (permit 06460).

We estimated mean hatch success and standard error for the treatment and control groups using all nests that were active on the day prior to hatch. Hatch success was defined by the number of goslings that hatched divided by the number of eggs present on the day prior to hatch. We assumed that variation in natural hatchability was similar across both the treatment and control groups. We used a 2-tailed Student's t-test ($\alpha = 0.05$) to test for differences between the mean hatch success of the treatment and control groups. We also calculated the proportion of hatchlings that were successfully marked within each brood for the treatment and control groups, and we tested for differences between the proportions of the two groups using a Chi-squared test ($\alpha = 0.05$).

RESULTS

We located and monitored 222 Canada goose nests in 2010. We assigned 110 nests to the treatment group and 111 nests to the control group. Seventy-one nests failed during the incubation period prior to hatch. On the day prior to hatch, 72 nests remained in the treatment group, and 79 nests remained in the control group. The average clutch size was 5.17 eggs (SE $\pm$ 0.12 eggs).

The mean hatch success of the treatment group was 0.803 (SE $\pm$ 0.02), while the mean hatch success of the control group was 0.834 (SE $\pm$ 0.03). There was no difference between the mean hatch success of nests contained with clutch-containment bags and control group ($\chi^2_1 = 0.71$, $P = 0.40$). Six hundred thirty-one goslings hatched from 151 nests; and of those, we web-tagged 555 goslings for use in a separate gosling survival study. Seven goslings from 3 nests were found dead in nest bags from the treatment group, and 6 goslings from 3 nests were found dead in nest bowls from the control group. We were unable to distinguish natural deaths from those caused by the clutch-containment bag in the field.

The average proportion of hatchlings marked within broods in the treatment group was 0.897 (SE $\pm$ 0.04). The average proportion of hatchlings marked within broods in the control group was 0.824 (SE $\pm$ 0.04). There was no difference between the proportion of marked hatchlings within the treatment and control groups ($\chi^2_1 = 1.584$, $P = 0.21$).

DISCUSSION

We did not find a difference between the hatch success of the treatment and control groups. The mean hatch success rates of nests within the treatment and control groups were similar to those of other Atlantic Flyway Resident Population Canada goose nesting studies (Rummel 1979, Conover 1998, Huskey et al. 1998, Peters et al. 2003). Thus, this technique did not apparently affect hatch success in this study.

However, we did not mark a larger proportion of hatchlings whose clutches were contained compared to control nests. Due to the increased accessibility of nesting locations in comparison with those of sub-Arctic nesting geese, we were able to mark a large proportion of hatchlings within each brood (0.855). For gosling survival studies of sub-Arctic nesting geese, this technique may offer additional time during the hatch period to be present for marking entire broods (See Stolley et al. 1999 for broad discussion of biases).

We observed that incubating females in both the treatment and control groups spent time tending the contained clutch (i.e., rotating eggs, arranging down and nest materials) immediately after returning to the nest. We observed no apparent difference in the reaction of adults between control and treatment groups following the application of the containment bag. However, in one instance, a contained clutch of unhatched eggs was found floating in the water adjacent to a nest on the edge of a pond. Given that the clutch was contained within the bag as a unit, the clutch apparently fell into the water when the female was tending the nest. Had this clutch not been contained within a bag, perhaps only a single egg would have fallen into the water. Although this only happened on one occasion, we nevertheless recommend consideration of the nest location when using this methodology.

This methodology successfully ensures that sampling efforts will measure full clutches with little to no harm to hatchlings. Although containing the clutch during hatch has the potential to allow for an increased sample size of marked hatchlings, we did not observe a difference in sample size using this technique. Nonetheless, we urge prudent caution to minimize potential biases with administering this technique. First, we applied bags during the late part of the day prior to hatch, and we removed them during the following morning to ensure that hatched goslings were not enclosed during the heat of the day. Second, attention must be directed toward ensuring that all nest bags are removed on the hatch date, and that no unhatched eggs are left contained. This will avoid the rare occurrence of a late-hatching bird being contained within a nest bag on a warm day after their brood has left the nest site. Third, although newly hatched goslings are not able to walk, ample space must be given for movement of hatchlings immediately following hatch. Fourth, when studies are conducted on public lands in temperate regions, there is the potential that members of the public will observe this technique in practice and not understand its purpose or that it is not causing undue harm. As a result, signage may be necessary in nesting areas that are open to the public.

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