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COMPARING THE ACCURACY OF EGG CANDLING AND EGG FLOTATION TO ESTIMATE THE HATCHING DATE OF NORTHERN BOBWHITE CLUTCHES

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ABSTRACT

Floating and candling avian eggs to assess hatch dates has been used successfully to estimate hatch dates for wild bird clutches for decades. However, there is a dearth of information assessing the accuracy of these techniques to estimate northern bobwhite (*Colinus virginianus*) hatch dates. We captured and fitted a hen bobwhites with very high frequency transmitters during January and February of 2011–2012. We monitored each bird twice weekly until nesting was initiated. We searched for the nest while the hen was away from the nest (i.e., feeding) to reduce potential abandonment. We used egg floatation and egg candling methods to attempt to estimate wild northern bobwhite clutches during the 2011–2012 nesting seasons. We used a mini MagLite© (97 lumens; Mag Instrument, Inc., Ontario, CA, USA) with the glass lens removed so eggs would sit near the bulb to increase the illumination. We used a dark green 68-cm × 137-cm towel to cover the observer in the field to reduce the naturally occurring light, which might have reduced the visibility of the chick embryo. We based age of the eggs (no. of days since the start of incubation) on the embryo growth stage at the time of nest discovery. We conducted egg floatation at the same time as candling. We used a 100-mL glass beaker with 100-mL of ambient temperature tap water to completely submerge the egg to estimate hatch date. We based the flotation estimation age on the angle at which the egg floated in the water. We also conducted a controlled laboratory experiment using pen-raised quail eggs collected from the breeding colony at the Quail-Tech Alliance breeding facility in Lubbock, Texas. We placed 110 eggs in a commercial incubator that was maintained at 37° C with 55% humidity for the duration of the study. We used 3 novice observers to determine the impact of observer bias on the techniques of estimating hatch date. We placed random groups of eggs (i.e., 5–15 eggs at a time until 110 eggs were obtained) into the incubator at a staggered rate to increase variation in the study. We used the same field techniques for hatch date estimation in the controlled study. We first floated eggs during both controlled and field observations to reduce any potential bias that candling might have on the hatch date estimation (i.e., lack of embryo growth). During the controlled study observers examined the eggs individually. Using the average estimated hatch date (Julian date) as a predictor, we used linear regression to determine the accuracy of the candling and floating methods. We also used a linear regression to determine the accuracy of each estimation technique and observers. When candle and egg floating occurred in a field setting, both methods were found to overestimate the actual hatch date of the clutches discovered ($n = 47$; $R^2_2 = 0.993$, $P < 0.001$; estimated hatch days when using candle: $\bar{x} = 1.21 \pm 0.92$ days, floating: $\bar{x} = 0.89 \pm 0.97$ days). However, the mean difference between the candling and floatation was –0.38 days (SE = 1.07 days). Regression analysis suggests that candling and egg flotation are fairly accurate predictors of the actual hatch date for newly discovered bobwhite nests (candling: $\beta = 0.43$, $t = 3.75$, $P = 0.001$; floating: $\beta = 0.53$, $t = 4.79$, $P < 0.001$). Use of the candling method appears to be correct 43% of the time whereas egg floatation accurately predicted the estimated hatch date 53% of the time. Under controlled conditions, all 3 observers were new to both techniques of hatch date estimation and were all taught by the same instructor for each method. During the controlled test, we found that observers were highly variable. Two observers could predict the estimated hatch date by using the candling and egg flotation methods to a close estimation of the actual hatch date (floating [observer 1: $\beta = 0.23$, $t = 2.80$, $P = 0.006$ and observer 2: $\beta = 0.47$, $t = 5.52$, $P < 0.001$]; candling [observer 1: $\beta = 0.30$, $t = 4.00$,$P = 0.006$, observer 2: $\beta = 0.219$, $P < 0.01$]). Although observer 3 was unable to predict the estimated hatch date for both estimation methods (floating: $\beta = -0.001$, $t = -0.013$, $P = 0.684$; candling: $\beta = 0.043$, $t = 0.40$, $P = 0.990$). We also examined any potential abandonment or hatchability issues that might have risen while using candling or floating to estimate hatch dates for wild clutches. We found that 0.06% (5 of 80 nests) of hens abandoned their clutches during this study. Of the 5 nests that were abandoned zero were abandoned because of measurements obtained during the initial investigation of the nest site. All abandonments were due to either weather (i.e., summer hail), predators, or livestock. Viability and hatchability were unaffected for the remaining clutches that were measured during the field study. We found that candling and egg flotation are both viable methods for estimating hatch dates of bobwhite clutches during an initial measurement when a nest is discovered. When an entire clutch is measured accuracy can be within 1 day of the actual estimated hatch date (based on a 24-day incubation period). However, observers or researchers who will estimate hatch dates for clutches should be properly trained and allowed time to acclimate to the measuring techniques to potentially increase their accuracy at estimating hatch dates for northern bobwhite clutches.

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Key words: egg candling, egg floatation, *Colinus virginianus,* hatch date, linear regression, northern bobwhite

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