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Nest Success of Giant Canada Geese in Southern Illinois

Michael Sertle[1] and Michael W. Eichholz[2]
[1,2]Cooperative Wildlife Research Laboratory
[2]Department of Zoology, Center for Ecology
Southern Illinois University, Carbondale, IL 62901-6504

ABSTRACT

Giant Canada Geese (*Branta canadensis maxima*) were released by the Illinois Department of Conservation (IDOC) in west-central Illinois in the late 1960's and in southern Illinois in the mid-1980's in an effort to re-establish resident flocks of Canada geese in Illinois for their aesthetic value and harvest potential. Illinois Department of Natural Resources Giant Canada Goose surveys, however, indicate a density three times greater in the northern 2/3 of the state than in the southern 1/3 of the state. To determine if variation in nest success explains the difference in Giant Canada Goose nesting density between northern and southern Illinois, we estimated nest success of geese nesting in various wetland habitat types in southern Illinois, then compared those estimates to estimates from other studies conducted in central and northern Illinois. In 2003, 181 nests were located and in 2004, 221 nests were located providing 402 total nests for the study. The most parsimonious model included a covariate of clutch initiation date and habitat type, but daily nest survival was held constant between years, and among days of the breeding season, and locations. Nest success for a nest initiated on the mean initiation date over all study sites and years combined was estimated to be 61% (SE = 4.8%). Nest success in our study was greater than or equal to estimates of nest success in other regions of Illinois indicating variation in nest success is not leading to lower population densities of Giant Canada Geese in southern Illinois.

INTRODUCTION

Giant Canada Geese (*Branta canadensis maxima*) were released by the Illinois Department of Conservation (IDOC) in west-central Illinois in the late 1960's and in southern Illinois in the mid-1980's in an effort to re-establish resident flocks of Canada Geese in Illinois for both their aesthetic value and harvest potential. Estimates of breeding densities of Giant Canada Geese in Illinois, however, indicate a nesting density three times greater in the northern 2/3 of the state than in the southern 1/3 of the state (Illinois Department of Natural Resources unpublished goose survey data). Variation in population density between the 2 regions could be due to variation in immigration, emigration, productivity, or mortality.

Variation in productivity of most waterfowl species is most sensitive to variation in nest success (e.g., Hoekman et al. 2002). Kadlec and Smith (1992) suggested differences in habitat type among geographic regions may be the principle factor affecting variation in nest success because habitat dictates: (1) available nesting sites, (2) nutrients available prior to laying and during incubation, (3) behavior of the breeding pair, and (4) protective cover. Habitat differences can influence predator abundance and concealment from predators, both of which impact nest success (Hines and Mitchell 1983, Johnson et al. 1989). Because of the considerable variation in habitat structure among regions of the state, variation in nest success between northern and southern Illinois may lead to differences in regional Canada Goose productivity. In fact, in previous studies, estimates of nest success tended to be higher in southern Illinois (73% SE = 4%) than northern (44%, SE = 1.5%) or central (63% SE = 2%) Illinois. These results indicate low nest success is not the cause of the difference in population density between regions of the state (Butler 1987, Lawrence 1987, Cline 2004). Despite these results, management strategies designed to increase nest success (e.g., building nesting structures and islands) have been implemented to increase productivity of Giant Canada Geese in southern Illinois. An argument supporting the continued use of these practices is the method used to estimate nest success in central and southern Illinois (termed apparent nest success), is inherently biased high (Mayfield 1961). Furthermore, reclamation of the surface mines on which most of the nests were located in southern Illinois was completed within 5 years of the initiation of the study, thus, the successional stage of the vegetation in those habitats has likely advanced considerably since the original study; leading to potential changes in nest success. Because of the potential bias associated with the methodology originally used to estimate nest success in central and southern Illinois, and the likely changes in the successional stage of the habitat in southern Illinois, we believe additional information regarding variation in nest success is needed to determine if management actions designed to increase productivity by increasing nest success is an appropriate strategy.

To determine if variation in nesting densities among regions of the state may be at least partially explained by variation in nest success and determine the potential of increasing Giant Canada goose productivity in southern Illinois by implementing management strategies that increase nest success, we estimated current nest success of geese nesting in a variety of habitat types in southern Illinois. We then compared those findings to previous studies of goose productivity in central and northern Illinois.

METHODS

Study Site

Our study sites included minelands, parklands, and reservoirs; habitats that are commonly found in southern Illinois. A study site was classified as parklands if > 50% of the upland habitat was mowed and the mowed area was larger than the surface area of any associated waters (e.g., city parks). A study site was classified as reservoir if < 50% of the upland habitat was mowed and the mowed area was smaller than the surface area of any associated waters. Minelands were classified as any habitat associated with reclaimed surface mines. Study sites that were classified as reservoirs included Baldwin Lake, an 809 ha reservoir located north of the town of Baldwin, Illinois, on the border of Randolph and St. Clair Counties and Kinkaid Lake, a 1115 ha reservoir located west of Murphysboro, Illinois, in Jackson County. The lone parkland site was the DuQuoin State Fairgrounds located in Perry County east of DuQuoin, Illinois.

Reclaimed surface mines are distributed widely throughout southern Illinois and were included as a separate category because of the inherent physical traits associated with mine reclamation. Surface mines are categorized as either “pre-law” or “post-law.” Pre-law surface mines are those where mining was completed prior to the first Illinois reclamation law in 1962 (Lueth 1986). Pre-law mines are characterized by numerous spoil ridges, steep and elongated islands, deep lakes, small ponds between spoil ridges, and dense forest cover (Lueth 1986, Butler 1987). Pyramid State Park, a 809 ha mine located southwest of Pinckneyville, Illinois, in Perry County and purchased by the Illinois Department of Natural Resources for recreational use was the lone a pre-law surface mine included in our study.

Post-law mine reclamation initially required spoil ridges to be leveled off to a minimum width (~ 3m), but later reclamation laws required that spoil ridges be graded to the original land contour and restored to its original production capability (Lueth 1986:3). Post-law mines are characterized by deep lakes, small ponds, rounded islands, limited tree growth, fields composed of grasses and herbaceous plants, and agricultural fields (Lueth 1986, Butler 1987). The study sites classified as post-law minelands include: Burning Star #5, a 2,025 ha mine located east of DeSoto, Illinois in Jackson County; Captain-Hunter, a 6,475 ha sub-unit of Pyramid State Park, located southeast of Cutler, Illinois, in Perry County; River King #3 a 728 ha mine located northeast of New Athens, Illinois, in St. Clair County; and a 200 ha portion Sahara #6, located west of Harrisburg, Illinois, in Saline County. The River King #3 and Sahara #6 mines were included in earlier studies of giant Canada goose populations in southern Illinois, following initial reintroduction in the early 1980's (Lueth 1986, Butler 1987).

After our first field season, efforts were focused on those study sites with the highest nesting densities of Giant Canada Geese, thus, Pyramid State Park was dropped from our study. This was done to increase the number of web-tagged goslings that were used in a different component of the study.

Data Collection

Nest Searches. Nest searches were conducted weekly at each study site, beginning the first week of March and continuing through the end of the nesting season (approximately the middle of May). We visually located nests with a shore-based spotting scope by observing females sitting on nests or pairs displaying nesting activities, on foot by walking potential nesting areas, or by boat to survey potential nesting areas. A nest was considered to be active if at least one viable egg was found within the nest bowl upon the first encounter, additional eggs were found upon subsequent encounters, or incubating activities (i.e. lining the nest bowl with down feathers, female actively incubating the clutch, or pair defending the clutch) were observed. Each nest was assigned an alphanumeric code (site and nest number), which was recorded on an aerial photograph of each site. During the 2004 field season, nests in high-density nesting areas were marked with a numbered stick to avoid nest misidentification.

Nest Monitoring. Nests were visited once a week until hatching, nest loss, or abandonment. The age of the clutch within each nest was determined by egg flotation, allowing us to also estimate the projected hatch date of each clutch (Westerkov 1950, Alberico 1995, Walter and Rusch 1997). During times of expected hatch, some nests were visited twice a week to increase the chance of observing goslings in the nest bowl. Nests were classified as successful if one or more eggs hatched.

Statistical Analysis

Nest Success. We used Dinsmore's model in Program MARK to determine if the data indicated nest survival varied by study site, nesting habitat, age of nest when first located, year, date, and initiation date (White and Burnham 1999, Dinsmore et al. 2002). Dinsmore's model in Program MARK was chosen because it allows us to relax some of the assumptions associated with the Mayfield Method (White and Burnham 1999, Dinsmore et al. 2002). For example, the Mayfield Method is based on the assumption of nest survival being constant over time, whereas Dinsmore's model in Program MARK generates daily survival estimates, which allow for modeling across multiple groups, such as age of nest when first located and initiation date (Dinsmore et al. 2002, White pers. comm. 2005). The quasi-likelihood parameter (*c*-hat) was calculated by dividing deviance by the degrees of freedom of the saturated model. The *c*-hat was used to adjust for over-dispersion of the data for each model, and to obtain a quasi-Akaike's Information Criterion (QAICc) in order to determine which model best fit the nesting data from a model set that included models with all main factors and two-way interactions. The daily nest survival estimated from the most parsimonious model was multiplied exponentially by a power equal to the sum of average total clutch size and a twenty-eight day incubation period (for this study that value was equal to 33) to calculate the nest success for each study site (Brakhage 1965, Cooper 1978, Coluccy 2001).

$$\text{Nest Success} = \text{Daily Survival Estimate}^{\text{(Average Total Clutch Size + Incubation Period)}}$$

To estimate overall nest success for the study, the most parsimonious model was chosen from the models which did not allow nest success to vary by individual study site or habitat type, and the above equation was used. The Delta method was used to estimate the variance for estimates of nest success (Seber 1982:7).

RESULTS

In 2003, 181 nests were located and in 2004, 221 nests were located providing 402 total nests for the study. All nests were found on islands or peninsulas and no artificial nest sites were used even though they were available in both years of the study. The first nest located in 2003 was initiated on March 11 and the first nest located in 2004 was initiated on March 4. The last nest was initiated on April 22 in 2003 and on April 27 in 2004. Peak initiation was March 25 in 2003, March 15 in 2004, and March 24 for both years combined. The peak hatch date was April 24 in 2003, April 21 in 2004, and April 24 for both years combined.

Nest Survival and Success. The value for *c*-hat was calculated as 3.51 for the global model indicating moderate over-dispersion, therefore, a variance inflation factor of 3.51 was applied to all estimates of sampling variance and model selection criteria. The most parsimonious model included a covariate of clutch initiation date and habitat type (i.e., mineland, parkland, and reservoir) but held nest survival constant across all other parameters (Table 1). Daily nest survival was estimated to be greater for the parkland habitat than for the mineland or reservoir habitat (Table 2). Using the most parsimonious model that held nest survival constant among habitat types and study sites (the second model in Table 1) we estimated daily survival rate of nests with an average initiation date to be 0.985 (SE = 0.003) and nest success to be 61% (SE = 4.8%). Nest depredation was the cause of > 98% of the nest failure with nest abandonment (likely due to wave action on one reservoir) accounting for the other approximately 2%.

DISCUSSION

For an unknown reason, the current nesting density of Giant Canada Geese in southern Illinois is low relative to the northern 2/3 of the state. The density of a population is primarily determined by the product of its various vital rates. One vital rate that has been identified as having a large influence on the productivity of waterfowl populations is nest success. Therefore, variation in nest success among regions of Illinois may help explain variation in nesting density, and thus, management strategies designed to increase nest success may be appropriate when attempting to increase nesting density of Giant Canada Geese in southern Illinois. Our estimate of nest success, 61% (SE = 4.8%), however, was higher than that from a study conducted in northern Illinois (44% SE = 0.8%, Cline 2004), and similar to a study conducted in central Illinois (63% SE = 2%, Lawrence 1987). While it should be noted, apparent nest success was used for the study in the central Illinois, thus, the estimate is likely biased high (Mayfield 1961); unbiased estimators were used for both Cline's (2004) study in northern Illinois and our study.

For this study, we were unable to locate nests in habitats other than islands or peninsulas, and most noticeably, no artificial nesting sites (i.e. tubs, tires, hay bales, etc.) were used despite their availability during both years of the study. Nest success is generally higher when islands or nesting structures are chosen as nesting sites (Ewaschuk and Boag 1972, Lueth 1986, Butler 1987, Lawrence 1987, Coluccy 2001). Even when we compare nest success of nests found only on islands or peninsulas between regions of Illinois, however, it appears nest success is as high or higher in southern Illinois (61%, SE = 4.8%) than northern Illinois (48%, calculated from Cline 2004's estimates of daily nest survival).

Nest success has been found to be negatively impacted by predation, abandonment, dump nesting, weather, overcrowding, and poor nest site location (Hines and Mitchell 1983, Lueth 1986, Johnson et al. 1989, Kadlec and Smith 1992). In our study, almost all nest failure (> 98%) was attributed to nest depredation, whereas, in northern Illinois, predators played a lesser role causing only about 60% of he nest failures while nest abandonment (approximately 20%), and nest flooding (approximately 8%) were also important. We hypothesize causes of nest failure differed between the regions due to differences in predator density and density of nesting geese. Almost all nest locations from our study were in rural settings relative to nests located in Cline's (2004) study in northern Illinois. We hypothesize the more rural conditions found in southern Illinois likely supported a higher density of goose nest predators leading to greater nest predation. This hypothesis is supported by the variation in nest success observed among habitat types in our study (Table 2). In our study, nest failure was substantially higher in more rural habitats (minelands and reservoirs) than in the more urban parkland habitat. Furthermore, we hypothesize the reason other factors commonly found to impact nest success (i.e. nest abandonment and flooding) were unimportant in our study was due the low nesting density in southern Illinois relative to northern Illinois. Most nest abandonment occurs from conflicts between neighboring nesting pairs (Kadlec and Smith 1992). We suggest nesting density in southern Illinois is inadequate to cause substantial conflict between neighboring pairs, thus little nest abandonment occurs. Also, we hypothesize low nesting density relative to other regions allows geese to select nest sites with little likelihood of flooding, preventing nest failure due to flooding. This hypothesis is supported by our observation that, in contrast to most areas where artificial nesting structures exist, artificial nesting structures were unused on our study, indicating that more natural secure nesting sites were available. Alternatively, Kadlec and Smith (1992:597) suggested that the use of artificial nesting structures "may be a learned trait, resulting in low occupancy rates until a local population accustomed to the structures is built up." Indeed, the vast majority of artificial nesting structures available during this study had only been available for one to two years. Thus, it is possible that the Canada Geese nesting on study sites with artificial nesting structures had not yet "learned" how to efficiently use them.

Despite the apparent high rate of nest failure due to nest predation in southern Illinois relative to northern Illinois, nest success in southern Illinois (61%, SE = 4.8%) appears to be greater than nest success in northern Illinois (44% SE = 0.8%) and similar to the potentially biased estimate of nest success in central Illinois (63%, SE = 2%). Therefore, low nest success is likely not the explanation for the low population density of Giant Canada Geese in southern Illinois relative to other regions of the state. Even in regions of the country where tools such as artificial nesting platforms have been used extensively as a management strategy to increase nest success, nest success rates substantially greater that 61% have rarely been achieved (see Coluccy 2001 for review), thus artificially increasing nesting habitat in southern Illinois would likely have little effect on productivity of Giant Canada Geese. In addition, if other components of productivity such as gosling growth (Sertle 2005) are more limiting, increasing nest success will likely have little impact on the population. These results indicate management strategies designed to increase nest success will not likely achieve the goal of increasing nesting density of Giant Canada Geese in southern Illinois.

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Table 1. Comparison of nest survival models using Dinsmore's model in Program MARK including all models with a $\Delta QAIC_c$ of < 25.

Model	Deviance	K	$QUIC_c$	$\Delta QAIC_c$	w_i
Initiation Date + Habitat	232.82	4	240.82	0.00	0.83
Initiation Date	240.94	2	244.94	4.12	0.11
Site + Initiation Date	228.95	9	246.97	6.15	0.04
Year + Site + Initiation Date	228.94	10	248.97	8.15	0.01
Year + Site + Initiation Date + Age of Nest	228.88	11	250.91	10.09	0.00
Year * Site * Initiation Date	216.45	18	252.54	11.72	0.00
Site * Initiation Date	226.96	14	255.01	14.19	0.00
Constant	259.06	1	261.07	20.24	0.00
Calendar date	235.56	15	265.62	24.80	0.00
Site	249.86	8	265.87	25.05	0.00

Year = 2003, 2004.
Habitat = Mineland, Parkland, Reservoir.
Age of Nest = The age of the nest at the time of discovery in days.
Initiation Date = The Julian date on which the clutch was believed to have been initiated.
Calendar Date = Allowed survival to vary by date.
Site = Baldwin Lake, Captain-Hunter, Sahara #6, Burning Star #5, Pyramid State Park, Kinkaid Lake, River King #3, DuQuoin State Fairgrounds.
K = The number of parameters.
w_i = The model weight.

Table 2. Percent nest success ± standard error (SE) from the second model in Table 1.

Study Site	No. of Nests	Daily Nest Survival	Nest Success
Reservoir	256	0.982 ± 0.003	52% ± 2%
Mineland	106	0.984 ± 0.005	56% ± 3%
Parkland	40	0.998 ± 0.002	95% ± 1%
Southern Illinois	402	0.985 ± 0.003	61% ± 5%