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Precocious Breeding by Yearling Giant Canada Geese

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Many species of waterfowl are capable of breeding as yearlings. In the subfamily Anserinae, however, reproduction normally does not commence until individuals reach two to four years of age (Rohwer 1992). Most published accounts indicate that Canada Geese (*Branta canadensis*) conform to the pattern typically found in other geese, deferring reproduction as yearlings and initiating breeding when birds are two years of age or older (Hanson 1962, Brakhage 1965, Bellrose 1980, Moser and Rusch 1989). The few documented exceptions (Brakhage 1965, Cooper 1978, MacInnes and Dunn 1988) suggest that the likelihood of a successful breeding attempt is higher for yearling males than females and that when early breeding occurs, one member of the pair is often at least two years old. Only two records of nesting attempts by yearling female Canada Geese have been published (Hall and McGilvrey 1971, Mickelson, 1975). In each case, the female produced some fertile eggs but deserted the nest before the eggs hatched.

The observations noted above demonstrate that reproduction by yearling Canada Geese is physiologically possible for both sexes, but they also raise a number of interesting questions regarding why most individuals defer breeding during their first year. Energetic or nutritional constraints, and the inability of yearlings to secure and successfully defend a territory, are likely physiological (Elder 1946) and social (Brakhage 1965) impediments to early breeding. From an evolutionary perspective, reduced reproductive success of yearlings relative to adults, and increased mortality associated with early breeding, also may contribute to deferred sexual maturity in waterfowl (Rohwer 1992).

A nine-year study of the demographics and ecology of Giant Canada Geese (*B. c. maxima*) in central Missouri provided an opportunity to monitor the incidence and success of nesting attempts by yearling males and females in a local population that was established by translocation of wild geese 20 years ago. In this paper, we present data on the incidence of breeding by yearlings in this population and offer several potential explanations for the occurrence of precocious reproductive activity.

Methods.—Because the age of adult geese cannot be determined accurately from plumage or morphology, estimation of age-specific breeding rates requires data from geese marked during their first summer of life. To obtain a sample of marked individuals, geese were captured by drive trapping each year from 1989 through 1998 during the summer flightless period. Age (hatching year or after hatching year) and sex of captured geese were determined using cloacal and plumage characteristics (Hanson 1959). Geese were marked with standard U.S. Fish and Wildlife Service aluminum leg bands and uniquely coded white neckbands that could be read with a spotting scope from a distance of 200 m (Malecki and Trost 1986).

Nesting data from marked yearling geese were classified as nesting attempts or as successful nests. The category "nesting attempt" included all observations of marked yearlings that were known to have established a nest. These data were derived through observations of marked pair members incubating during spring nesting surveys, observations of marked pair members with goslings during June brood surveys, and capture of marked yearling females with incubation patches during June banding (Hanson 1959). Nesting attempts were classified as "successful nests" only when hatching was confirmed by observation of young.

Results.—Between 1989 and 1997, 4,161 geese were neck-banded in central Missouri. Of these marked individuals, 1,549 were hatching-year males and 1,420 were hatching-year females. During seven years of monitoring, we obtained 1,062 records of nesting attempts (415 involving known-age individuals) by marked adult and yearling Giant Canada Geese. Nesting by yearling geese accounted for 19 of these records, and the incidence of yearling nesting was equally divided between males (10 records) and females (9 records). Six of the yearling nesting attempts were confirmed from multiple observations, and the remaining 13 involved single observations.

Of the seven nesting attempts by yearlings that were known to produce young, four involved yearling females and three involved yearling males. In instances where we knew the age of both members

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of a pair, males and females breeding for the first time as yearlings were always paired with older mates. Although the other 12 breeding attempts by yearlings also may have been successful, we were unable to confirm the success of these attempts by observation of goslings.

Discussion.—Although previous accounts indicate that Canada Geese typically defer reproduction until individuals have reached two to four years of age (e.g. Hanson 1962, Craighead and Stockstad 1964, Raveling 1981, Moser and Rusch 1989), our data demonstrate that yearlings of both sexes can reproduce successfully in wild populations, and they provide the first records of successful reproduction by yearling females. These results confirm assertions of earlier investigators that reproduction by yearlings probably is not deterred solely by physiological capability (Hall and McGilvrey 1971).

We note that our determination of yearling success based solely on the observation of yearlings with goslings provides a conservative estimate. Because nest fate could not be determined for all nesting attempts by yearlings, it is possible that some successful attempts were not recorded because complete brood loss from creching, predation, or other causes occurred between hatching and the time marked yearlings were detected.

For either sex, pairing with an older mate provides a potential mechanism that could contribute to the entry of yearlings into the breeding population. In all instances in which the age of a yearling breeder's mate was known, the mate was at least two years old (Brakhage 1965, this study). We believe that pairing with an older bird could influence reproductive status and/or activity of a yearling in several ways. For example, it may confer the advantage of experience in securing a specific nesting territory (assuming that the bird paired with the yearling had nested previously but lost its mate) or in competing with other geese for nesting sites. Another possibility is that the reproductive readiness of the older member of the pair functions as a stimulus that results in precocious breeding.

Another factor that might account for the entry of yearlings into the breeding population is a skewed sex ratio (Brakhage 1965). Brakhage found evidence for a female-biased sex ratio in his study area and suggested that the preponderance of females in the population influenced the incidence of breeding by yearling males. However, the fact that we observed breeding by yearlings of both sexes in a population that according to our nine years of banding records had a nearly equal sex ratio among adults and yearlings would seem to refute Brakhage's explanation.

We do not know whether our results typify reproductive activity by yearling Giant Canada Geese in other parts of their range, or whether they are a function of the sedentary nature of this population. Because these geese are essentially nonmigratory (except for occasional molt migrations), this population may be less constrained physiologically than are other populations or subspecies of Canada Geese. It seems probable, however, that future studies of marked populations of Canada Geese in mid-latitudes also will reveal a higher incidence of breeding by yearlings (particularly females) than has been indicated by earlier work.

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Evaluation of Mist-net Sampling as an Index to Productivity in Kirtland's Warblers

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Many applied and theoretical investigations require information on how productivity varies in time and space (Temple and Wiens 1989, DeSante 1995). Examples include studies of habitat quality, population trends, life-history tactics, and metapopulation dynamics. From a demographic perspective, productivity is the number of young, counted at a given time of year, produced per adult (e.g. Caswell 1989). Various measures have been used to estimate productivity. One of the most attractive is mist netting during the summer after young have left the nest, but ideally before they have left the study area. Several programs use this approach, including the Constant Effort Sites Scheme of the British Trust for Ornithology (Baillie et al. 1986, Bibby et al. 1992) and the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante et al. 1993) in North America.

Hatching-year (HY) and after-hatching-year (AHY) birds are widely believed to have different susceptibilities to netting (DeSante et al. 1995, Peach et al. 1996), so the ratio of HYs to AHYs obtained from netting is not used as an estimate of productivity. Instead, investigators hope that the relative susceptibility to capture is about the same among the samples being compared so that the age ratios in mist-net samples provide a reliable index to productivity (DeSante 1995, DeSante et al. 1995).

Because numerous factors can affect mist-net captures, the reliability of productivity indices based on mist netting needs to be evaluated using independently derived productivity estimates. Feu and McMeeking (1991) found that age ratios in mist-net samples were correlated with nesting success in Eurasian Blackbirds (*Turdus merula*) but not in Song Thrushes (*T. philomelos*). Similarly, Nur and Geupel (1993) found a correlation between mist-netting results and nesting success in Song Sparrows (*Melospiza melodia*) but not in Wrentits (*Chamaea fasciata*).

Studies of this sort have convinced specialists in avian monitoring that mist netting at a single location does not provide a valid index to productivity, either at that site or across a larger region (e.g. DeSante 1995, Peach et al. 1996). It remains uncertain, however, whether mist netting at several locations yields a reliable index of average productivity for the region in which the sites are located. It is possible that annual variation in relative susceptibility of HY and AHY birds to capture in mist nets might obscure trends in productivity across time or space.

Here, we report on the correlation between mist-net indices and productivity in Kirtland's Warblers (*Dendroica kirtlandii*). Our study is unusual because we had good estimates of population-wide productivity, and our mist netting also sampled most of the population. Thus, we had an opportunity to study mist-net indices without the confounding influence of immigration and emigration.

Our primary objective was to determine whether mist netting at several sites provided a useful index to population-wide productivity. Our data also allowed a comparison of capture rates for HY and AHY birds and thus supplement the results presented by Feu and McMeeking (1991) and Nur and Geupel (1993) on the validity of mist netting at a single

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