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NESTING PHENOLOGY AND SUCCESS OF RING-NECKED DUCKS IN EAST-CENTRAL MAINE

DANIEL G. MCAULEY AND JERRY R. LONGCORE
U.S. Fish and Wildlife Service
Patuxent Wildlife Research Center
Maine Research Station
Rm 242, Nutting Hall
Orono, Maine 04469 USA

Abstract.—Selected aspects of the nesting biology of Ring-necked Ducks (*Aythya collaris*) in east-central Main were studied during 1983–1985 and compared to previous studies. Nesting chronology, clutch size, and hatching success were similar to results reported from previous studies, but nest success was 32–42% lower. Thirty-eight percent of the nests were successful (hatched ≥1 egg); 90% of the eggs in successful nests hatched. Among unsuccessful nests predation (66.6%) and flooding (23.8%) caused most failures. Early nesting attempts varied each year with amount of rainfall in May and resulting water levels. For all 3 yr the peak of nest initiation and incubation was 21 May–7 Jun. Early clutch size ($\bar{x}$ = 8.8, SE = 0.27) was larger ($P < 0.001$) than later clutches ($\bar{x}$ = 7.1, SE = 0.38). Females nesting on acidic (pH < 6.0) wetlands and on wetlands of higher pH had similar nest success, clutch size, and renesting effort.

FENOLOGÍA Y ÉXITO DE ANIDAMIENTO EN (*AYTHYA COLLARIS*) EN LA PARTE ESTE-CENTRAL DE MAINE

Resumen.—Durante 1983–1985 se llevó a cabo un estudio en la parte este-central de Maine sobre algunos aspectos de la biología reproductiva del pato *Aythya collaris*. La cronología de anidamiento, tamaño de la camada y el porcentaje de eclosionamiento resultó ser similar al informado en estudios previos. No obstante el éxito de anidamiento resultó ser menor (32–42%). El 38% de los nidos resultaron exitosos (al menos eclosionó uno de los huevos). En los nidos exitosos el 90% de los huevos empollaron. Las causas principales del fracaso de nidos lo fueron la depredación (66.6%) y las inundaciones (23.8%). El comienzo del anidamiento varió cada año de acuerdo con la cantidad de lluvia durante el mes de mayo y los niveles de agua. Durante los tres años de estudio el pico del comienzo del anidamiento resultó entre las fechas del 21 de mayo y 7 de junio. Las camadas de principio de temporada ($\bar{x}$ = 8.8, SE = 0.27) resultaron de mayor tamaño ($P < 0.001$) que aquellas que se produjeron tarde ($\bar{x}$ = 7.1, SE = 0.38). Hembras que anidaron en anegados ácidos (pH < 6.0) tuvieron una camada, éxito de anidamiento y esfuerzo de re-anidamiento (reciclo) similar a hembras que anidaron en lugares con pH más alto (>6.0).

Many variables can affect nesting phenology and success of waterfowl. For prairie-nesting ducks, early nesting has been correlated with high spring temperatures (Hammond and Johnson 1984, Sowls 1955) while length of nesting season has been positively correlated with amount of water in spring (Afton 1984, Krapu et al. 1983). Nutrients used by waterfowl for reproduction are obtained either from body reserves or from food obtained at the time of nesting (Krapu 1981). Therefore, food availability and female condition also affect egg production and nest initiation in waterfowl (Afton 1984, Bengtson 1971). Causes of nest failure have been studied extensively and reported as predators, flooding, and human disturbance (Andrews 1952, Greenwood et al. 1987, Mendall 1958, Rienecker and Anderson 1960, Sowls 1955, Townsend 1966, and others).

Destroyed nests are partly compensated for, because females may renest (Coulter and Miller 1968, Hunt and Anderson 1966, Krapu 1981, Sowls 1955). Because body protein and lipid reserves are used to produce the initial clutch, all nutrients required for renesting are acquired exclusively from the environment at the time the second or third clutch is laid (Hohman 1986, Krapu 1981). Therefore, renesting is influenced by female condition and wetland quality (abundance of invertebrates) (Swanson et al. 1979).

Ring-necked Ducks are one of the principal anatids that nests in Maine. Most available information on breeding Ring-necked Ducks in the Northeast was reported by Mendall (1958). Since then there has been little research on this species in the Northeast. This study was initiated as part of a larger effort to investigate effects of wetland acidity on Ring-necked Duck productivity in Maine (McAuley 1986, McAuley and Longcore 1988a,b). In this paper we report on nesting ecology and nest success of Ring-necked Ducks on wetlands in east-central Maine and compare our findings to the results of previous studies.

STUDY AREA AND METHODS

In 1983–1985, we located nests on 14 wetlands in Waldo, Hancock, and Washington counties in east-central Maine. The pH of the wetlands ranged from 5.0 to 7.3 and alkalinities ranged from 6 to 369 microequivalents/l of $CaCO_3$. Also, we located broods from these and six other wetlands on the area. A detailed description of the study area is presented by McAuley (1986).

Nests were located by observing the behavior of Ring-necked Ducks during waterfowl surveys for pairs and broods. Observations were from concealed, 3–20 m high, tree stands located along the water edge. Most surveys started before sunrise or 1.5 h before sunset and lasted 2 h. Nest locations were determined by observing females returning from foraging. At the nest, eggs were counted and their stage of development was determined using the egg-floating technique of Westerskov (1950). Before leaving the nest, we covered the eggs with the down and nesting material and when necessary we inconspicuously marked the nest site by placing a small piece of flagging on vegetation ≥ 5 m from the nest. Nests were not revisited until 5 d before the predicted hatch date, when we attempted to capture and mark the female. Within a day or two after the predicted hatch date, we visited the nest to determine its fate and quantify habitat variables; nest site characteristics, proximity to water, and plant associations. A nest was considered successful if ≥ 1 egg hatched.

Females seemed to have regular morning and evening recesses from the nest. When a female was not observed going to a site during two or more surveys or a pair was observed feeding or loafing longer than usual, we visited the nest to determine its status. We determined the causes of nest failure by inspecting the remaining eggshells, nesting material, and "sign" left by predators (Rearden 1951).

We back-dated clutches to determine the start of egg-laying and in-

TABLE 1. Clutch size, hatching success and Class Ia brood size of Ring-necked Ducks in east-central Maine (1983–1985).

Year	Clutches n	Clutches Eggs/nest $\bar{x}$ (SE)	Successful nests n	Successful nests Hatched/nest $\bar{x}$ (SE)	Ia broods n	Ia broods brood size $\bar{x}$ (SE)
1983	13	8.23 (0.46)	6	8.80 (0.87)	9	8.66 (0.53)
1984	19	8.10 (0.32)	7	6.14 (0.91)	18	6.11 (0.55)
1985	—[a]	—	—	—	24	5.25 (0.55)
Totals	32	8.15 (0.26)	13	7.38 (0.72)	51	6.15 (0.36)

[a] — no data.

cubation, assuming an egg-laying rate of one egg/d and an incubation period of 26 d, with incubation starting after the last egg was laid (Mendall 1958). To increase the sample size for determining the peak of nest initiation, we used Class Ia (1–5 d old) (Gollop and Marshall 1954) broods and back-dated them from the initial day of sighting. Differences between clutch or brood sizes were tested using Student's t-test (Zar 1984). Rainfall data were obtained from the files of Moosehorn National Wildlife Refuge, Calais, Maine.

Water samples were collected in July 1983–1984. Alkalinity and pH were determined with methods used by Haines and Akielaszek (1983). More detailed water chemistry data are presented in McAuley (1986).

RESULTS AND DISCUSSION

Nesting biology.—We located nests and broods in 1983 and 1984, but only broods in 1985. Thirty-four nests were located during 1983 and 1984 (Table 1). Two nests were destroyed during egg-laying. In addition, 51 Class Ia broods were located during 1983–1985 and were included to calculate dates of egg-laying and incubation. Complete clutches (n = 32) averaged 8.15 eggs (Table 1). Initial nests (nests started before 1 Jun., n = 20) averaged 8.8 (SE = 0.27) eggs, while renests (nests started after 31 May, n = 12) averaged 7.1 (SE = 0.38, $P < 0.001$). Ninety percent of the eggs in successful nests hatched; 13 (38.2%) of 34 nests were successful. Known causes of nest failure were predation (n = 14) (66.6%), mostly raccoons (*Procyon lotor*), mink (*Mustela vison*), and otters (*Lutra canadensis*), flooding (n = 5) (23.8%), and abandonment (n = 2) (9.5%).

In 1983, an average of 8.8 eggs hatched from successful nests (n = 6), whereas in 1984 6.1 eggs hatched from successful nests (n = 7) (Table 1). In both years, size of Class Ia broods was similar to the number of eggs hatched/nest (Table 1). For all years (1983–1985) brood size of Ia broods (n = 51) averaged 6.2 (Table 1).

Ring-necked Ducks begin nesting later than all other waterfowl species in Maine. The peak of nest initiation was 21–31 May (Fig. 1) and laying dates ranged from 27 Apr. (1984) to 18 Jul. (1984). The peak period of incubation was 21 May through the first week of Jun. The earliest start of incubation was 6 May (1984) and the latest estimated dates were 18

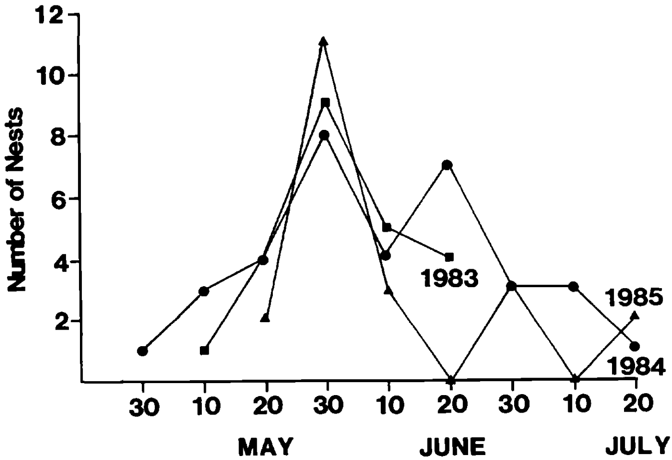


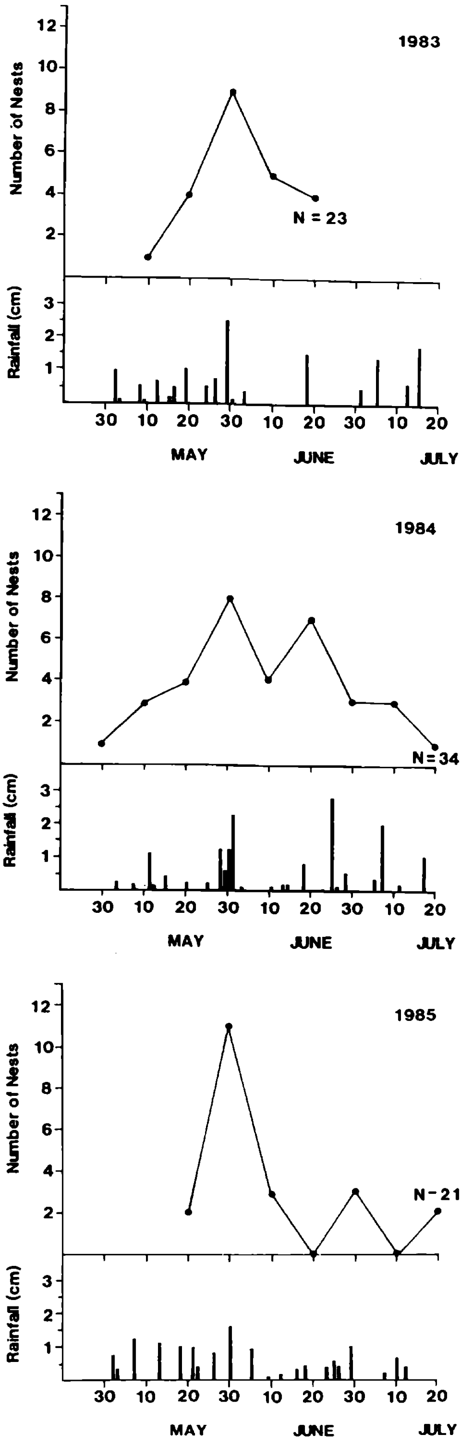
FIGURE 1. Ring-necked Duck nest initiation dates by 10-d intervals in east-central Maine, 1983–1985.

Jul. (1984) and 17 Jul. (1985). Mendall (1958) reported similar peaks for nest initiation.

Most (87%) Ring-necked Duck nests were adjacent to a channel or pool of open water and all were accessible by swimming ducks. Most (83%) of the nests we located were on hummocks and 8% on bog mat. Sedges (*Carex* spp.) or sedge/sweetgale (*Myrica gale*) associations were the dominant vegetation around 18 of 24 (75%) nest sites analyzed and blue-joint grass (*Calamagrostis canadensis*) or blue-joint/sweetgale associations dominated in 21% of the sites.

Water levels in Apr. and early May are determined by both snowmelt and precipitation and are usually high enough to inundate sedge hummocks. As water levels recede and temperatures rise in May, sedges and blue-joint grass on hummocks start to grow. Late nesting seems to be a response to the growth of these plants, which provide cover for the nests. During the three years of this study, snow melted from the woods before Apr. and water levels were affected only by precipitation. Nest initiation varied each year and was affected by rainfall in May (Fig. 2). Amounts of early rainfall were lowest (4.39 cm) in 1984, the year with the earliest nest initiation dates (27 Apr.) and highest (9.04 cm) in 1985, when nesting starts were latest (14 May). Despite the variation in early nesting attempts each year, the peak of nest initiation was the same in all years (Fig. 1). Female Ring-necked Ducks seemed to delay nesting during early May if water levels were high, but by the end of May most of the females were either laying or incubating.

Nest success (38%) was 32–42% lower in our study compared with the 70% and 74% nesting success reported by Mendall (1958) and Sarvis (1972) and 80% success recorded by Townsend (1966). Predation and flooding were the major causes of nest loss. We do not believe that the



1983
Number of Nests
N = 23
Rainfall (cm)
MAY
JUNE
JULY
1984
Number of Nests
N=34
Rainfall (cm)
MAY
JUNE
JULY
1985
Number of Nests
N-21
Rainfall (cm)
MAY
JUNE
JULY

lower nest success was caused by an increase in the predator population and the loss of wetland habitat as is occurring in the prairie regions. Waterfowl habitat in Maine is usually forested habitat and often beaver-created. Maine is 90% forested (Powell and Dickson 1984) and beaver populations are currently increasing (files: Maine Dept. Inland Fish and Wildlife). Populations of mammalian predators such as raccoon, mink, and otter are estimated to have remained relatively stable over the last 10–15 yr (files: Maine Dept. Inland Fish and Wildlife).

We believe that high water conditions caused by heavy rainfall in late May was responsible for the lower nest success. Losses caused by flooding (24% of the total losses) probably were underestimated in our sample. An unusually large amount of rainfall fell at the end of May during both years (5.33 cm on 30–31 May, 1983 and 8.84 cm on 29 May–1 Jun. 1984) and probably flooded most of the Ring-necked Duck nests on the wetlands. Because we located most of the nests after these rains, flooded nests would not be represented in the sample. Also, we believe that the high water caused by rainfall may have increased the predation rate. During periods of high water, open water and channel areas are flooded and birds are forced to nest closer to the wetland edge. As water levels recede, these nests are no longer surrounded by water and, therefore, more exposed to predators that hunt around the wetland margin. Mendall (1958:110) also believed there was a relationship between water levels and types of nesting losses; if water levels in spring are unusually low, birds nest in the sedge zone and are more likely to be flooded during heavy rains. Conversely, if water levels recede after nests have been established, birds are more vulnerable to mammalian predators.

Although we did not locate nests in 1985, nest success was probably higher than in 1983–1984. During 1985, rainfall and water levels were constant over the May nesting season (Fig. 2). In 1985, we conducted brood counts on fewer wetlands (14 vs. 18) but located more broods (37 vs. 14 and 22 in 1983–1984). Also, the hatching period was more synchronous in 1985; wherein 26 of 37 broods hatched before 7 Jul., whereas only nine broods were located by that date in 1983 and ten in 1984.

Losses from flooding and predation may be partly compensated for, because some female Ring-necked Ducks are persistent nesters (Mendall 1958) and capable of renesting twice (Hunt and Anderson 1966). In 1984, heavy rains during the first nesting peak and again 3 weeks later during the renesting peak (Fig. 2) extended the nesting season into late July, probably representing the third nesting attempt by some females.

Clutch size was similar to that reported by Mendall (1958) (9.04 eggs in initial nests [n = 423] and 6.96 in renests [n = 48]) in Maine. Sarvis (1972) did not separate first attempts and renests and reported an average of 8.75 eggs per nest for 32 nests at Seney NWR in Michigan, and

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FIGURE 2. Daily rainfall during the nesting season and the number of nests initiated by Ring-necked Ducks during 10-d intervals in east-central Maine, 1983–1985.

Townsend (1966) reported an average clutch size of 8.4 (n = 49) in Saskatchewan. In our study, the average clutch size was 8.8 for early nests and 7.1 for late nests, and is similar to these figures. Hatchability of eggs from successful nests (90.5%) in our study was similar to the findings of Sarvis (1972) (89.5%). Most unhatched eggs resulted from being rolled out of the nest when hens built up the nest during periods of rising water. Average size of Class Ia broods for the 3 yr of our study was similar to that of Ring-necked Ducks in the Northwest Territories (6.4, n = 74) (Toft et al. 1984), but lower than the average Class Ia size of 8.4 reported by Mendall (1958).

Wetland pH and productivity.—Clutch sizes from early nests varied between years and between wetland pH classes. In 1983, clutches (n = 5) from low pH (<6.0) wetlands averaged 9.3 eggs/nest, while clutches (n = 4) on high pH (>6.0) wetlands averaged 8.0 eggs. In 1984, however, clutch size averaged 8.8 (n = 5) on the low pH wetlands and 8.8 (n = 5) on the high pH wetlands. For both years combined, clutch size was not different (t = 1.22, v = 18, P > 0.20) between wetlands with low and high pH. Renesting occurred on both groups of wetlands, but we were not able to quantify what proportion of the birds renested. To show differences attributable to wetland pH, a female would have to feed exclusively on the wetland where she nested. This did not occur. On one of our study areas we observed eight pairs that fed on a high pH (6.1) wetland during the laying and incubation period and nested on a low pH (4.9) wetland. Hatching success did not differ between nests on high vs. low pH wetlands (0.72 vs. 0.71).

Conclusions.—In our study, nesting phenology and habitat use were similar to the findings of Mendall (1958). Clutch size, hatching success and renesting efforts did not differ from that of past research. Nest success was lower than that reported by Mendall (1958), Sarvis (1972), and Townsend (1966). Predation was the major cause of nest loss, but this was probably influenced by flooding, which occurred during the 2 yr that we located nests. There were no adverse effects related to egg quality and clutch size that could be attributed to wetland pH.

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