Nest Success and Nesting Habitats of Mottled Ducks on the Mississippi River Delta in Louisiana

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Abstract: Waterfowl management is a major goal at the Delta National Wildlife Refuge, yet there is little information on mottled duck *(Anas fulvigula)* nesting on the Mississippi River Delta (MRD) in Louisiana to guide management decisions. In 1998 and 1999, we determined nest success and its relationship to sites and habitat types. Average Mayfield nest success for all locations and years was 20.0%. Nest success differed among sites in 1998 and among habitat types in 1999. Greatest nest success (56.7%) was on Mississippi River levee sites and lowest nest success (0.3%) was on canal banks. Most nest failure was attributed to female abandonment (33.1%) and nest depredation (27.7%). Habitats selected for nesting sites were not used in proportion to their availability, with grassland habitats being used more than expected and marsh and forested habitats being used less than expected. No nests were located on splays. Habitat loss and degradation of coastal marshes in the MRD probably has an adverse affect on mottled duck nesting. Identifying nest locations and habitat types may allow managers to protect existing mottled duck nesting habitats or create new nesting sites.

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Nest success is an important determinant of waterfowl production and is often used as an index to productivity (Cowardin and Johnson 1979). Previous studies of mottled ducks have demonstrated substantial variation in nest success among locations and habitat types (Engeling 1950, Stieglitz and Wilson 1968, Baker 1983, Stutzenbaker 1988, Holbrook et al. 2000). While mottled ducks are residents of most Gulf coastal areas (Moorman and Gray 1994), over half of the United States population occurs in Louisiana (Chabreck et al. 1989). The rapid deterioration of Louisiana coastal marshes may severely impact nesting habitats and reduce mottled duck pro-

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duction. Despite the importance of the Mississippi River Delta (MRD) to mottled ducks, no research has been conducted on nesting in this region. Data leading to a more precise understanding of nesting ecology may provide land managers with information necessary to maintain critical habitat and increase nest success. Our objectives were to determine nest success and nesting habitat characteristics relating to vegetation type and specific nest locations of mottled ducks in the MRD.

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Methods

This study was conducted on Delta National Wildlife Refuge (NWR) (2914N, 8913W) and surrounding public and private lands. Located approximately 160 river-kms south of New Orleans, Delta NWR encompassed 19,749 ha of Plaquemines Parish, Louisiana. For a detailed description of vegetation and marsh characteristics in the MRD see Chabreck (1972) and Chabreck and Condrey (1979).

We searched for mottled duck nests on splays, canal banks, spoil islands, cattle pastures, and levees along the Mississippi River. Splays were areas of accreting mudflats associated with natural or man-made cuts in a river bank or levee (White 1989, Hohman et al. 1990, U.S. Fish and Wildl. Serv. 1992). Canal banks were narrow (50m) areas of high ground (+1.1 m above mean river stage) along a river pass or canal formed by natural or man-made processes. Spoil islands were created from placement of dredge spoil (Penland et al. 1997). Cattle pastures were typically spoil islands that were grazed year-round. Levee sites were areas adjacent to the Mississippi River formed from levee construction.

Areas were systematically searched by 2–7 people walking 2–3 m apart and beating the vegetation with PVC poles to flush nesting females (Willms and Crawford 1989). We searched for nests between 0800 and 1500 hours to increase likelihood of females being on the nest (Gloutney et al. 1993). Areas were searched 2–5 times at approximately 3-week intervals. Nests were permanently marked with a numbered PVC pole 5 m due north. At each nest we recorded number of eggs and estimated embryonic development by candling eggs (Weller 1956). We monitored nests at 7–10 day intervals until fate could be determined. Nest fate was determined as successful ($\geq$1 egg hatched), depredated, flooded, abandoned, or abandoned due to observer activities, which included all nests where the female never uncovered her eggs after we first found the nest. We excluded nests from analyses of success if they were abandoned due to observer activities, had only infertile eggs, or fate could not be determined. For comparisons we converted apparent measures of nest success from older literature to Mayfield estimates (Green 1989)

We calculated nest success using Mayfield (1961) estimators as modified by

Johnson (1979). When exact termination date was unknown, it was assumed to be midway between the last 2 visits (Johnson 1979). For each nest, we calculated a daily survival rate (DSR). The DSR of a successful nest was 1. The DSR for an unsuccessful nest was calculated as 1– (1/exposure dates). We converted DSR to nest success using a 36-day exposure period (Stutzenbaker 1988). We used an analysis of variance (SAS 1990) with least squares means comparisons to test for differences in nest success weighted by exposure days for different location in 1998 and 1999 and different habitat types in 1999 (Greenwood et al. 1995). Significant differences ($P < 0.05$) were further examined using Tukey's Standardized Range Test.

To determine mottled duck habitat use, we measured vegetative profiles in 1999 at 50-m intervals along transects. Within a 10-m^2 plot (Bonham 1989) we recorded percentage cover of the 5 dominant plant species and percentage bare ground (Holbrook et al. 2000). Habitat classifications of Penland et al. (1995) and Holbrook et al. (2000) were modified to include bare ground, marsh, grassland, grassland/shrub, scrub/shrub, and forest. Bare ground habitats had <10% vegetative groundcover. Marsh habitats were vegetated areas subject to tidal influence with ≥10% ground cover and dominated (>50%) by wetland-dependent plants. Grassland habitats were ≥10% ground cover and dominated (>50%) by grasses. Grassland/shrub areas had >10% ground cover that contained <30% shrubs (<6 m woody vegetation), while scrub/shrub habitats were areas with ≥30% ground cover of shrub species. Forested habitats were areas of ≥10% ground cover of woody vegetation over 6 m high.

We constructed odds ratios to compare habitat availability relative to use for various nesting habitat types. We followed the Neu et al. (1974) method as described by Byers (1984) to determine if habitats were used in proportion to availability. A Chi-square test (PROC FREQ, SAS 1990) was used to determine if mottled ducks used habitats according to availability. We excluded bare ground from analysis due to the violation of the assumption that each category contains at least one observation. We constructed 95% Bonferroni confidence intervals to test whether habitats were used more or less than expected by chance.

Results

We found 178 mottled duck nests on 13 sites in 1998 and 159 nests on 12 sites in 1999. In 1998, Mayfield nest success ($N = 143$) was 17.8% (Table 1). We excluded 16 parasitized nests, 17 nests abandoned because of observer activities, 1 nest of infertile eggs, and 1 nest with unknown fate. In 1999, Mayfield nest success ($N = 136$) was 22.3% (Table 1). We excluded 7 parasitized nests, 8 nests abandoned because of observer activities, 3 nests with infertile eggs, and 5 nests of unknown fate.

Nest success differed ($F_{3, 139} = 5.34$, $P = 0.001$) among nesting sites in 1998, but not in 1999 ($F_{3, 132} = 1.81$, $P = 0.148$). Mayfield nest success for canal banks was lower ($P = 0.05$) than on Mississippi River levee sites, spoil islands, and pastures. There was no difference ($F_{4, 131} = 2.10$, $P = 0.084$) in DSR among habitats in 1999. Mayfield nest success was 0.2% for marsh habitats, 32.3% for grassland, 29.1% for grassland/shrub, 25.9% for scrub/shrub, and 1.6% for forest habitats.

Table 1. Mayfield nest success estimates for locations of mottled ducks nesting in the Mississippi River Delta, 1998–1999.

Location [a]	Mayfield nest success 1998	Mayfield nest success 1999	N[b]	% of nests
Canal banks	0.3%	4.3%	16	5.7
Cattle pasture	2.7%	7.0%	133	47.7
Mississippi River levee	42.4%	56.7%	10	3.6
Spoil islands	25.8%	21.3%	120	43.0
Summary	17.8%	22.3%	279	100.0

a. No nests were found on splays during this study.

b. Excludes 23 parasitized nests, 25 nests abandoned due to observer activities, 4 nests with infertile eggs, and 6 nests in which fate could not be determined.

Table 2. Bonferroni confidence intervals (95%) for nesting habitats used by mottled ducks nesting in the Mississippi River Delta, 1999.

Habitat Type	Expected proportion of usage (P_0)	Observed proportion of usage (P_0)	Bonferroni interval[a] for P_0	Usage
Marsh	0.1725	0.0377	$-0.0047 \leq x \leq 0.0801$[b]	less than expected
Grassland	0.2042	0.3082	$-0.2053 \leq x \leq 0.4111$[b]	more than expected
Grassland/shrub	0.1690	0.2704	$0.1714 \leq x \leq 0.3694$[b]	more than expected
Scrub/shrub	0.2729	0.3711	$0.2634 \leq x \leq 0.4788$	as expected
Forest	0.1814	0.0126	$0.0123 \leq x \leq 0.0375$[b]	less than expected

a. $\alpha = 0.05$.

b. Indicates a significant difference in usage of habitat types.

Nest failure resulted from predation, abandonment, abandonment due to observer activities, and flooding. In 1998, nest failure was attributed to depredation 36.4%, abandonment 46.4%, observer activity 15.5%, and flooding 1.7%. In 1999, nest failure attributed to depredation was 51.5%, abandonment 30.7%, observer activity 8.9%, and flooding 8.9%.

Mottled ducks did not use habitats in proportion to availability ($x^2_4 = 51.26$, $P < 0.001$). Bonferroni confidence intervals (95%) revealed that grassland and grassland/shrub habitats were used more than expected, marsh and forest habitat types were used less than expected, and scrub/shrub habitats were used as expected by chance (Table 2). Chi-square contingency tables revealed differences ($P < 0.001$) between habitat availability and use for the following nesting habitat types: marsh and grassland; marsh and grassland/shrub; marsh and scrub/shrub; forest and grassland; forest and grassland/shrub; forest and scrub/shrub (Table 3). We detected no differences between habitat availability and use for marsh and forest ($P = 0.157$), grassland and grassland/shrub ($P = 0.894$), grassland and scrub/shrub ($P = 0.901$), and grassland/shrub and scrub/shrub habitats ($P = 0.617$; Table 3).

Table 3. Odds ratios (and *P*-values from 2x2 Chi-square contingency tables) comparing availability relative to use for nesting habitats used by mottled ducks in the Mississippi River Delta, 1999. Values show differential use of column habitat relative to row habitat.

	Habitat type				
Habitat type	Marsh	Grassland	Grassland/shrub	Scrub/shrub	Forest
Marsh		6.86 (0.001)	7.17 (0.001)	6.26 (0.001)	0.32 (0.157)
Grassland	0.15 (0.001)		1.04 (0.894)	0.91 (0.901)	0.05 (0.0001)
Grassland/shrub	0.14 (0.001)	0.96 (0.894)		0.87 (0.617)	0.05 (0.0001)
Scrub/shrub	0.16 (0.001)	1.09 (0.901)	1.15 (0.617)		0.05 (0.0001)
Forest	3.13 (0.157)	20.0 (0.001)	20.0 (0.001)	20.0 (0.001)	

Discussion

Coastal areas of Louisiana and Texas offer a wide range of habitat types and land configurations with much variation in mottled duck nest densities and success (Engeling 1950, Stieglitz and Wilson 1968, Baker 1983, Stutzenbaker 1988). Similar variation appears within the much smaller spatial scale of the MRD. Nests on the levee of the Mississippi River had high success in both 1998 (42.4%) and 1999 (56.7%), yet we found few nests ($N = 10$) on the levee. In contrast, we found the greatest number of nests ($N = 133$) in cattle pastures, yet nest success averaged less than 5%. Spoil islands, like pastures, were created from river dredge material, but spoil islands had 120 nests over 2 years and 23% nest success.

Creating spoil islands in the MRD has been used to increase nesting habitat for birds (Penland et al. 1997, E. Creef, pers. commun.), including habitat for mottled ducks. Disposal of dredge spoil is a reoccurring issue in the MRD, but spoil can be beneficially used to create islands for nesting birds. Island nesting by Mallard *(Anas platyrhynchos)* and Gadwall *(A. strepera)* has been documented in the prairie pothole region (Duebbert 1966, Duebbert et al. 1983, Lokemoen and Woodward 1992), as well as for mottled ducks in Florida (Stieglitz and Wilson 1968) and Louisiana (Johnson et al. 1996, Holbrook et al. 2000). Nest success for island nesting waterfowl in the prairies was higher (80%, Duebbert 1966; 73%, Duebbert et al. 1983; 38%, Lokemoen and Woodward 1992) than reported for mottled ducks. Nest success for mottled ducks on spoils islands in the MRD (23.2%) was lower than reported for spoil islands in Florida (57%, Stieglitz and Wilson 1968) and the Atchafalaya River in Louisiana (30.6%, Holbrook et al. 2000). Nest success on islands may fluctuate depending on the elevation and island age. Islands that are vegetated with early succession grasses that provide dense cover appeared to be ideal nesting locations for mottled ducks.

Cattle grazing in south Louisiana is a common practice and may maintain grassland habitat on areas where succession would quickly lead to woody habitats. In the prairie pothole region extensive grazing reduces cover for concealment from predators and reduces residual vegetation available to nest construction (Kadlec and Smith

1992), but grazed areas often have relatively high nest success (Ignatiuk and Duncan 2001). Stutzenbaker (1988) concluded that light to moderate grazing generally did not adversely affect mottled duck production; however, high stocking rates that resulted in vegetation trampling decreased attractiveness of cordgrass pastures for nesting. Mottled duck nests in pastures on the MRD appeared to be well concealed in dense blackberry (*Rubus* sp.) patches, but had high abandonment rates (40.9%) for both years. Disturbance by cattle and people may have increased abandonment of nests by mottled ducks.

Nesting mottled ducks demonstrate an affinity for tall grass with 100% overhead cover (Rorabaugh and Zwank 1983). Marsh habitats provide relatively tall (~1 m) nest vegetation, but at elevations susceptible to flooding. During a 4-year study in Texas, no mottled duck nests were located in marsh areas (Stutzenbaker 1988). We found few mottled duck nests in marsh habitats ($N = 6$) and all were destroyed by flooding.

Grasslands had the greatest nest success (32.2%) among all habitat types and provided nesting locations for 30.8% of nests. Plants typifying grasslands were cordgrass (*Spartina* spp.), panic grass (*Panicum* spp.), goldenrod *(Solidago sempervirens)*, and broomsedge *(Andropogon virginicus)*. On the Atchafalaya River Delta (ARD), grass habitats provided cover for 24.5% of mottled duck nests and were utilized more than expected (Holbrook et al. 2000). Mottled duck nests in coastal Texas were confined to cordgrass meadows (Stutzenbaker 1988). At the MRD, grassland/shrub habitat was used frequently for nesting, just as moderate shrub habitats were used frequently at the ARD (Holbrook et al. 2000). In contrast, Baker (1983) and Stutzenbaker (1988) concluded that grassland habitats invaded by shrubs were not used for nesting in coastal marsh. Perhaps that avoidance of shrubs reflected reduced residual cover in comparison with cordgrass.

There is concurrence that mottled ducks avoid forested habitats. We only found 2 nests in forest habitats, likewise mottled ducks did not use forested habitat in the ARD (Holbrook et al. 2000) or coastal Texas (Singleton 1953). Nests in forests on the MRD were at the edge of forested habitats were flight may not have been impeded.

Conclusions

Mottled duck nest success varied substantially among habitats and sites on the MRD. Good mottled duck nesting habitat can be created using dredge spoil to build islands above the typical level of wind driven high tides. Early successional spoil islands provide tall, dense grass and herbaceous vegetation that can attract large numbers of nesting female mottled ducks and produce high nest success. While grazing retains open habitats on these spoil islands, our finding suggest that nest success may be sacrificed. Splays create excellent marsh habitat that is routinely used by mottled ducks, but few females nest in these low elevation areas. We recommend further research to evaluate the impact of grazing on mottled duck nest success on spoil islands in the MRD.

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