Estimating Abundance of Breeding Mottled Ducks in Texas
Author(s): Bart M. Ballard, M. Todd Merendino, Russel H. Terry, Thomas C. Tacha
Source: *Wildlife Society Bulletin*, Vol. 29, No. 4 (Winter, 2001), pp. 1186-1192
Published by: Allen Press
Stable URL: http://www.jstor.org/stable/3784143
Accessed: 04/09/2009 14:56

Estimating abundance of breeding mottled ducks in Texas

Bart M. Ballard, M. Todd Merendino, Russel H. Terry, and Thomas C. Tacha

Abstract Estimates of abundance of breeding mottled ducks (*Anas fulvigula*) along the western Gulf Coast are rare, and most information has been based on localized surveys. Current information reporting trends in mottled duck abundance suggests a declining population in Texas. Our objectives were to estimate breeding mottled duck abundance in Texas and evaluate an aerial circling technique. We compared the ability of the aerial circling survey to estimate numbers of breeding mottled ducks to intensive ground surveys of a stratified random sample of approximately 300 wetlands throughout the mottled duck's range in Texas. From ground surveys during peak breeding (April) in 1994 and 1995, we estimated approximately 105,000 breeding pairs of mottled ducks in Texas and a total spring population of approximately 220,000 mottled ducks both years. Aerial circling survey estimates for breeding mottled duck abundance in March 1994 and April 1995 were similar to ground survey estimates. Estimates from aerial circling surveys in May 1994 and March 1995 were higher than ground surveys, partly because certain wetland types were surveyed more readily from aircraft. There were discrepancies in classifying pairing status between aerial circling and ground survey personnel, with aerial circling surveys recording more ($P<0.001$) lone mottled ducks and ground surveys recording more pairs. The aerial circling method appears more advantageous than ground surveys to estimate breeding mottled duck abundance along the Texas coast. There appear to be considerably more mottled ducks breeding along the Texas Gulf Coast than previously thought. Information on breeding abundance should give managers critical information to interpret midwinter survey tallies and evaluate habitat needs.

Key words abundance, *Anas fulvigula,* breeding, circling survey, mottled duck, survey technique, Texas coast

The Texas Coast is an important area for migrating and wintering waterfowl (United States Fish and Wildlife Service and Canadian Wildlife Service 1986, Hobaugh et al. 1989, Stutzenbaker and Weller 1989); however, breeding waterfowl have received little attention in this region. Mottled ducks (*Anas fulvigula*) are presumably the most abundant breeding species of waterfowl along the Texas Coast (Bellrose 1980, Stutzenbaker 1988). Other breeding species include black-bellied whistling duck (*Dendrocygna autumnalis*), fulvous whistling duck (*D. bicolor*), and, to a lesser extent, blue-winged teal (*Anas discors*) and ruddy duck (*Oxyura jamaicensis*) (Bennet 1966, Bellrose 1980, Bolen and Rylander 1983, McAdams 1987). Mottled duck management is particularly important to Texas because the species is nonmigratory and accounts for as much as 8% of the coastal duck harvest (Stutzenbaker 1988; Texas Parks and Wildlife Department [TPWD], unpublished data). The

Address for Bart M. Ballard, Russel H. Terry, and Thomas C. Tacha (deceased): Caesar Kleberg Wildlife Research Institute, MSC 218, Texas A&M University, 700 University Blvd., Kingsville, TX 78363, USA; e-mail for Ballard: bart.ballard@tamuk.edu. Present address for Terry: Ducks Unlimited, Inc., 331 Metty Drive, Suite 4, Ann Arbor, MI 48103, USA. Address for M. Todd Merendino: Texas Parks and Wildlife Department, 1700 7th Street, Bay City, TX 77414, USA.

Continental Conservation Plan of Ducks Unlimited (1994) stated that long-term monitoring of mottled duck populations is needed to effectively manage this species and identified population assessment of the mottled duck as a high international priority. Furthermore, Johnson et al. (1984) indicated that a reliable population survey is the most critical need for mottled duck management.

An annual survey that provides representative population information is needed to make informed management decisions concerning any harvested population. Survey results from the annual midwinter inventory (MWI) and the United States Fish and Wildlife Service (USFWS) breeding survey revealed that mottled duck numbers in Texas have declined in recent years (TPWD, unpublished data; USFWS, unpublished data). Although the annual MWI is used as a population index for breeding mottled ducks in Texas and Louisiana, its ability to reliably monitor mottled duck abundances has been questioned (Johnson et al. 1989, 1991). Johnson et al. (1991) indicated that <1% of the mottled ducks in Florida were recorded during the MWI. Although breeding pair surveys of mottled ducks have received considerable attention in Florida (Johnson et al. 1989), efforts to assess or improve population estimates for mottled ducks breeding in Texas or Louisiana have been more limited (Chabreck and Roberts 1993). During March of each year, the USFWS conducts ground-truthed, aerial transect surveys to count breeding pairs of mottled ducks on coastal National Wildlife Refuges in Texas. Breeding pairs are used as an annual index of relative abundance on those refuges, but the survey is not designed to encompass all habitat types important to breeding mottled ducks and data are not intended to be extrapolated to a population estimate.

Information on breeding mottled duck abundance along the Texas Coast has primarily been based on localized surveys, and overall there has been little attempt to estimate breeding duck abundance along the entire Texas coast. Therefore, our objectives were to estimate numbers of breeding mottled ducks and evaluate a new aerial survey technique for its ability to estimate breeding mottled duck abundances.

Methods

In 1994, we selected a stratified (by wetland type) sample of 300 wetlands from 1,009 random quarter-sections surveyed by Muehl (1994). These wetlands represented 25 wetland types and were distributed proportional to the distribution of wetland areas in the Laguna Madre, Texas mid-coast (Muehl 1994), and Chenier Plain (Tacha et al. 1992) regions of the Texas Gulf Coast (Figure 1). We classified wetlands according to Cowardin et al. (1979). Minimum sample size for each wetland type was 3; however, due to the dynamic nature of wetland systems, maintaining a monthly sample size of 3 was not possible for some wetland types.

In 1995, we reallocated study sites among wetland types based on variances of mottled duck

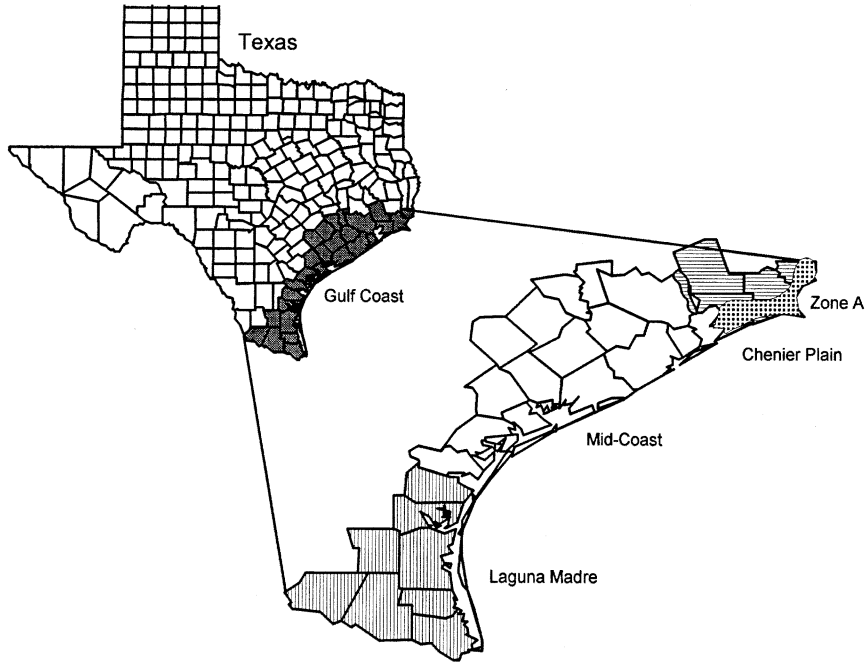


Figure 1. Shaded area indicates counties of Texas that compose the Gulf Coast Joint Venture where this study occurred. The enlarged area shows counties that comprise the Chenier Plain, Mid-coast, and Laguna Madre initiative areas of the Gulf Coast Joint Venture in Texas (dotted area denotes Zone A of the MWI). The ≥300 wetlands surveyed during this study were distributed proportional to the distribution of wetland areas in these initiative areas based on results from Muehl (1994) and Tacha (1992).

densities within wetland types in 1994. Based on the methodology described by Cochran (1963) for Neyman allocation, sample size was then increased to 330 wetlands representing 23 wetland types. This reallocation was an attempt to reduce variances of breeding population estimates of mottled ducks. In 1995, we omitted wetland types on which mottled ducks were not observed during 1994.

In March of each year we ground-truthed each wetland to corroborate previous classification prior to surveys. Additionally, we drew detailed maps of each wetland during each monthly survey for wetland area estimation. We used Global Positioning System to obtain coordinates for study wetlands to help aerial survey crews locate each site. Ground survey personnel recorded wetland surface area and classification during each site visit.

We conducted ground surveys of all wetlands during the last 2 weeks of each month from March through May during 1994 and 1995 to attempt to determine peak breeding activity. Wetlands were first observed from 100–200 m with a 15–60X spotting scope, then were searched systematically on foot to flush ducks from emergent and peripheral vegetation (Rumble and Flake 1982). We did not conduct ground or aerial circling surveys in Zone A (see Figure 1) because this portion of the Texas coast is an extensive coastal marsh that is impractical to survey by foot.

We conducted aerial circling surveys of wetlands in a Cessna 206 aircraft at 96–128 km/h and at an altitude of 30–45 m. When surveying small wetlands, we flew down one edge, circled around, and flew down the opposite edge of the wetland. If the wetland was large, we would fly the edges as described and then make one or 2 passes over its center. A minimum of 2 passes was made over all wetlands and up to 4 passes over large wetlands and those with considerable emergent cover. A primary observer in the front right-hand seat made all observations. Aerial circling surveys were often conducted on the same day and always within the same week as ground surveys during the last 2 weeks of March and May 1994 and March and April in 1995. We omitted 9 wetlands from aerial circling surveys in 1994 and 23 in 1995 because they were located in areas dangerous (e.g., located near power lines) to survey from the air. Comparisons between aerial and ground surveys included only those wetlands surveyed by both techniques.

Surveys began in mid-March based on mottled duck nesting chronology (Stutzenbaker 1988, Grand 1992). Observers counted all single and paired mottled ducks and all groups ≥3 in size. Although many of the groups of mottled ducks were undoubtedly comprised of pairs and lone males, we felt this would provide a conservative estimate because of the difficulty in distinguishing sex. We calculated the area of each surveyed wetland during each monthly site visit using a dot grid placed randomly over quarter-section maps on which ground crews had delineated wetland boundaries (Millar 1973). We averaged 3 dot-grid readings to estimate wetland area. Muehl (1994) conducted an extensive study and estimated the wetland area for all wetland types within the Texas Coastal Plain. Our study wetlands were from those sampled by Muehl (1994), to detect changes in wetland area and extrapolate to the Texas coast. We estimated total wetland area along the Texas coast for each wetland type during each survey period using a correction factor obtained by dividing our estimates of wetland size by those of Muehl (1994) for the same wetlands. We calculated monthly estimates of wetland area for each wetland type by multiplying the mean correction factor for each wetland type by the March 1993 (Muehl 1994) estimates of total wetland area.

We calculated densities (number of mottled ducks/ha of water) of lone ducks, pairs, indicated breeding pair (IBP: lone ducks + pairs), number of mottled ducks in groups ≥3 in size, and total ducks ([2 × IBP] + total number of ducks in groups ≥3) for each wetland. We calculated breeding and total population estimates from ground and aerial circling surveys by multiplying mean densities of IBP and total ducks for each wetland type by the total area of that wetland type.

Results

Mottled duck abundance

Ground surveys of ≥300 wetlands along the Gulf Coast of Texas indicated that breeding activity of mottled ducks peaked during April in 1994 and 1995. April estimates were similar between years at approximately 105,000 breeding pairs and 220,000 total mottled ducks in the spring population (Table 1).

In 1994, 24% of the mottled ducks observed in March by ground personnel were in groups, compared to 9% in April and 3% in May. More IBPs were observed and distributed over a greater proportion

Table 1. Estimates of indicated breeding pair (IBP) and total breeding population abundances of mottled ducks determined from ground counts of 300 wetlands during 1994 and 330 wetlands in 1995 along the Texas coast.

	1994				1995			
Month	IBP	SE	Total	SE	IBP	SE	Total	SE
March	35,667	16,244	85,411	33,282	76,260	22,631	157,109	45,906
April	102,893	24,584	213,300	49,337	107,245	26,653	225,838	55,714
May	71,687	18,387	144,929	36,808	43,635	18,510	97,832	40,795

of our surveyed wetlands in April; ground personnel observed mottled ducks on 52% more wetlands in April than in March and May 1994. The higher proportion of mottled ducks in groups and on fewer wetlands resulted in a higher coefficient of variation in estimated number of IBPs during March 1994 (46%), compared to April (24%) and May (26%).

Breeding intensity increased earlier in 1995, as indicated by a higher number of estimated IBPs (Table 1) and a lower proportion of birds in groups during March 1995 (4%) compared to 1994 (24%). According to our estimates of wetland availability along the Gulf Coast of Texas, wetland area was 16% higher in March of 1995 than in 1994, which may have influenced the timing of breeding activity. In 1995, we estimated peak IBP abundance at 107,245 in April, with a total spring population at 225,838 mottled ducks (Table 1). Number of breeding pairs dropped off sharply in May 1995 and the coefficient of variation increased because of observing a greater percentage of mottled ducks in groups during May (10% of mottled duck observations) than in April (2% of observation). Also, in May 1995, mottled ducks were concentrated on only 59% of the wetlands that they were observed using in April. Reallocation of study sites to wetland types in 1995 did not reduce the estimated variances of population estimates as the coefficient of variation for IBPs in April of both years was similar (~24%).

Evaluation of aerial circling survey

From the 291 wetlands in 1994 and 307 wetlands in 1995 that we surveyed using aerial circling and ground survey methods, respective estimates of IBP abundance were similar (<4% difference) during March 1994 and April 1995 (Table 2). Estimates derived from aerial circling surveys in May 1994 were 45% higher than ground surveys for that same month. In March 1995, aerial circling surveys estimated over 2 times more IBPs than did ground surveys (Table 2). However, aerial observers recorded approximately 3.3 times more lone ducks than ground personnel and ground personnel recorded more pairs and groups than aerial observers during March 1995 (Table 3). More ($P \leq 0.001$) lone mottled ducks were recorded during aerial surveys than during ground surveys in all 4 survey periods. Ground survey crews observed more pairs of mottled ducks in each survey period; however, this difference was significant only in May 1994 ($P<0.001$;Table 3). Differences in the estimates of breeding abundance between the ground and aerial circling surveys appeared to be partly due to discrepancies in classifying pairing status. We recorded more IBPs during aerial circling surveys than during ground surveys in March 1994 and 1995; however, there was no significant difference ($P > 0.137$) between the survey techniques in the actual number of mottled ducks observed that generated IBPs (loners + [2×pairs], Table 3) during any survey period.

Discussion

Mottled duck abundance

Our results from aerial circling and ground surveys indicated that there may be as many as 5 times more mottled ducks in Texas than previously thought (Stutzenbaker 1988). Although there are limited data available on adult summer mortality, nest success, and brood survival, based on approximately

Table 2. Estimated indicated breeding pair abundance of mottled duck along the Gulf Coast of Texas during 1994 and 1995 using 2 survey techniques[a].

	Ground counts		Aerial circling	
Date	estimate	SE	estimate	SE
1994				
March	32,815	16,156	32,316	8,769
May	68,333	18,089	98,827	22,342
1995				
March	76,463	23,398	178,524	55,664
April	104,114	25,276	108,012	21,042

[a] Estimates derived from 291 of 300 wetlands in 1994, and 307 of 330 wetlands in 1995 due to inability of aerial crew to survey some wetlands.

Table 3. Mean number of lone ducks, pairs, number of ducks observed that comprised IBPs (lone ducks + [2 × pairs]) and groups of mottled ducks/wetland surveyed during ground and aerial circling surveys along the Texas Coast during March and May 1994, and March and April 1995.

Date	Ground		Aerial circling			
Variable	$\bar{x}$	SE	$\bar{x}$	SE	t [a]	$P > t$
March 1994 (n=76)						
Lone ducks	0.23	0.06	0.63	0.09	–3.36	0.001
Pairs	0.89	0.18	0.85	0.13	0.18	0.859
Loners + (2 × Pairs)	2.01	0.39	2.33	0.30	–0.61	0.545
Groups	0.81	0.37	0.21	0.05	1.67	0.100
May 1994 (n=132)						
Lone ducks	0.66	0.10	1.31	0.15	–3.58	<0.001
Pairs	0.97	0.14	0.36	0.07	3.95	<0.001
Loners + (2 × Pairs)	2.60	0.35	2.04	0.26	1.32	0.190
Groups	0.08	0.05	0.06	0.03	0.40	0.693
March 1995 (n=142)						
Lone ducks	0.41	0.07	1.35	0.13	–6.61	<0.001
Pairs	1.17	0.19	1.08	0.12	0.42	0.678
Loners + (2 × Pairs)	2.75	0.41	3.51	0.31	–1.50	0.137
Groups	0.11	0.03	0.05	0.02	1.74	0.083
April 1995 (n=137)						
Lone ducks	0.67	0.10	1.36	0.14	–3.97	<0.001
Pairs	1.52	0.27	1.10	0.12	1.43	0.154
Loners + (2 × Pairs)	3.71	0.60	3.57	0.34	0.20	0.839
Groups	0.15	0.04	0.07	0.02	1.48	0.141

[a] Paired t-test.

105,000 IBPs that we report, there may have been a fall population of >300,000 mottled ducks in Texas during our study. We base this on Peterson indices of preseason population size using methods outlined by Anderson and Burnham (1976) and assuming a band reporting rate of 0.40 (Johnson et al. 1984).

The MWI is considered a breeding index for mottled ducks because only 2 months separate it and assumed peak breeding (Stutzenbaker 1988). Tallies of mottled ducks from the MWI in Texas were 47,377 and 41,920 during January 1994 and 1995, respectively (TPWD, unpublished data), which were 22% and 19% of the breeding population derived from ground surveys in this study during the breeding season of the same years. It is believed that 20% of the estimated Atlantic Flyway black duck (*A. rubripes*; i.e., a species of similar cryptic coloration and nongregarious behavior) population is counted each year during the MWI (Rusch et al. 1989). Previous studies have evaluated the accuracy of aerial surveys for mottled ducks and found that aerial surveys detect 16–40% of those observed by ground surveys (Lotter and Cornwell 1969, Johnson et al. 1989). Also, the USFWS has conducted a breeding mottled duck survey in March along portions of the Texas coast each year since 1985. These surveys also are conducted via fixed-wing aircraft along transect lines. A visibility index, derived using marsh buggies to "ground-truth" the transects, suggests that aerial crews observed approximately 30% of the mottled ducks present (USFWS, unpublished report). Comparison of our ground survey estimates and MWI counts during corresponding years appear consistent with previous findings when visibility bias is factored in. There also was consistency between years, as the MWI was approximately 20% of ground estimates in both years.

Breeding intensity appeared to increase earlier in 1995 than in 1994, according to March survey results. Mottled ducks have been reported to respond quickly to changes in wetland conditions (Stutzenbaker 1988), and possibly the greater wetland area during March 1995 influenced timing of breeding intensity. Also, we observed mottled duck broods 3 weeks earlier in 1995 than in 1994, suggesting that intense breeding may have occurred earlier. Furthermore, a greater proportion of lone males observed during the 1995 USFWS March breeding survey compared to 1994 also suggested that breeding intensity may have peaked earlier in 1995 (USFWS, unpublished data).

Evaluation of aerial circling survey

The large differences in breeding pair estimates between aerial circling and ground surveys for May 1994 and March 1995 appeared to be due partly to inconsistency in delineating pairing classification between the 2 survey crews. Apparently, when survey crews encountered 2 mottled ducks on a wetland, aerial circling crews tended to count them as 2 lone ducks and ground surveys tended to count them as one pair of ducks. This disparity in classification of pairing status greatly affects the resulting

estimated IBP population. If one pair of mottled ducks is counted as 2 lone ducks, their contribution to IBP is doubled. Conversely, if 2 lone ducks are recorded as one pair of ducks, their contribution to IBP is halved.

The aerial circling survey appeared to be advantageous to survey mottled ducks along the Texas coast in certain habitats. For instance, aerial circling surveys were more proficient at detecting mottled ducks in rice fields than were ground surveys. Ground personnel were restricted to observing from levees and were not able to adequately cover entire rice fields. This factor may have influenced the difference between estimates in May, as rice fields were not flooded prior to May surveys. The rice was not tall enough to limit visibility from the air; however, ground visibility in the rice was limited to approximately 30 m from the levee.

Another challenge often faced by ground personnel was surveying wetlands associated with rangeland, which comprised approximately 50% of the wetlands surveyed. While ground personnel would attempt to approach wetlands so as not to disturb mottled ducks, the numerous cattle that typically congregated around available water would flee at the observers' approach. Consequently, ducks that may not have been paired or grouped on the water would flush together and be recorded as pairs or groups by ground personnel. Cattle would not respond to the presence of aerial crews. If these were major causes of the variability between techniques, it suggests that the estimates derived from ground surveys may be conservative. In any case, given that ground and aerial circling surveys counted similar numbers of ducks that comprised pairs and loners, this survey technique may be superior to aerial transect-based surveys, which tend to observe 16–40% of mottled ducks observed by ground surveys (Lotter and Cornwell 1969, Johnson et al. 1989). Heusmann (1990) also found aerial surveys to be superior to ground counts for black ducks in Massachusetts during winter; however, this was due mainly to the ducks being congregated in large flocks.

Management implications

Our findings indicate there are substantially more breeding mottled ducks in Texas than previously reported (Stutzenbaker 1988). Additionally, when our ground counts are compared to MWI tallies for both years, the proportion of ducks present that were observed on the transect based MWI were comparable to other studies (Lotter and Cornwell 1969; Johnson et al. 1989; Rusch et al. 1989; USFWS, unpublished data). Results from our study are currently the only estimates of breeding mottled duck abundance in Texas. This has a multitude of implications regarding harvest management strategies, habitat management goals, and research objectives.

Assuming that 1994 and 1995 were typical years in breeding chronology, surveys to estimate the breeding population of mottled ducks along coastal Texas should occur during mid-April to coincide with peak breeding. During April, mottled ducks were distributed across more wetlands and were less concentrated in groups. Previous studies suggested March as the optimal time to survey breeding waterfowl (Stutzenbaker 1988), and current USFWS breeding mottled duck surveys are conducted in March. It appears that mid-April is an appropriate median date to coincide with peak breeding activity, as IBP data from both March and May showed high variability between years.

Aerial circling surveys show promise for estimating breeding mottled duck abundance along the Texas Coast, especially when rice fields and areas associated with cattle are surveyed. Although we conducted our aerial circling survey in only one year to coincide with peak breeding in April, it appears to be consistent with ground surveys when birds are most dispersed. Finally, aerial circling surveys were completed with approximately 15% of the manpower required to complete ground surveys. An average of 265 man-hours, mostly associated with travel between wetland sites, were needed to complete ground surveys each 2-week survey period. Aerial circling surveys generally required 40 man-hours (pilot and observer) during each survey period.

Acknowledgments. This study was funded by the Texas Parks and Wildlife Department and the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville. We are grateful to the numerous landowners who allowed access to their properties throughout this study. We thank R. L. Bingham and D. G. Hewitt for reviewing this manuscript, and especially B. Wilson for offering valuable suggestions. This is manuscript number 00-125 of the Caesar Kleberg Wildlife Research Institute.

Literature cited

ANDERSON, D. R., AND K. P. BURNHAM. 1976. Population ecology of the mallard:VI. The effect of exploitation on survival. United States Fish and Wildlife Service, Resource Publication 128, Washington, D.C., USA.

BELLROSE, F. A. 1980. Ducks, geese, and swans of North America. Second edition. Stackpole, Harrisburg, Pennsylvania, USA.

BENNETT, L. J. 1966. The blue-winged teal: it's ecology and management. Collegiate, Ames, Iowa, USA.

BOLEN, E. G., AND M. K. RYLANDER. 1983. Whistling ducks: zoogeography, ecology, anatomy. Texas Tech University, Special Publication 20, Lubbock, USA.

CHABRECK, R. H., AND S. M. ROBERTS. 1993. Evaluation of aerial transect surveys of mottled ducks. Northeast Gulf Science 13:43–51.

COCHRAN, W. G. 1963. Sampling techniques. Second edition, John Wiley and Sons, New York, New York, USA.

COWARDIN, L. M., V. CARTER, F. C. GOLET, AND E. T. LAROE. 1979. Classification of wetlands and deepwater habitats of the United States. United States Fish and Wildlife Service FWS/OBS 79/31, Washington, D.C., USA.

DUCKS UNLIMITED. 1994. Continental conservation plan. Ducks Unlimited, Memphis, Tennessee, USA.

GRAND, J. B. 1992. Breeding chronology of mottled ducks in a Texas coastal marsh. Journal of Field Ornithology 63: 195–202.

HEUSMANN, H. W. 1990. Evaluation of air-ground count comparisons for wintering American black ducks. Wildlife Society Bulletin 18:337–381.

HOBAUGH, W. C., C. D. STUTZENBAKER, AND E. L. FLICKINGER. 1989. The rice prairies. Pages 367–383 *in* L. M. Smith et al., editors. Habitat management for migrating and wintering waterfowl in North America. Texas Tech University, Lubbock, USA.

JOHNSON, F. A., F. MONTALBANO, AND T. C. HINES. 1984. Population dynamics and status of the mottled duck in Florida. Journal of Wildlife Management 48:1137–1143.

JOHNSON, F. A., K. H. POLLOCK, AND F. MONTALBANO III. 1989. Visibility bias in aerial surveys of mottled ducks. Wildlife Society Bulletin 17:222–227.

JOHNSON, F. A., J. D. TRUITT, AND D. R. EGGEMAN. 1991. Distribution, abundance, and habitat use by mottled ducks in Florida. Journal of Wildlife Management 55:476–482.

LOTTER, C. F., AND G. W. CORNWELL. 1969. Comparison of airplane, air-boat and helicopter for censusing Florida ducks, Anas platyrhynchos fulvigula. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 23:97–101.

MCADAMS, M. S. 1987. Classification and waterfowl use of ponds in south Texas. Thesis, Texas A&I University, Kingsville, USA.

MILLAR, J. B. 1973. Estimation of area and circumference of small wetlands. Journal of Wildlife Management 37:30–38.

MUEHL, G. M. 1994. Distribution and abundance of waterbirds and wetlands in coastal Texas. Thesis, Texas A&M University, Kingsville, USA.

RUMBLE, M. A., AND L. D. FLAKE. 1982. A comparison of two waterfowl brood survey techniques. Journal of Wildlife Management 46:1048–1053.

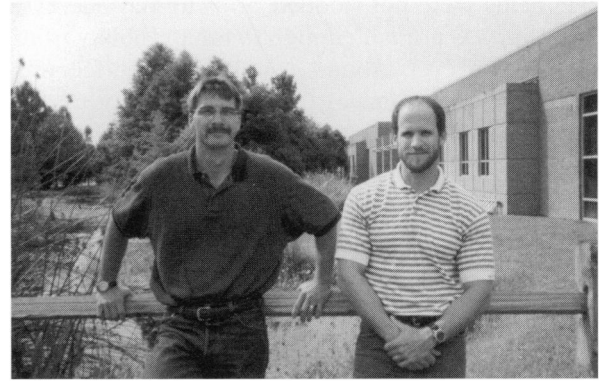
RUSCH, D. H., C. D. ANKNEY, H. BOYD, J. R. LONGCORE, F. MONTALBANO, J. K. RINGELMAN, AND V. D. STOTTS. 1989. Population ecology and harvest of the American black duck: a review. Wildlife Society Bulletin 17:379–406.

STUTZENBAKER, C. D. 1988. The mottled duck; it's life history, ecology, and management. Texas Parks and Wildlife, Austin, USA.

STUTZENBAKER, C. D., AND M. W. WELLER. 1989. The Texas Coast. Pages 385–405 *in* L. M. Smith et al., editors. Habitat management for migrating and wintering waterfowl in North America. Texas Tech University, Lubbock, USA.

TACHA, T. C., A. M. HOLZEM, AND D. W. BAUER. 1992. Changes in freshwater wetlands and waterfowl distribution in the Chenier Plain of Texas, 1970–1992. Final Project Report, United States Fish and Wildlife Service, Albuquerque, New Mexico, USA.

UNITED STATES FISH AND WILDLIFE SERVICE AND CANADIAN WILDLIFE SERVICE. 1986. North American Wildlife Management Plan. A strategy for cooperation. United States Fish and Wildlife Service, Washington, D.C., USA.



Bart M. Ballard (right) is an associate research scientist with the Caesar Kleberg Wildlife Research Institute (CKWRI) at Texas A&M University-Kingsville. He is a Ph.D. candidate in a joint Ph.D. program with Texas A&M University and Texas A&M University-Kingsville, where he studied nutritional ecology of wintering northern pintails. He received his B.S. degree from Iowa State University and his M.S. degree from Texas A&I University. His research interests include avian ecology and management with a particular interest in waterfowl. ***M. Todd Merendino*** (left) is leader for Texas Parks and Wildlife Department's Central Coast Wetland Ecosystem Project. His professional interests and job duties include wetland–wildlife management and research activities on waterfowl and alligators, wetland management, and wetland mitigation. He received his B.S. and M.S. from Texas Tech University and a Ph.D. from the University of Western Ontario. He is a certified wetland scientist with the Society of Wetland Scientists and an adjunct member of the graduate faculty at Texas A&M University-Kingsville. ***Russel Terry*** is a regional biologist with Ducks Unlimited at its Great Lakes office. He received his B.S. from Lake Superior State University and his M.S. from Texas A&M University-Kingsville. His research interests include ecology and management of waterfowl as well as habitat management and restoration. ***Thomas C. Tacha*** (deceased) was a professor with the CKWRI at Texas A&M University-Kingsville. He received his B.S. from Kansas State University, his M.S. from South Dakota State University, and his Ph.D. from Oklahoma State University. Tom was an authority on the biology, behavior, and management of sandhill cranes and conducted considerable research in waterfowl ecology and management.

Associate editor: *Kilgo*