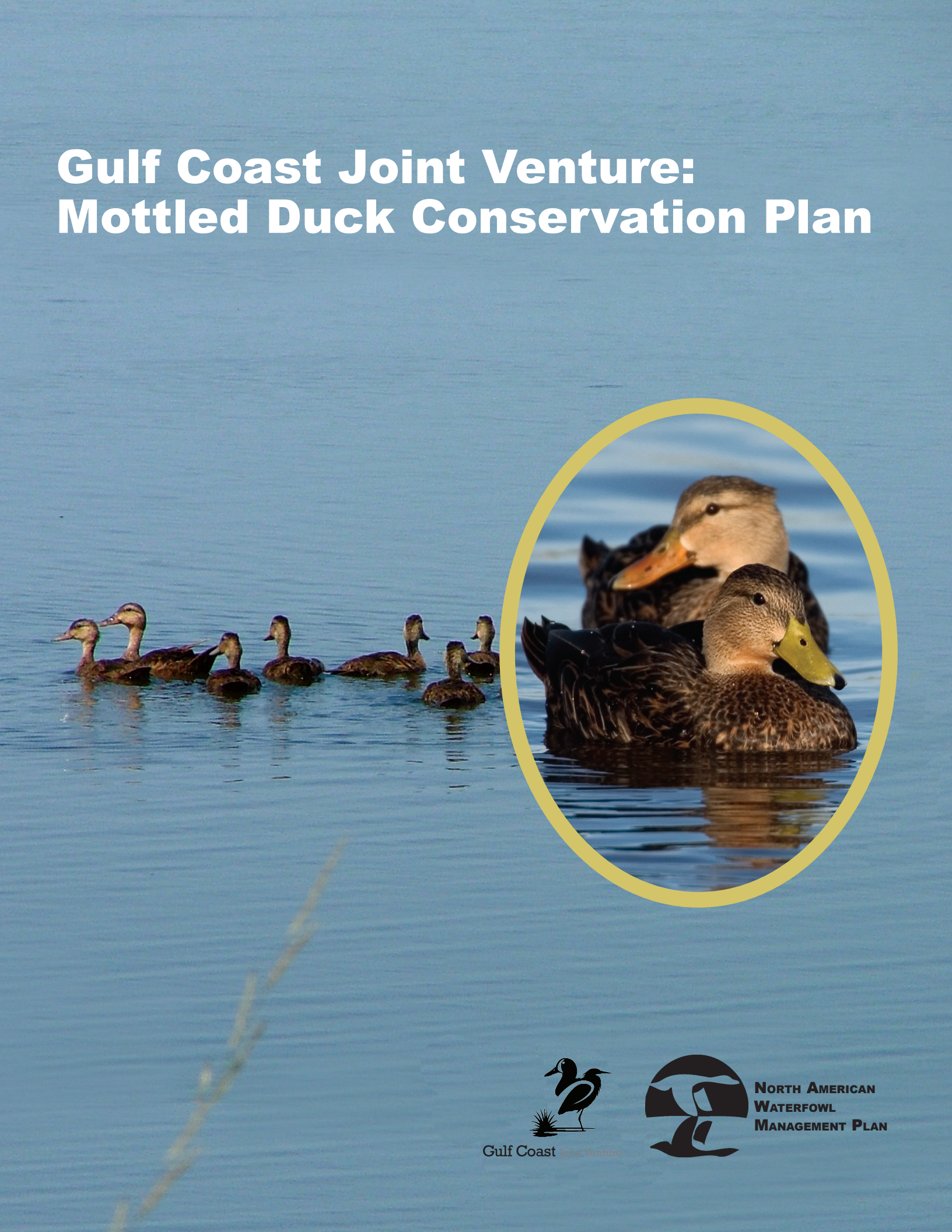
Gulf Coast Joint Venture: Mottled Duck Conservation Plan



Gulf Coast Joint Venture

North American Waterfowl Management Plan

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Gulf Coast Joint Venture
Mottled Duck Conservation Plan

A product of the
North American Waterfowl Management Plan
Gulf Coast Joint Venture
Mottled Duck Working Group

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Gulf Coast Joint Venture

North American Waterfowl Management Plan

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Executive Summary

The mottled duck (*Anas fulvigula*) is a resident species with a primary range of Florida and the western Gulf of Mexico Coast (WGC) portions of Alabama, Mississippi, Louisiana, Texas, and northeast Mexico. Mottled ducks in the WGC must meet all their life cycle requirements from their year-round home of the Gulf of Mexico Coast marshes and associated habitats, and their U.S. range is nearly the same as the geographic boundaries of the Gulf Coast Joint Venture (GCJV). The GCJV is a bird conservation partnership situated in one of the priority habitat regions of the North American Waterfowl Management Plan (NAWMP). Because of concerns about the population status of WGC mottled ducks, the GCJV Management Board initiated a Mottled Duck Working Group (hereafter, Working Group) to provide mottled duck conservation guidance to GCJV partners. This document is the product of that Working Group.

After reviewing all available population trend data, Working Group responses to questionnaires indicated that WGC mottled ducks warrant a degree of special attention by managers that is approximately halfway between that of a stable population and one threatened with extinction and that mottled ducks should be an above average concern for partners of the GCJV. Declining population trends in Texas are of particular concern.

Mottled ducks along the WGC face potential survival and/or reproductive stresses from coastal marsh degradation, declines in rice farming, lead exposure from spent shotshells, harvest, disturbance, reptilian and mammalian predators, and the whims of precipitation. Available evidence points toward recruitment (addition of fledged young to the population) as the most likely source of current population limitation, but survival constraints also warrant attention.

Faced with limited options, the Working Group chose the U.S. Midwinter Survey long-term coastal average (1971-2004) as the basis for a population target to guide habitat conservation. There are three geographic components of the overall population target, each of equal significance: WGC total (105,816), Texas (35,322), and Louisiana (70,132). The Texas component is currently 52% below target. Development of a population target highlighted the limitations of current population data, leading to a recommendation to develop an improved rangewide survey.

The highest priorities to improve WGC mottled duck populations are actions to increase nest success and brood survival. Recommendations to improve nest success include improving nesting grassland conditions proximal to wetlands suitable for brood rearing, minimizing interactions with predators, and maintaining optimal habitat sizes. Improving brood survival incorporates management of shallow wetlands that have low salinities in mid-April through July, minimal opportunity for predator interactions, vegetative substrate to support invertebrate duckling foods, and connectivity to nesting habitat.

Moderate priorities to improve WGC mottled duck populations are actions to increase breeding propensity and adult survival during molt. Increasing breeding propensity calls for availability of wetlands near suitable nesting habitat for loafing and foraging breeding pairs in February and March. Improving adult survival during molt involves providing shallow wetlands (particularly during drought periods) from mid-July through mid-September with low reptilian predator populations, very short vegetation, and patches of escape cover.

Because most specific habitat management recommendations included in this document are based on expert opinion as opposed to rigorous scientific documentation, implementation must

occur in a strategic manner that facilitates evaluation and is accompanied by appropriate monitoring. Adapting management according to the evaluations made during the plan's implementation allows preliminary recommendations based on imperfect information but relies on habitat implementation and evaluation investments that facilitate learning and feed future management choices.

Genetic introgression of native WGC mottled ducks with nonmigratory mallards is a conservation concern that is unrelated to perceived population trends, but genetic introgression is potentially significant in its long-term impacts to the species. Managers should strive to minimize interactions between mottled ducks and nonmigratory (i.e., feral, released, or domesticated) mallards.

Several specific opportunities have been identified as potential means to achieve recommendations outlined in this document. These include Farm Security and Rural Investment Act (2002) or "Farm Bill" programs administered by the U.S. Department of Agriculture, management of state and federal properties, partnership programs to manage private lands, and permanent land protection programs. Explicit consideration of mottled duck needs in the planning and implementation of each of these programs is warranted. Further, all managers of mottled duck habitats are encouraged to consider the needs of mottled ducks as outlined in this document and to develop and implement specific actions to address those needs.

Introduction to the Species

The mottled duck (*Anas fulvigula*) is a resident species of the northern Gulf of Mexico Coast that is closely related to the mallard. The primary range of the mottled duck is limited to the western Gulf of Mexico Coast (WGC) and peninsular Florida (Fig. 1). Population size is unknown and debatable, but recent estimates suggest approximately 30,000 in Florida and 630,000 in the WGC region of Alabama, Mississippi, Louisiana, Texas, and northeast Mexico (North American Waterfowl Management Plan, Plan Committee 2004). There is no evidence of interchange in recorded history between these two groups despite thousands of bandings in the WGC and Florida and thousands of recoveries; consequently, this document relates only to mottled ducks of the WGC.

Mottled ducks in the WGC are important components of the waterfowl harvest in Texas and Louisiana, recently making up approximately 1% of the statewide duck harvest in Texas and 3% in Louisiana. Mottled ducks compose a higher proportion of the waterfowl harvest from the coastal portions of each state, with recent estimates ranging up to 9% for coastal public hunting areas in Texas and 5% in Louisiana.

Mottled ducks in the WGC must meet all their life cycle requirements from their year-round home of Gulf Coast marshes and associated habitats. These habitat requirements vary seasonally. The year-round residency of this species makes it susceptible to potential population stresses that are unique among ducks. In short, Gulf Coast habitats are entirely responsible for the well-being of this species. As such, special consideration is warranted to ensure that their unique needs are met.

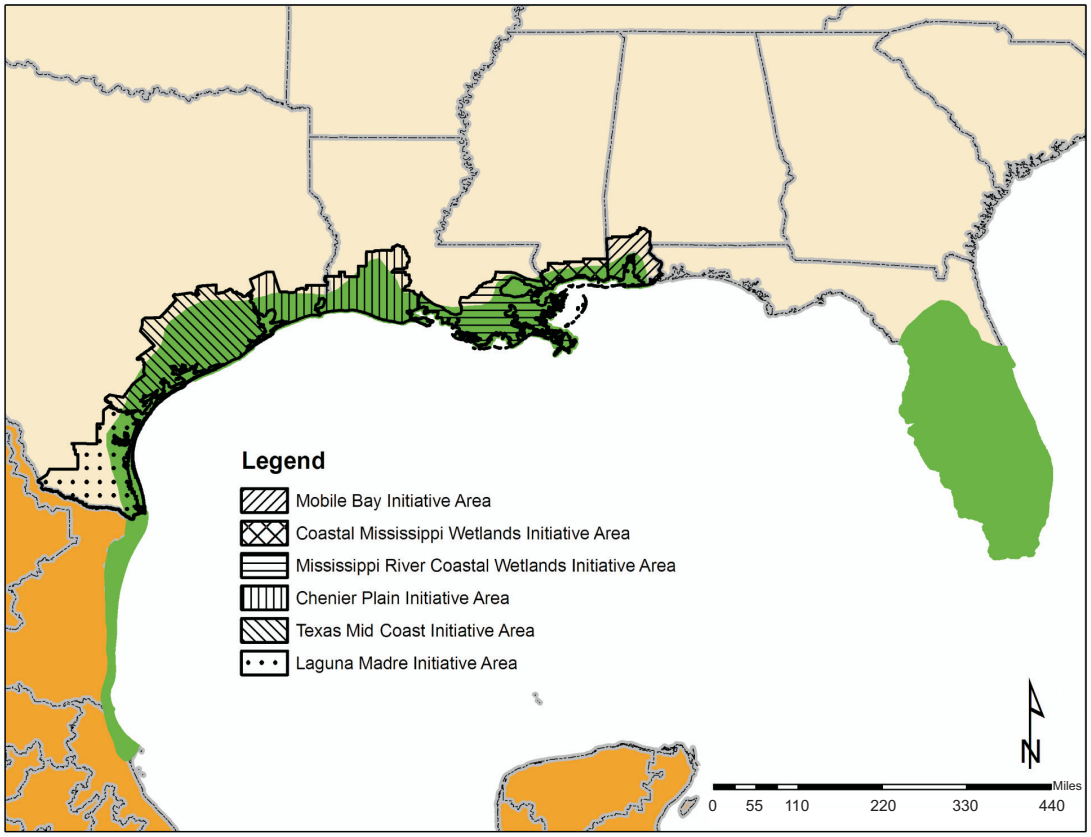


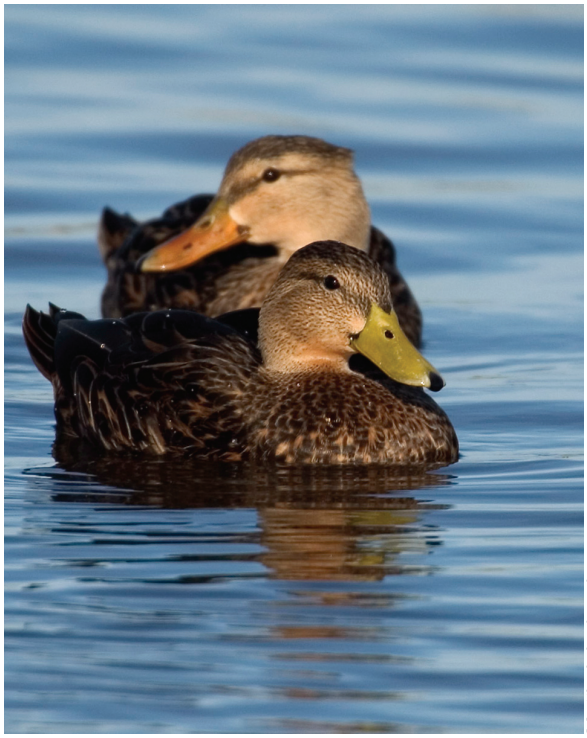
Figure 1. Mottled duck range (green shading, Moorman and Gray 1994; Stutzenbaker 1988) and Gulf Coast Joint Venture initiative areas.

Introduction to the Gulf Coast Joint Venture

The Gulf Coast Joint Venture (GCJV) was established in 1988 as a conservation partnership in one of the priority habitat regions identified by the North American Waterfowl Management Plan (NAWMP). The GCJV Management Board is composed of agencies and organizations that have accepted responsibility for collectively developing and attaining a common set of habitat objectives in furtherance of the NAWMP and other national or continental bird plans.

The GCJV region encompasses coastal marsh and associated habitats from Alabama to south Texas and is geographically subdivided into six initiative areas—Mobile Bay, Coastal Mississippi Wetlands, Mississippi River Coastal Wetlands, Chenier Plain, Texas Mid coast, and Laguna Madre (Fig. 1). For each initiative area, a habitat implementation plan guides waterfowl habitat conservation by GCJV partners via population objectives, biological models to derive habitat objectives, and recommended strategies and actions to achieve habitat objectives. A corresponding GCJV evaluation plan identifies and prioritizes filling of information gaps that currently preclude effective planning and untested assumptions used in the planning process, providing a feedback loop for adaptive refinements in biological planning.

The primary role of the GCJV region relative to continental waterfowl populations is providing migration and wintering habitat for over 13 million midcontinent dabbling and diving ducks and for over 1 million geese. Consequently, the emphasis of GCJV initiative plans is provision of sufficient habitat to meet the needs of these migratory birds. The four initiative area plans that cover Texas and Louisiana address the need to provide suitable habitat for mottled ducks during and after their breeding periods, but they do not provide the specific guidance that GCJV partners need. This document is intended to meet that need as well as provide a framework for adaptive refinements in mottled duck conservation planning by GCJV partners.



Mottled duck pair.

Gulf Coast Joint Venture Mottled Duck Working Group

In June of 2003 the GCJV Management Board established a working group to review available information and make specific habitat conservation recommendations to benefit WGC mottled ducks and to complement existing initiative area implementation plans. Following the conservation framework outlined in initiative area implementation plans, the mission of the ad hoc GCJV Mottled Duck Working Group (hereafter Working Group) was further refined as:

1. reviewing all available information on population status of WGC mottled ducks and making a determination regarding the urgency of mottled duck conservation issues,
2. reviewing all available information on potential limiting factors and identifying those factors most likely to be limiting current WGC mottled duck populations,
3. identifying habitat management recommendations to mitigate the habitat-related factors most likely to be limiting WGC mottled duck populations,
4. developing a list of research or monitoring protocols necessary to evaluate each management recommendation, and
5. developing a population target to guide and assess habitat conservation for WGC mottled ducks.

With guidance from the GCJV Management Board, a cross-section of participants was invited to participate, including chairpersons of GCJV Initiative Teams (for initiative areas that include mottled duck recommendations); members of the GCJV Management Board; U.S. Fish and Wildlife Service (USFWS) Regions 2 and 4 migratory bird staff; state flyway council and/or technical committee representatives; academics involved in mottled duck research; the GCJV Monitoring, Evaluation, and Research Team; state and federal biologists associated with coordination of recent Louisiana-Texas cooperative monitoring programs; and two retirees from the USFWS and Texas Parks & Wildlife Department whose careers included significant contributions toward mottled ducks. Working Group participants convened August 25-26, 2003, in Port Arthur, Texas, and again on February 10, 2004, in Lafayette, Louisiana. The following sections of this document represent the discussion topics, reviewed material, and recommendations from these two meetings. This plan was formally adopted by the GCJV Management Board on February 1, 2006.

Mottled ducks.

Mottled duck hen on nest.

Assessing the Evidence: I. Is There a Problem?

Population status of WGC mottled ducks in the United States is tracked via several means, but none of them are ideal for assessing population trend over their geographic range. There are three datasets available to examine rangewide population trend of WGC mottled ducks in the United States: the U.S. Midwinter Survey (Fig. 2), Breeding Bird Survey (Sauer et al. 2003) (Fig. 3), and U.S. Fish and Wildlife Service harvest and hunter activity surveys (i.e., kill-per-day index) (Fig. 4). Despite each of their individual shortcomings, all three datasets suggest that mottled duck numbers have declined precipitously in the Texas portion of the range and are stable elsewhere (or unknown, in the case of kill-per-effort that is confounded with bag limit changes in Texas).

Regional datasets on mottled duck population trend include a survey of mottled duck breeding pairs on upper Texas Gulf Coast national wildlife refuges (NWRs) (Fig. 5), monthly winter waterfowl surveys on all Texas Gulf Coast NWRs (Fig. 6), and monthly winter waterfowl surveys of the Louisiana coastal zone (Fig. 7). These datasets generally corroborate the results of the rangewide surveys, namely that there is strong evidence for declines in Texas, whereas numbers appear stable in Louisiana.

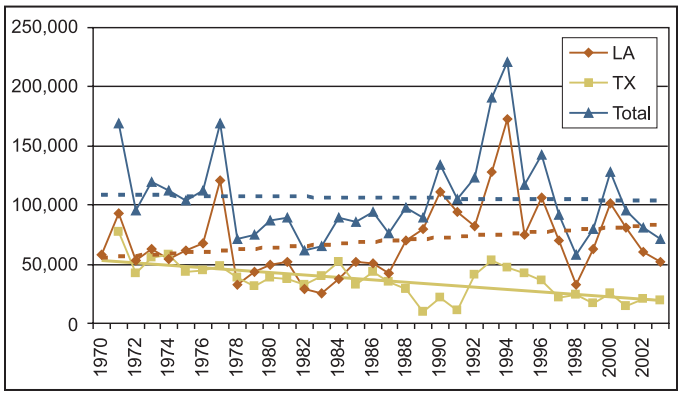


Figure 2. Mottled duck trends from U.S. Midwinter Survey index, 1970-2003. Straight solid lines depict significant (P<0.05) linear regression trends, and straight dashed lines depict nonsignificant linear regression trends. Incomplete 1993 and 1997 surveys in Louisiana replaced with average of prior and subsequent years. Excludes data from south Texas, which has been surveyed only since 1997. Texas coastal survey transects and survey zones changed in 2000.

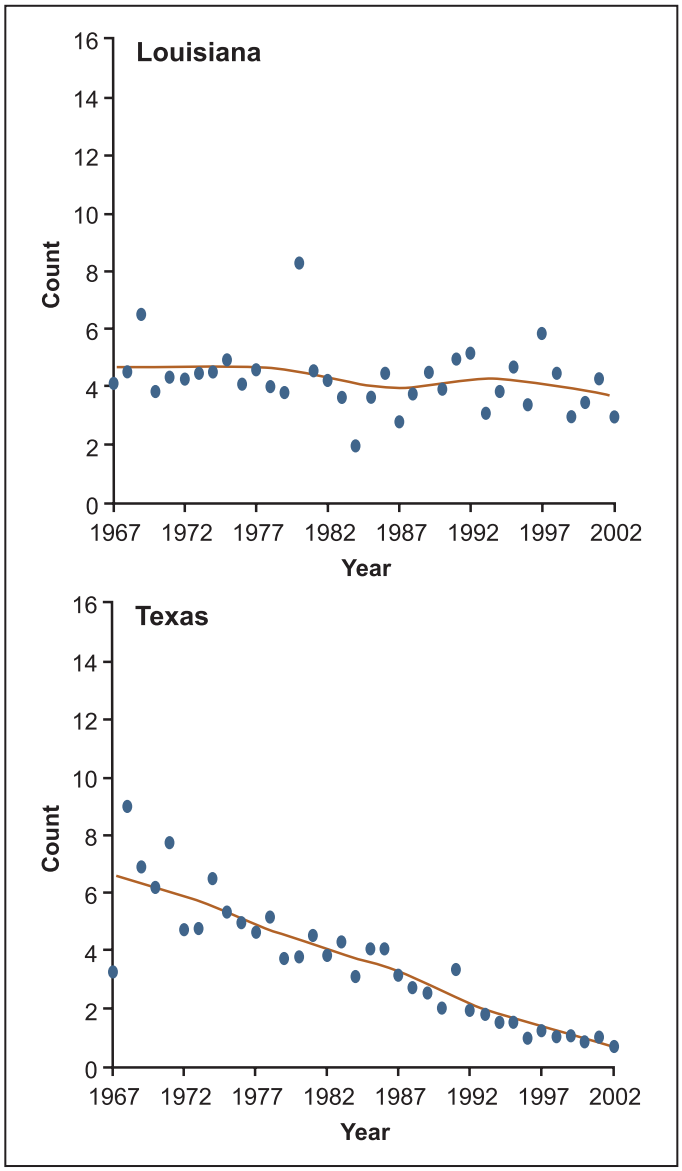


Figure 3. Mottled duck trends from North American Breeding Bird Survey for Louisiana (LA) and Texas (TEX), 1966-2002, reproduced from Sauer et al. (2003). Trend for Louisiana is nonsignificant (P=0.93), and trend for Texas is significant (P<0.005).

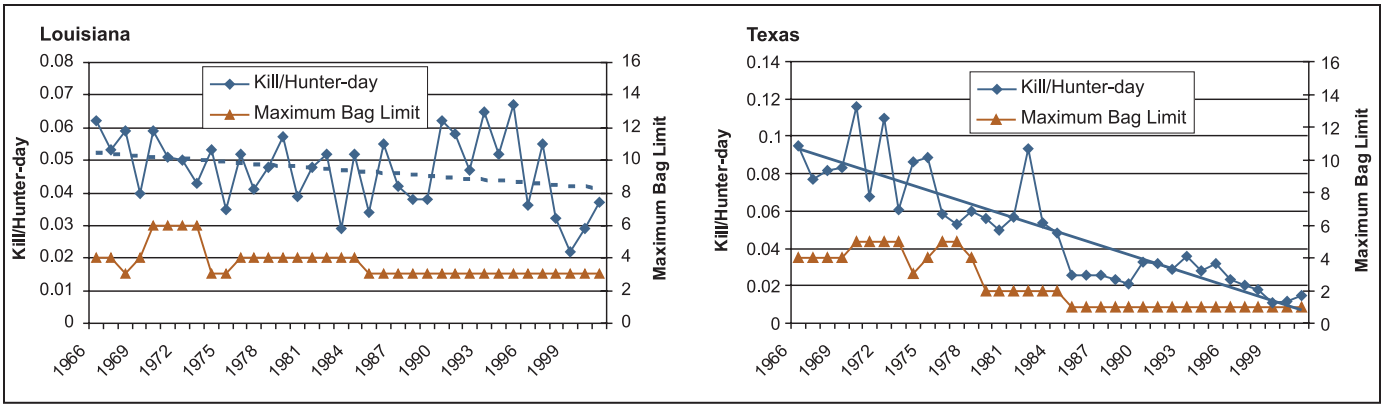


Figure 4. Mottled duck kill per hunter per day in Louisiana and Texas. Straight dashed line in Louisiana depicts nonsignificant linear regression trends, and straight solid line in Texas depicts significant (P<0.05) linear regression trends. Harvest, total adult hunters (potential), and total hunter days from U.S. Fish and Wildlife Service Mail Questionnaire Survey (Martin and Padding 2002).

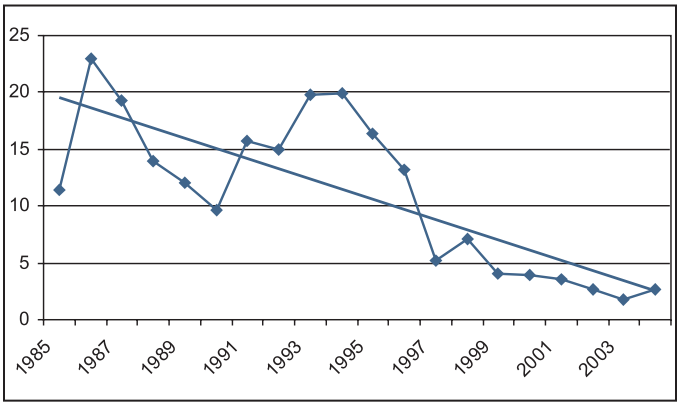


Figure 5. Mottled duck breeding pairs per square mile in national wildlife refuges along upper Texas Gulf Coast, 1985-2004 (U.S. Fish and Wildlife Service, unpublished data). Straight solid line depicts significant (P<0.05) linear regression trend.

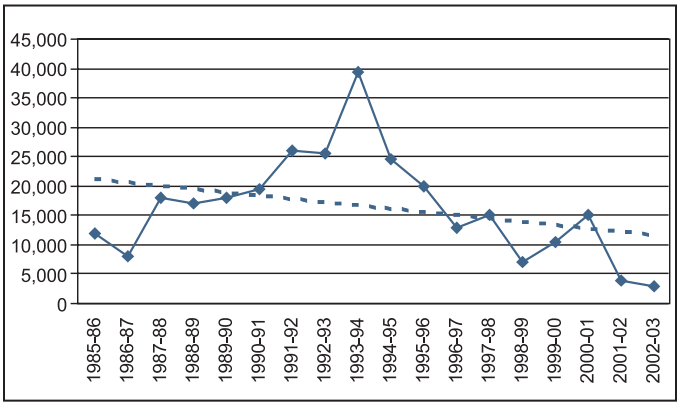


Figure 6. Mottled duck seasonal totals from 1985-86 through 2002-03 monthly winter surveys of Texas coastal national wildlife refuges (U.S. Fish and Wildlife Service, unpublished data). Straight dashed line depicts nonsignificant (P>0.05) linear regression trend. Surveyed areas changed somewhat through time.

Mottled duck breaks from nesting.

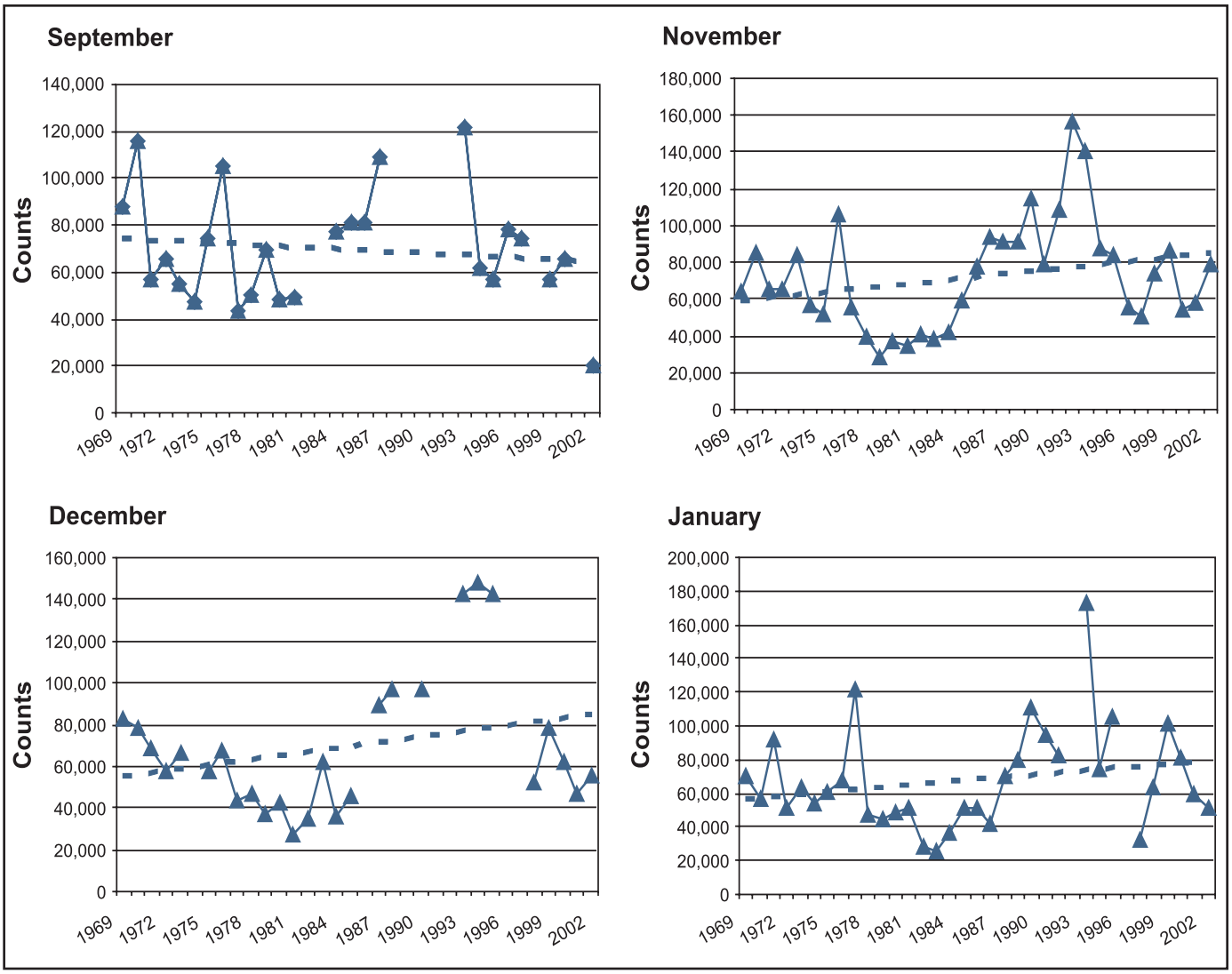


Figure 7. Mottled duck counts from monthly winter surveys of the Louisiana coastal zone, 1969-2002 (Louisiana Department of Wildlife and Fisheries, unpublished data). Straight dashed line depicts nonsignificant (P>0.05) linear regression trend.

After reviewing all available data on population trend and discussing the strengths and limitations of each dataset, attendees of the initial meeting of the GCJV Mottled Duck Working Group (Appendix 1) assessed the degree of concern for WGC mottled ducks with responses to three closed-format questions (Fig. 8, Appendix 2). In summary, the group found that WGC mottled ducks warranted a degree of special attention approximately halfway between that of a stable population and one threatened with extinction and that mottled ducks should be an above average concern for partners of the GCJV. Special attention now may prevent the need for crisis management later.

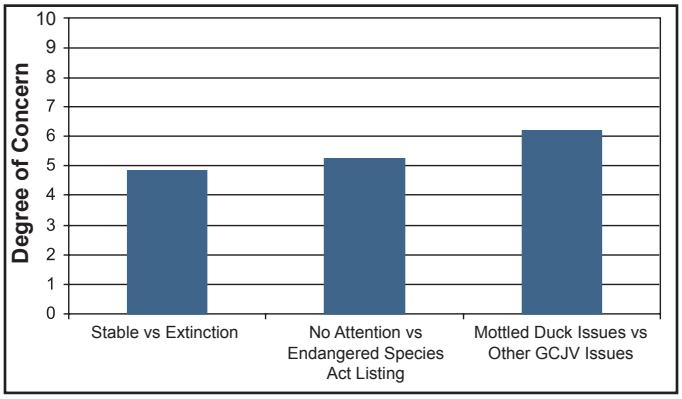


Figure 8. Average degree of conservation concern (on a 10-point scale) expressed for western Gulf Coast mottled ducks by Working Group participants in response to closed format questionnaire.

Assessing the Evidence: II. Identifying the Limiting Factors

Survival vs. Recruitment

Factors limiting population growth of WGC mottled ducks are related to either recruitment (addition of fledged young to the population) or survival. There is one rangewide dataset directly relevant to survival and one rangewide dataset directly relevant to recruitment. An intensive effort to band mottled ducks since 1994 (Louisiana) and 1997 (Texas) (Table 1) offers data to help estimate survival rates for comparison to other dabbling ducks and mottled ducks from other locations and periods (Wilson et al. 2003) (Table 2). These survival rate data suggest that annual survival of mottled ducks is generally low compared to other dabbling ducks. Recent survival rates of WGC mottled ducks are variable and remarkably low for some years and cohorts, but they generally fall within the ranges of other published estimates for the species. Rangewide recruitment data are limited to age ratios among harvested birds from the U.S. Waterfowl Parts Collection Survey. These recruitment data suggest higher age ratios in the Mississippi Flyway (i.e., Louisiana) than those in the Central Flyway (i.e., Texas), and the disparity is greatest in the two most recent decades (Table 3) when population trends in Texas and Louisiana diverged the most (Figs. 2-4).

Table 1. Hunting preseason (June 1-September 15) banding totals for western Gulf Coast mottled ducks 1994-2001.

	Texas	Louisiana	Total
1994	0	1,958	1,958
1995	0	3,809	3,809
1996	0	3,452	3,452
1997	1,978	1,914	3,892
1998	1,331	706	2,037
1999	2,167	910	3,077
2000	2,532	2,587	5,119
2001	1,473	1,024	2,497
Total	**9,481**	**16,360**	**25,841**

Table 2. Annual survival rate estimates for western Gulf Coast mottled ducks, other mottled ducks, and other dabbling ducks from preseason or winter banding analyses.

Species and Study Area	Years	Cohort	Survival Estimate[1]
Mottled duck			
Louisiana/Texas[2]	1994-2000	males	0.559
Louisiana/Texas[2]	1994-2000	females	0.502
Florida[3]	1997-91	adult males	0.548
Florida[3]	1997-91	juvenile males	0.909
Florida[3]	1983-90	adult females	0.503
Florida[3]	1983-90	juvenile females	0.474
Texas[4]	1965-71	adults	0.575
Florida[5]	1969-71	all	0.364
Florida[5]	1977-81	all	0.385
Pintail[6, 10]			
Central/Mississippi Flyway	1952-85	males	0.582
Central/Mississippi Flyway	1953-78	females	0.573
Green-winged teal[7, 10]			
Gulf Coast	1967-80	males	0.615
Gulf Coast	1952-80	females	0.516
Mallard[8]			
Midcontinent	1979-88	males	0.646-0.679
Midcontinent	1979-88	females	0.565-0.606
Gadwall[9]			
Midcontinent	1975-85	males	0.752
Midcontinent	1975-85	females	0.690

[1] Includes averages of year-specific estimates [2] Wilson et al. 2003 [3] Johnson et al. 1995 [4] Stutzenbaker 1988 [5] Johnson et al. 1984

[6] Hestbeck 1993 [7] Chu et al. 1995 [8] Smith and Reynolds 1992 [9] Szymczak and Rexstad 1991

[10] From analysis of winter bandings

Table 3. 1961-2000 age ratios (immature/adult) of harvested mottled ducks from U.S. Fish and Wildlife Service Parts Collection Survey (Padding et al. 2001).

Decade	Central Flyway Age Ratio (n)		Mississippi Flyway Age Ratio (n)		Atlantic Flyway Age Ratio (n)	
1961-1970	1.08	(2,189)	1.25	(1,074)	1.41	(2,477)
1971-1980	1.34	(2,214)	1.42	(990)	1.92	(1,364)
1981-1990	1.13	(1,144)	1.67	(1,136)	1.76	(1,610)
1991-2000	1.02	(1,183)	1.45	(1,908)	1.41	(1,206)
Average	**1.14**		**1.48**		**1.63**	

Factors Potentially Limiting Survival or Recruitment

Factors that potentially limit survival or recruitment of WGC mottled ducks include harvest, lead exposure, disturbance, habitat loss or degradation, predators, and precipitation. Direct mortality from recreational harvest can be estimated as a proportion of total annual mortality by using year-specific estimates of recovery rates and band reporting rates from the 1994-2001 intensive banding period coupled with an estimate of crippling rate (Fig. 9). Although banding data to use for assessing long-term trends in harvest rates are not available, an index of harvest rates (Fig. 10) suggests declining or stable harvest rates over the past three decades. While the GCJV defers any judgments regarding harvest regulations to other entities charged with that responsibility, this assessment indicates that most room for improvement in annual survival rates falls outside of mortality factors associated with hunting, suggesting that improvements in habitat or other environmental variables within the purview of the GCJV partnership deserve attention.

Lead toxicity caused by ingestion of spent shotshell pellets is known to be a source of mortality and sublethal negative effects in waterfowl (Anderson et al. 2000). Even though there has been full implementation of steel shot requirements for waterfowl hunting in the United States since 1991, waterfowl continue to ingest lead pellets that (1) were deposited prior to the steel shot requirement, (2) are a result of nonwaterfowl hunting, and/or (3) are a consequence of illegal lead shot use. Anderson et al. (2000) found 2.8% of harvested Mississippi Flyway mallards with ingested lead pellets in their gizzards and estimated that 154,000-206,000 mallards nationwide likely succumbed to lead toxicosis in 1997, even with a 64% reduction of lead ingestion attributed to nontoxic shot regulations. Mottled ducks may be particularly vulnerable to the effects of lead ingestion because of their year-round exposure to agricultural and marsh habitats that have been heavily hunted for decades. Annual collections of gizzards from public hunting areas of the Texas coast suggest continued high incidences of lead shot ingestion ranging from 23.3% to 7.3% (Fig. 11). Similarly, a 2003-04 sample of 826 mottled duck gizzards in Louisiana found 7.8% had ingested lead pellets (J. Linscombe, unpublished data). The proportion of mottled ducks with ingested lead appears to far exceed those of other species, such as the mallards in the Mississippi Flyway study by Anderson et al. (2000). It is therefore probable that lead ingestion imposes some degree of survival limitation on WGC mottled duck populations. Sublethal effects, including potential effects on recruitment, are more speculative but possible.

Disturbance associated with human activity may affect mottled duck survival by increasing duck mobility and susceptibility to mortality from human hunters or other predators. Excessive disturbance could also have sublethal effects on their condition, possibly leading to recruitment impacts. Mottled ducks on the Texas coast have been documented with poorer conditions at Anahuac NWR, which has a fragmented landscape with high disturbance potential, than nearby McFaddin NWR (Haukos et al. 2001).

Habitat loss and degradation may negatively impact survival and recruitment through insufficient food resources, lack of nesting or escape cover

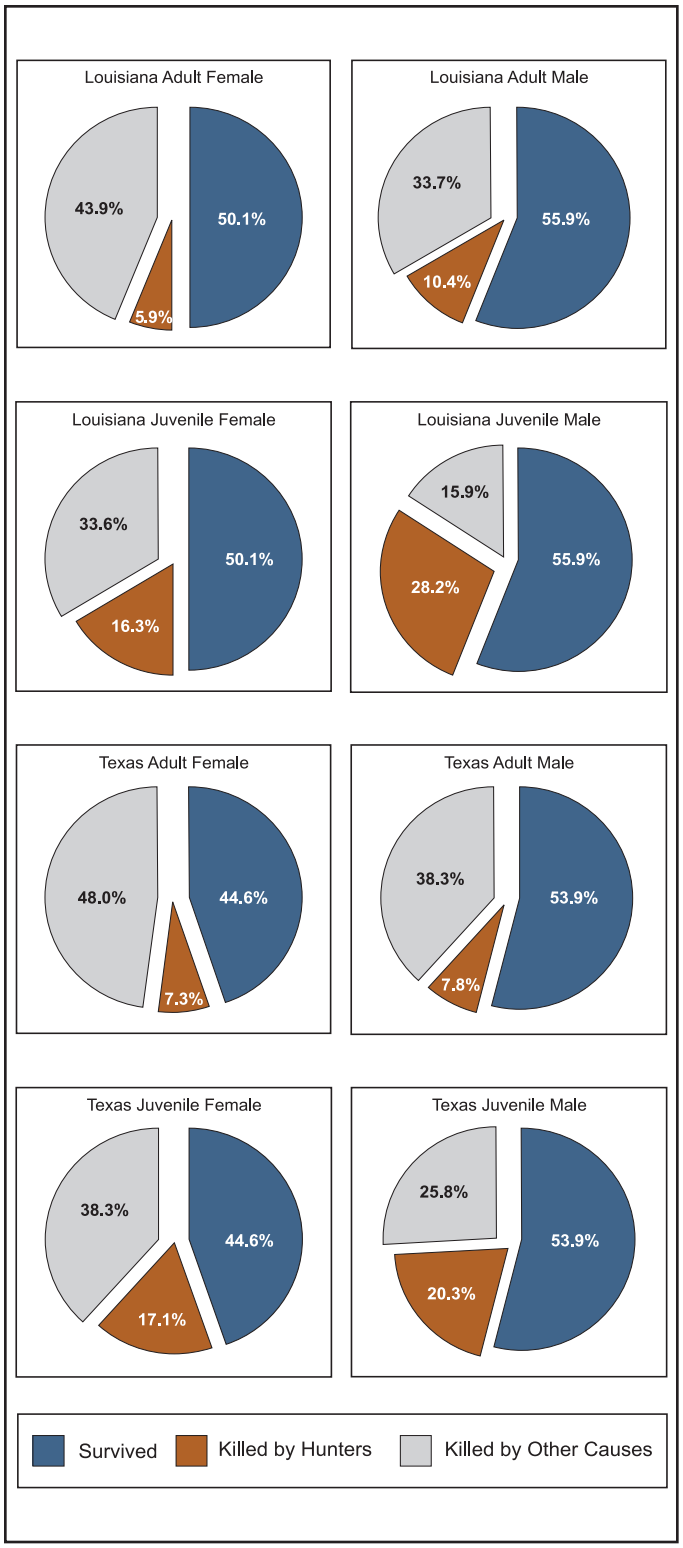


Figure 9. Fate of western Gulf Coast mottled ducks as estimated from averages of annual survival and recovery rates, 20% crippling rate, and year-specific mallard band reporting rates (Wilson et al. 2003). Data are from 1994-2000 for Louisiana and 1997-2000 for Texas.

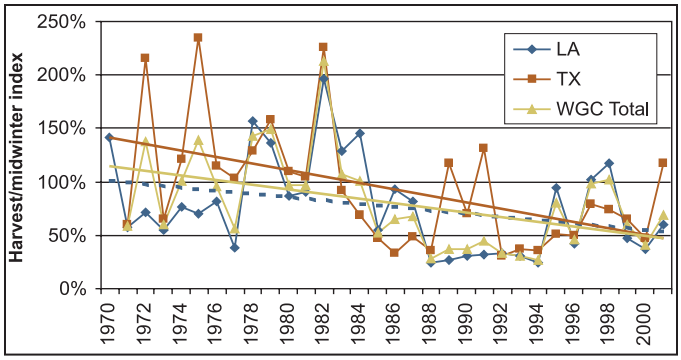


Figure 10. Western Gulf Coast mottled duck harvest rate index, 1970-2001. Harvest rate index is harvest estimate from the U.S. Fish & Wildlife Service mail questionnaire survey divided by the midwinter survey index. Straight solid lines depict significant (P<0.05) linear regression trends, and the straight dashed line depicts a nonsignificant linear regression trend. Data from 1993 and 1997 in Louisiana are averages of prior and subsequent years because of incomplete midwinter data. The graph excludes midwinter data from south Texas, which has only been surveyed since 1997.

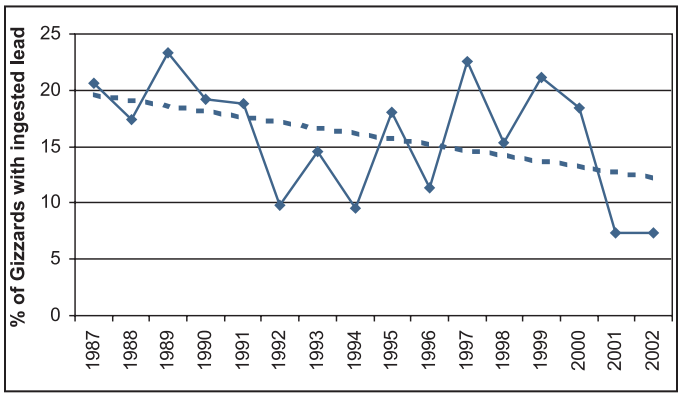


Figure 11. Frequency of ingested lead in mottled duck gizzards (n=6,850) collected from eight public hunting areas of the Texas coast, 1987-2002 (W. Johnson, unpublished data). Straight dashed line depicts nonsignificant (P>0.05) linear regression trend.

that protects from predators, concentration of birds in smaller areas of habitat that leads to increased disease transmission and other stresses, and ultimately fewer options when trying to avoid any negative impact. Habitats of WGC mottled ducks can generally be categorized as either coastal marsh or agricultural lands. Over 924,000 acres of emergent coastal marsh loss occurred in Louisiana between 1932 and 1990 (Louisiana

Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Coastal Texas similarly experienced the loss of over 210,000 acres of estuarine and palustrine coastal wetlands between 1955 and 1992 (Moulton et al. 1997). The value of WGC agricultural lands to mottled ducks is primarily due to the wetland nature of rice cultivation and associated idle fields in rice rotations, as well as the value of nesting habitat in pastures that are near coastal marsh or agricultural wetlands. Acreages of planted rice in coastal Texas and Louisiana have declined markedly (Fig. 12) and presumably so has the acreage of idle fields in rice rotations that are 1-2 times the acreage of cultivated rice.

American alligators (*Alligator mississippiensis*) are predators of mottled ducks where the ranges of the two species intersect in fresh to brackish coastal marsh. Mottled ducks are generally a minor prey item of alligators (Valentine et al. 1972, McNease and Joanen 1977), though Elsey et al. (2004) documented one instance that contradicts this generality. Infrequent ingestion by individual alligators does not necessarily preclude the more abundant alligator population as a substantial mortality agent for mottled ducks. The degree to which alligator predation influences mottled duck populations is unknown but is likely to be a function of alligator abundance. Alligator abundance in coastal Louisiana has increased at an average rate of 4.2% per year since 1970 (Fig. 13), and although there has been less of a change in alligator populations in Texas, there is some evidence of increase (Fig. 14).

The abundance of North American dabbling ducks is typically cyclic and strongly correlated with precipitation on breeding areas. Because of the influences of annual environmental variability on nesting effort and reproductive success, duck abundance typically increases as breeding habitats become wet and decrease as they become dry. Because ducks can move in response to wet and dry conditions to find the best options within their breeding range, species with smaller breeding ranges may be less likely to find suitable breeding conditions in a given year. In the prairie pothole region, ducks have an area ten times larger than

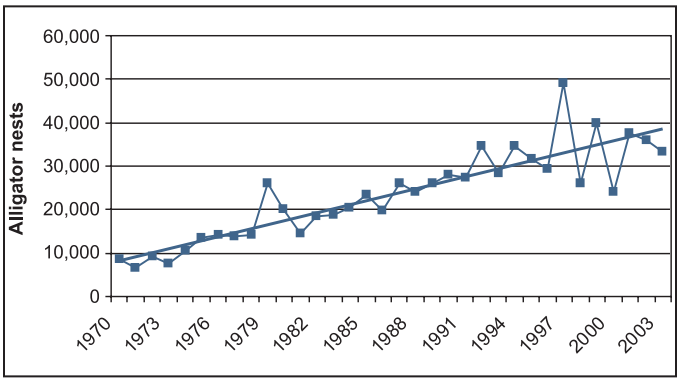


Figure 13. Alligator population trends in coastal Louisiana, 1970-2003 (Louisiana Department of Wildlife and Fisheries, unpublished data). Straight solid line depicts significant (P<0.05) linear regression trend.

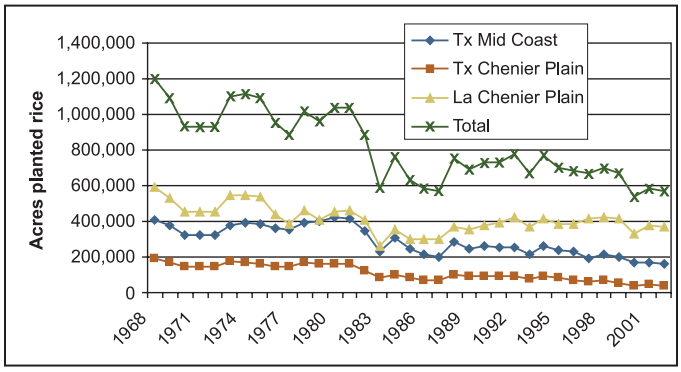


Figure 12. Planted rice acres in Texas and Louisiana, 1968-2002, according to U.S. Department of Agriculture, National Agricultural Statistics Service.

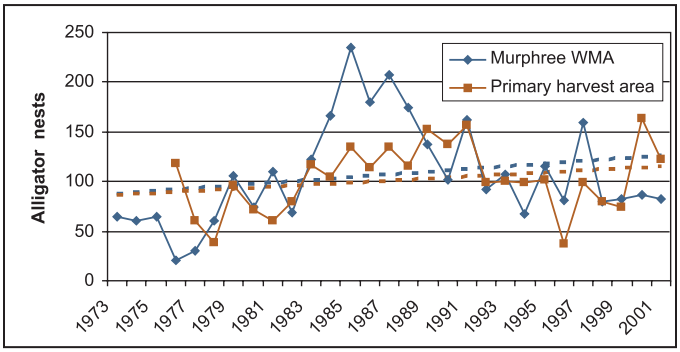


Figure 14. Alligator population trends in coastal southeast Texas, 1973-2001 (Texas Parks and Wildlife Department, unpublished data). Straight dashed lines depict nonsignificant (P>0.05) linear regression trends.

that of the WGC in which to find suitable breeding conditions, and yet their populations still rise and fall with varying rainfall levels. With the relatively small size of the WGC region as compared to the prairie pothole region, we might expect mottled duck populations to vary at least as much as those of other dabbler ducks that breed in the prairie pothole region. A precipitation index for the GCJV region suggests a range of values that mostly fall within +/- 20% of the long-term mean, with notable exceptions that include a precipitation peak in the early 1990s and drought years in 1999 and 2000 (Fig. 15). Lacking more reliable indices of population size and breeding habitat conditions, preliminary attempts to correlate the midwinter population index with this precipitation index yielded no discernable relationship. Durham (unpublished data) found the possibility of a weak relationship between annual rainfall and age ratios in Louisiana.

Besides actual loss of emergent wetlands discussed previously, the quality of remaining wetlands is impacted by changes to salinity gradients. Relative sea-level rise, constructed channels and canals for navigation, restrictions of downstream freshwater flows, and other hydrologic alterations of the WGC have generally resulted in conditions that favor isohaline encroachment and increasingly saline coastal marshes (Chabreck and Linscombe 1982). Moorman et al. (1991) found that salinities of >9 parts per thousand (ppt) had negative consequences to mottled duck brood behavior and survival.

After reviewing all available data on the relative importance of survival and recruitment to current population limitation of WGC mottled ducks, attendees of the initial Working Group meeting (Appendix 1) responded to a question addressing the relative likelihood of each population parameter being limiting (Fig. 16, Appendix 2). Additionally, respondents assessed the relative importance of the various components of survival and recruitment as well as environmental factors discussed above and their relative importance in contributing to population limitation (Figs. 17-19, Appendix 2). In summary, recruitment was judged to be twice as important as survival in current population limitation of WGC mottled ducks. The most important aspect of survival was considered to be threats by spring and summer predators, and the most important aspects of recruitment in order of priority were considered to be nest success, brood survival, and breeding propensity. The most important factors influencing these aspects of survival and recruitment were judged to be availability of spring and summer habitats and how weather affects those habitats.

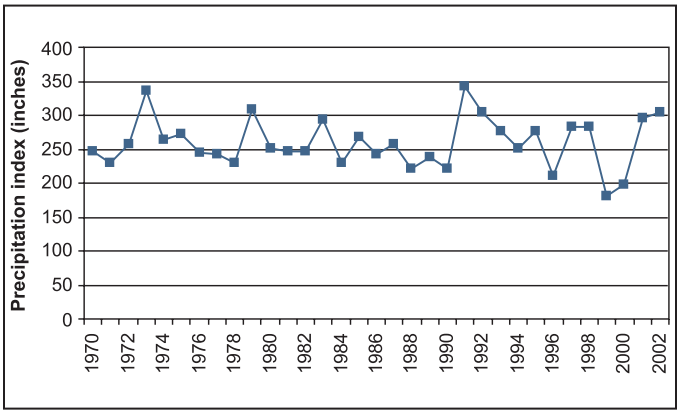


Figure 15. Precipitation index for the Gulf Coast Joint Venture region, composed of annual rainfall totals (National Oceanic and Atmospheric Administration) summed across the five initiative areas (outlined on fig. 1).

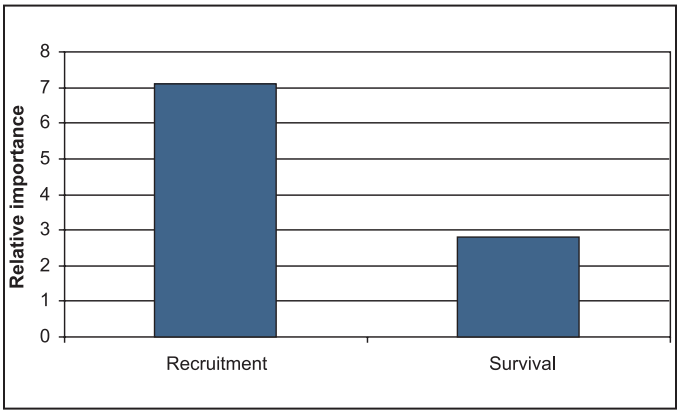


Figure 16. Average of Working Group participant assessments of the relative importance of recruitment versus survival as the parameter most likely to be constraining population growth of western Gulf Coast mottled ducks.

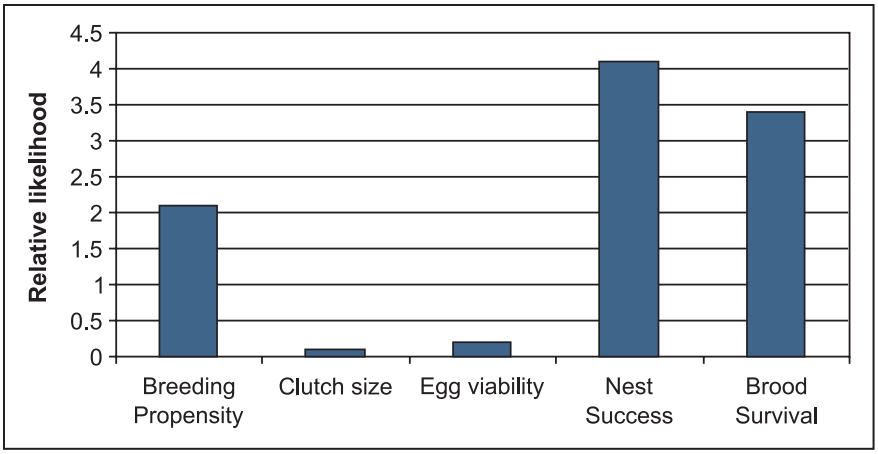


Figure 17. Average of Working Group participant assessments of the relative likelihood of various aspects of recruitment to be constraining recruitment of western Gulf Coast mottled ducks.

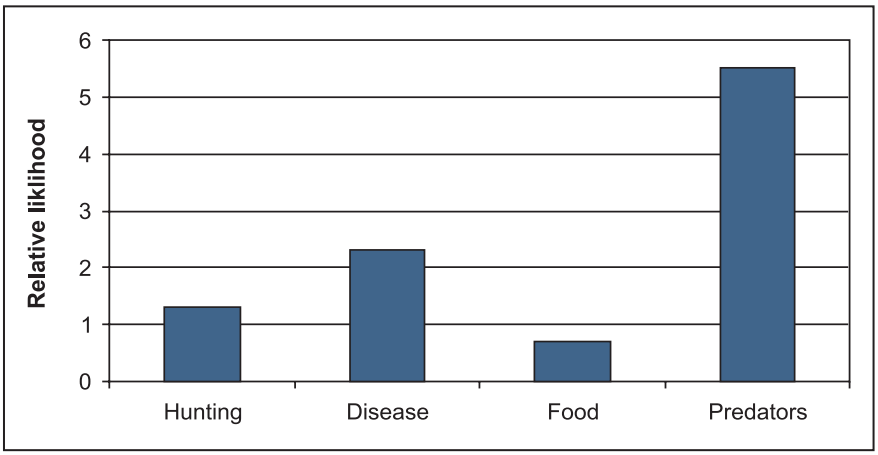


Figure 18. Average of Working Group participant assessments of the relative likelihood of various aspects of survival to be constraining survival of western Gulf Coast mottled ducks.

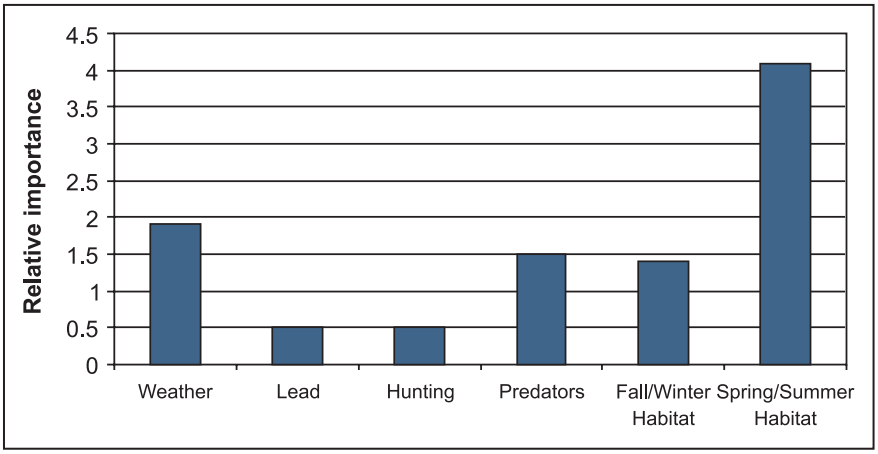


Figure 19. Average of Working Group participant assessments of the relative importance of various aspects of survival and recruitment in limiting population growth of WGC mottled ducks.

Population Target for Habitat Conservation

The NAWMP assigns continental waterfowl population targets to serve functions related to communications, planning, and evaluation. Population targets facilitate communication and promotion of NAWMP priorities with legislators, administrators, partners, and the public; serve as baselines for regional (i.e., joint venture) habitat conservation planning; and provide a metric for success for conservation accomplishments. Faced with the challenge of the 1998 and 2004 versions of the NAWMP to strengthen the biological foundations of regional waterfowl planning, but without existing population objectives from flyway councils or the NAWMP specifically for mottled ducks, the Working Group has adopted the same approach and rationale in determining a regional population target to guide habitat conservation for this species.

Of the three datasets available for rangewide population trends of WGC mottled ducks in the United States—the U.S. Midwinter Survey (Fig. 2), Breeding Bird Survey (Sauer et al. 2003.) (Fig. 3), and U.S. harvest and hunter activity surveys (i.e., kill-per-day index) (Fig. 4)—the U.S. Midwinter Survey was chosen as the base dataset for defining and assessing the population target. U.S. Midwinter Survey data was obtained from the U.S. Fish and Wildlife Service (Lubbock, Tex.), Texas Parks and Wildlife Department (Austin, Tex.), and Louisiana Department of Wildlife and Fisheries (Baton Rouge, La.). Only coastal portions of the Texas survey are used, as the south Texas region (Coastal Sand Plain and Brush Country) has only been surveyed since 1997. The long-term average (1971-2004) is the period used to define the target. Geographically, there are three components of the population target, each of equal significance: WGC total, Texas, and Louisiana. Consequently, the GCJV's WGC mottled duck population target to guide habitat conservation, as measured by the coastal portions of the U.S. Midwinter Survey, is 105,816 for the WGC (including Texas, Louisiana, Mississippi, and Alabama): specifically, 35,322 for Texas, and 70,132 for Louisiana (Fig. 20). Thus, data indicate numbers approaching two of the three population target components (i.e., WGC and Louisiana), while the Texas component is 52% below target. Population response at the scales identified is the ultimate success measure for all actions recommended in this document.

Working Group deliberations to develop this population target highlighted the limitations of current population monitoring data. An improved and operational rangewide survey is needed to reliably assess trends in mottled duck abundance and habitats. As we develop and gain experience with improved monitoring programs, the GCJV may revisit the derivation and assessment of the population target.

Mottled ducks and snowy egrets.

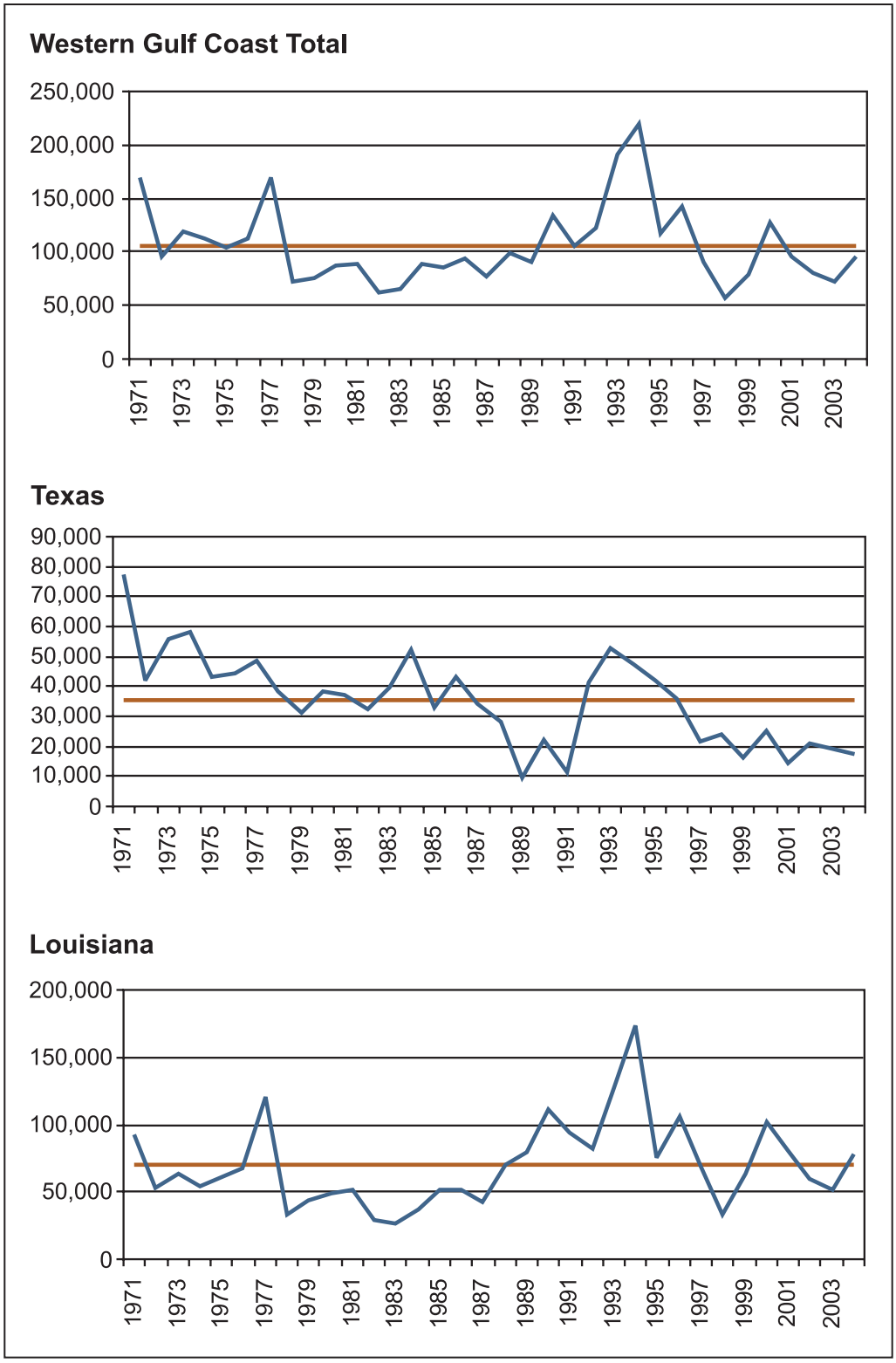


Figure 20. Gulf Coast Joint Venture population targets (orange lines) for habitat conservation for western Gulf Coast mottled ducks, based on 1971-2004 long-term averages of U.S. Midwinter Survey Index. Incomplete 1993 and 1997 surveys in Louisiana were replaced with average of prior and subsequent years. Excludes data from south Texas, which has only been surveyed since 1997. Texas coastal survey methodology changed somewhat in 2000.

Achieving and Maintaining the Population Target: Adaptive Implementation

Conservation of WGC mottled duck habitats should occur in a manner in which recommended actions are based on the best available information, implementation is never put on hold pending research results, and iterative refinement of management prescriptions and objectives is not only possible, but expected. This process of adaptive management requires making judgments and predictions based on imperfect information, explicitly stating the key underlying assumptions and knowledge gaps, implementing habitat in a manner that facilitates learning, and investing in evaluation to complement implementation.

Most habitats for WGC mottled ducks are generally associated with two categories: (1) permanent or semipermanent palustrine or estuarine coastal marsh (hereafter coastal marsh), or (2) former coastal prairie dominated by active agriculture, idle fields, grazing pastures, seasonal wetlands, and more intensively managed water delivery (hereafter agricultural lands). Because the management options differ markedly between the two broad categories, some management guidelines below offer separate recommendations. Managers of transitional sites that have characteristics of both habitat categories should be able to adapt recommendations below to suit the management potential of their particular site.

Mottled ducks on Wetland Reserve Program site near Gueydan, La.

Highest Management Priorities

The highest priority actions to address WGC mottled duck conservation needs are those that target increasing nest success and brood survival. It is important to note that management treatments to influence WGC mottled duck nest success or brood survival have never been directly or rigorously evaluated, so the following management recommendations are accompanied by suggestions for complementary evaluation.

Nest Success

Nest success is the probability that a nesting attempt will result in at least one hatched duckling (Klett et al. 1986). Nest success of dabbling ducks—and presumably mottled ducks—is typically a function of species and structure of vegetative cover, block size of nesting cover (i.e., habitat fragmentation), hen and egg predator community, and weather events that lead to nest destruction (e.g., flooding). Potential management actions to increase nest success will therefore involve manipulation of vegetative characteristics, habitat block size/configuration, or predator communities.

Vegetative characteristics of preferred nesting habitats are thought to include the following:

Agricultural Lands

- An abundant (>12) species mix of native bunch grasses
- Abundant plant litter
- Dense growth, but not too dense to prevent walking through by humans or ducks
- An absent or minor and dispersed component of small, woody (i.e., shrub) plants
- Permanent pasture and idle fields

Coastal Marsh

- High, well-drained, brackish or saline prairie ridges
- High marsh sites within fresh or intermediate marsh complexes
- Recently formed (i.e., early-successional) deltaic islands
- Absent or minor and dispersed component of woody plants

Size and configuration of preferred and successful nesting habitats are characterized as follows:

Agricultural Lands and Coastal Marsh

- Blocks of 500-1,000 acres are ideal, but no less than 40 acres
- Islands of 40-150 acres surrounded by water
- Perimeter-to-area ratios as small as possible
- Proximity to wetlands suitable for brood rearing is critical (see "Brood Survival," p. 19)

Predator removal guidelines from nesting habitats follow:

Agricultural Lands and Coastal Marsh

- Apply only to relatively small areas with known high densities of nesting.
- Apply only to islands or other isolated situations where predator replacement would be reduced by natural or constructed barriers.
- Apply only to situations where predator management can be sustained over several years and where it can be combined with optimal habitat for nesting and brood rearing.
- Target known mammalian hen and/or egg predators, such as raccoons, foxes, coyotes, skunks, and mink.
- Take advantage of natural disasters (e.g., hurricanes, tidal surges, and flooding) that are likely to set back mammalian predator abundance by ensuring the availability of other components of breeding habitat as quickly as possible following such an event.

Evaluating Treatments to Increase Nest Success

Ideally, the above guidelines (or a subset of them) should be similarly implemented at three or more sites simultaneously, with standard monitoring protocols applied to each site to evaluate nesting

density and nest success as compared to controls and/or previous conditions.

Further research is needed to identify the structural characteristics of preferred and successful nesting habitat. Once those characteristics have been identified to a greater degree of certainty than currently exists, habitat management techniques should be evaluated on their ability to create such structure.

By using the guidelines provided above, or as refined through further research, WGC mottled duck nesting habitat should be identified, quantified, and periodically monitored through remote sensing, if feasible.

Brood Survival

Brood survival relates to the period between egg hatching and duckling fledging (i.e., capable of sustained flight). In dabbling ducks—and presumably mottled ducks—brood survival is typically a function of duckling predator community; proximity to habitats for both nesting and brood rearing; food availability; weather; and vegetative, structural, and water quality characteristics of the wetlands. Consequently, because weather cannot be controlled, management actions to enhance brood survival will address one or more of the other parameters.

Mottled duck brood.

Proximity of habitats for brood rearing and nesting is especially critical for allowing brood movement between those habitats, with the following general guidelines:

Agricultural Lands

- Ideally, a 2,500-acre habitat mosaic with 1,000 acres permanent pasture and 1,500 acres in a rice rotation, resulting in about 500 acres of actively cultivated flooded rice prior to harvest
- <1 mi between habitats suitable for nesting and brood rearing

Coastal Marsh

- Suitable nesting habitat within 0.5 mi of suitable wetlands for brood rearing (see characteristics and timing below)

Structure, vegetation, and water quality characteristics of preferred wetlands for brood rearing are not well documented, but following are general guidelines:

Agricultural Lands

- Flooded growing rice
- Seasonal, semipermanent, and permanent natural wetlands that approximate coastal marsh characteristics outlined below

Coastal Marsh

- Shallow ponds with mudflats and/or water <5.9 in to bottom or dense Subaquatic Vegetation (SAV) substrate
- Peripheral emergent vegetation that is dominantly short, nonwoody, and sparsely or moderately dense
- Availability of some dense patches of emergent escape cover
- Salinities that do not exceed 6-8 ppt
- Emergent vegetation (not to exceed 50% pond coverage) or SAV to support an invertebrate food source

Predator management guidelines to reduce predator interactions with broods follow:

Agricultural Lands and Coastal Marsh

- See predator guidelines under "Nest Success" (p. 18).
- Minimize borrow areas, which would create potential habitat for water-borne predators such as alligators and snapping turtles, on the interior of wetlands otherwise suitable for brood rearing.
- Maximize suitable corridors (with minimal deep water) between habitats suitable for nesting and brood rearing.

Timing of available wetlands suitable for brood rearing is critically important, with the following guidelines:

Agricultural Lands and Coastal Marsh

- Mid-April through July is the most critical period for availability of wetlands suitable for brood rearing, but because mottled ducks have a long potential nesting season and a capacity for multiple renesting attempts, earlier and later periods would benefit some broods and may contribute to other wetland needs for WGC mottled duck (see "Breeding Propensity" p. 21, and "Adult Molting Survival" p. 22).

Evaluating Treatments to Increase Brood Survival

Ideally, the above guidelines (or a subset of them) should be similarly implemented for at least three sites simultaneously, with standard monitoring protocols applied to each site to evaluate brood survival results as compared to controls and/or previous conditions.

Further research is needed to identify the structural characteristics of preferred and successful brood rearing habitat. Once those characteristics have been identified to a greater degree of certainty than currently exists, habitat management techniques should be evaluated on their ability to create such structure.

By using the guidelines provided above or refined characteristics identified through further research, remote sensing should be used, if feasible, to identify, quantify, and periodically monitor brood-rearing habitat for WGC mottled ducks (other than rice cultivation rotations).

Mottled ducklings.

Moderate Management Priorities

Less urgent but desirable actions to address conservation needs of WGC mottled ducks are those that target increasing breeding propensity and adult survival during remigial wing molt. As with the nesting success and brood survival guidelines, management treatments to influence breeding propensity and adult molting survival have never been directly or rigorously evaluated, so the following management recommendations are accompanied by suggestions for complementary evaluation.

Breeding propensity

Breeding propensity is the total nesting attempts in a given year, as a proportion of that year's adult female population. Breeding propensity in dabbling ducks—and presumably mottled ducks—is typically influenced by the availability of suitable wetlands early in the breeding period and perhaps by the health of breeding females. Many midcontinent dabbling ducks may find poor wetland conditions in their primary production areas of the prairie pothole region and consequently overfly them for other options farther north; however, WGC mottled ducks generally restrict their range to an area 30 times less than the combined size of the prairie pothole and boreal forest regions. Consequently, fewer options are available to WGC mottled ducks when landscape conditions are not favorable for breeding, suggesting there is potential for substantial interannual variability in breeding propensity and subsequent production. Management actions to increase breeding propensity to allow for more availability of wetlands early in the breeding period will help stimulate initial breeding activity.

Mottled duck hen on nest.

Guidelines for wetlands used by breeding pairs:

Agricultural Lands and Coastal Marsh

- Surface water available by early February through March, in wetland types approximating wetlands required during brood rearing
- Red swamp crawfish (*Procambarus clarkii*) impoundments with above-water vertical structure of 25%-50% coverage may suffice
- Proximity (within 0.25-1 mile) to habitat for nesting and brood rearing (see above characteristics) may be important

Evaluating Treatments to Increase Breeding Propensity

Evaluating breeding propensity response to management is more challenging than assessing impacts of other recommendations contained herein. Consequently, localized nest density or indices to breeding activity (e.g., three-bird chase flights or lone male flights) may suffice as a surrogate response variable for breeding propensity.

Ideally, the above guidelines (or a subset of them) should be similarly implemented for at least three sites simultaneously, with standard monitoring protocols applied to each site to evaluate breeding propensity (or breeding activity indices) as compared to controls and/or previous conditions.

Research is ongoing to identify the structural characteristics of preferred wetlands for breeding pairs in marsh habitats, and similar studies in agricultural settings are probably warranted. Once wetland characteristics beneficial for breeding pairs have been identified to a greater degree of certainty than currently exists, management techniques should be evaluated on whether or not these techniques can create such a habitat.

By using the guidelines provided above, or as refined through further research, wetlands suitable for WGC mottled duck breeding pairs (aside from those rotated as part of rice cultivation) should be identified, quantified, and periodically monitored through remote sensing, if feasible.

Other factors that potentially affect breeding propensity through breeding female health parameters (e.g., lead exposure) should be investigated.

Adult Molting Survival

Mottled duck adults experience a 27-day flightless period that accompanies annual remigial wing molt, and during that time, their limited mobility renders them somewhat vulnerable to natural mortality agents. Little is known about molting habitats or the degree that molting-related vulnerability plays in the annual life cycle of WGC mottled ducks, but it seems probable that it is a major component of their nonhunting mortality, especially for males.

Guidelines for managing habitat for molting adults:

Agricultural Lands

- Mottled ducks are not known to use such habitats much for molting.

Coastal Marsh

- Transitional (degrading or recovering) vegetation in slightly brackish to fresh marsh
- Very low, herbaceous vegetation typical of marshes subjected to defoliation by large populations of nutria or muskrat (i.e., "eat-outs")
- Shallow ponds 6-18 inches deep
- Dense, emergent escape cover available nearby
- Where possible, managed units that can hold water during drought situations are particularly valuable
- Habitat should be targeted for the peak molt period of mid-July through mid-September
- Where possible, minimize interactions with alligators (e.g., minimizing deep borrow areas on the interior of a molting habitat management unit).

Evaluating Treatments to Increase Adult Molting Survival

Research is needed to identify the characteristics of preferred molting habitat. Locations with abundant molting adults appear to be relatively rare, but the extremely high numbers of molting ducks observed at some sites suggest that birds may concentrate there from very broad areas, so identification of those few unique sites is the first step to understanding their attractiveness. Once the characteristics of these sites have been identified to a greater degree of certainty than currently exists, management techniques should be evaluated on whether or not they can create such habitats.

The above treatments should be evaluated based on how effectively they attract molting adults and increase molting adult survival compared to controls and/or previous conditions.

By using the guidelines provided above, or as refined through further research, habitat suitable for molting WGC mottled ducks should be identified, quantified, and periodically monitored through remote sensing.

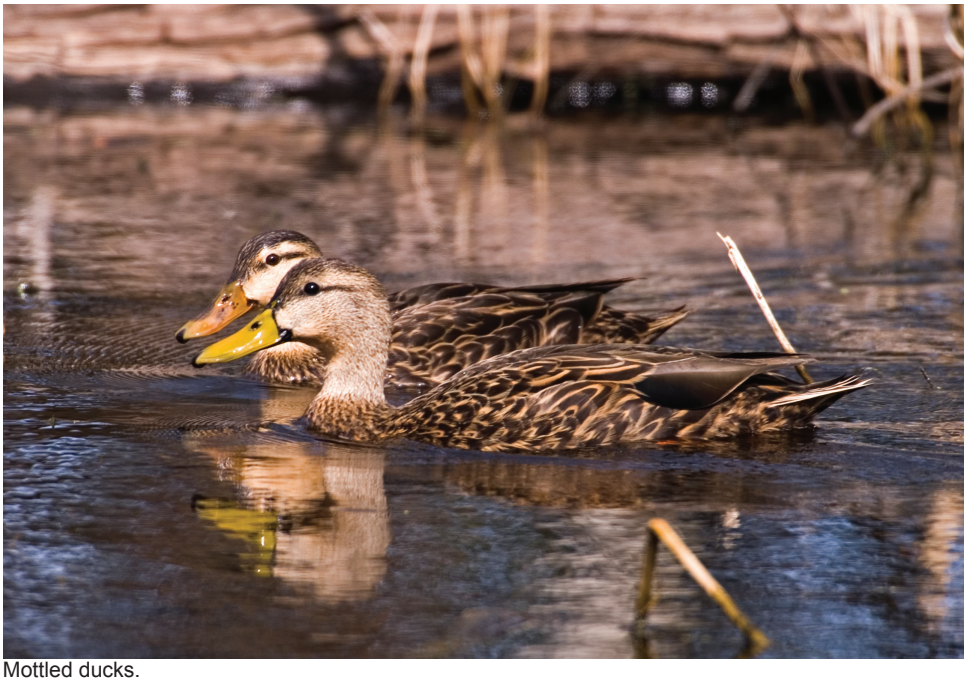
Molting mottled duck.

Hybridization

How genetic integrity of WGC mottled ducks is threatened is an emerging conservation concern. Hybridization of mottled ducks with feral mallards has long been a concern to managers of mottled ducks in Florida (Florida Fish and Wildlife Conservation Commission 1999), where it is considered by some to be the single greatest threat to the future existence of the species (Moorman and Gray 1994). Released mallards have been responsible for genetic swamping (genetic dilution of a species) of several similar species worldwide, demonstrating the devastating potential effects of widespread hybridization.

From a recent sample of 186 wings collected from public hunting areas across the GCJV, 9 (4.8%) showed external traits characteristic of mallard-mottled duck hybrids (W. Johnson, unpublished data). This evidence has spawned concern among managers of WGC mottled ducks, and efforts to monitor wings for signs of mallard-mottled duck hybridization continue.

The threat of genetic introgression from mallards is unique among the conservation issues discussed in this document. Hybridization is not responsible for any downward population trends, nor is it related to the stated population target, assuming that mallard-mottled duck hybrids are not discernable from mottled ducks during population monitoring. Nevertheless, it is an issue with important ramifications to the future of WGC mottled ducks, and management actions should strive to minimize interactions between mottled ducks and nonmigratory (i.e., feral, released, or domesticated) mallards.



Mottled ducks.

Priority Actions

Several specific opportunities have been identified as potential means to achieve some of the aforementioned recommendations. These include Farm Bill programs administered by the U.S. Department of Agriculture (USDA), management of government-owned properties, partnership programs to manage private lands, and permanent land protection programs.

Two of the USDA's Farm Bill programs—Wetland Reserve Program (WRP) and the new Grassland Reserve Program (GRP)—appear to have substantial potential for managing habitat for mottled ducks as described in this document. The WRP is not commonly implemented in the coastal zone of the GCJV, but there is at least one special WRP site in southwest Louisiana that could be improved upon and used as a model for meeting the native grassland and shallow wetland habitat mosaic described herein as habitat in agricultural lands that is optimal for nesting and brood rearing. The GRP appears to have similar potential for restoring and protecting such a habitat mosaic. Managers of mottled ducks need to be engaged with state technical committees and be included in other discussions of guidelines and priorities for these programs.

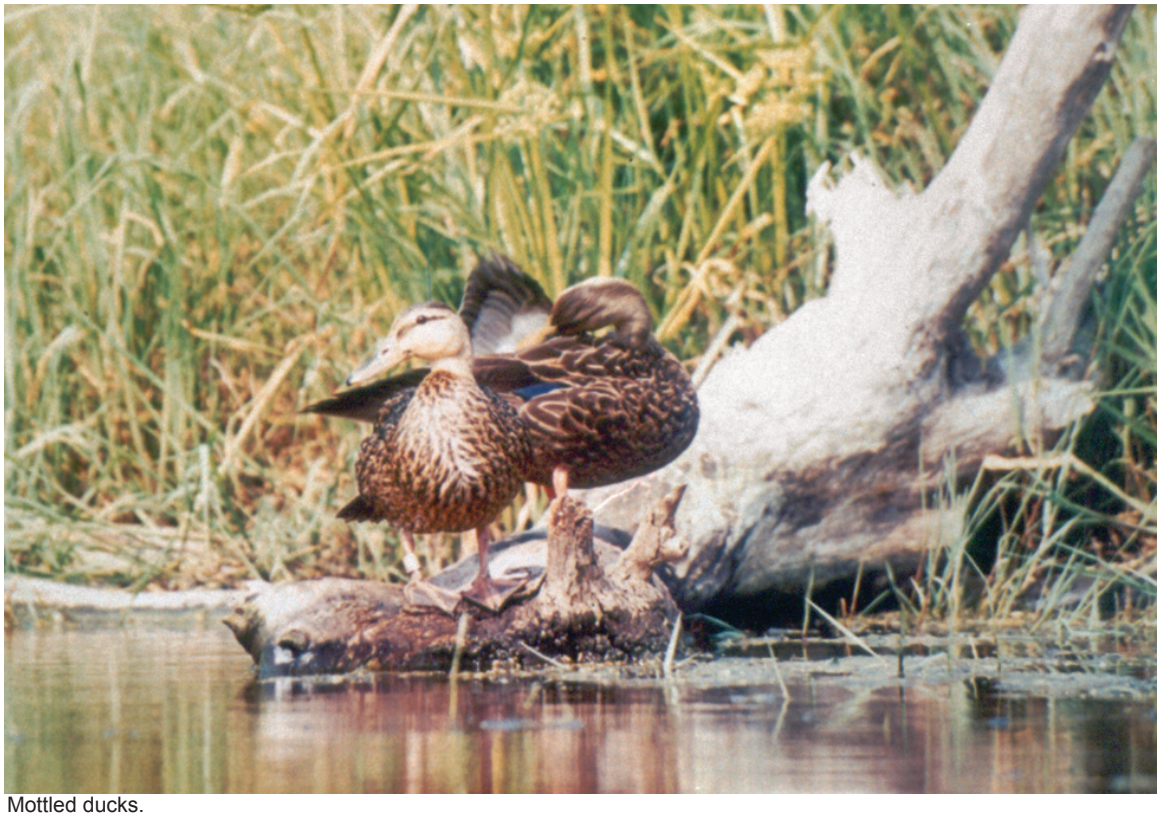
Perhaps the most ready source for a habitat base and expertise to implement mottled duck management occurs on the public properties of the state Wildlife Management Area and National Wildlife Refuge systems. Beyond the valuable attempts to comprehensively manage coastal wetlands to mitigate effects of erosion, saltwater intrusion, subsidence, and hydrological alterations, there are some additional specific actions that could benefit populations of WGC mottled ducks. These public land managers should identify tracts of habitat for nesting mottled ducks within their management boundaries where they should seek to minimize overgrazing, consider burn schedules that avoid the mottled duck nesting season, control the complete takeover of woody vegetation, and allow 2-5 years between burns so that some vegetative litter accumulates. Managers of public lands should also consider planning for a habitat mosaic that meets mottled duck needs for water during the following periods: February-March breeding (perhaps by delaying drawdowns on some units), April-July brooding (perhaps with a designated unit for mottled duck management), and July-September molting (especially during drought conditions). Where public lands include newly forming islands (e.g., through deposition of channel dredging sediment), managers should consider opportunities to set back vegetative succession and perhaps manage predator populations to maintain valuable nesting habitat as islands mature. Managers should also coordinate within and across agencies to implement and monitor mottled duck habitat in a coordinated manner that facilitates learning through adaptive management.

Partnership programs that target management of private lands can also play a role in implementing some of the management recommendations in this document. Private land managers should consider promoting actions that benefit mottled ducks. Encouraging landowners to hold water on some units through February and March could benefit breeding propensity, especially if the adjacent landscape included habitats suitable for nesting and brood rearing. Like public land managers, private landowners with large land holdings, adjacent nesting habitat, and multiple wetland management units should consider planning for a mosaic of wetland habitats to include the needs of breeding and brood-rearing mottled ducks. Opportunities may exist to target such wetland restoration near existing nesting habitat or implement wetland restoration in concert with other partnership programs that target grassland restoration. Managers of programs for private lands should strategically implement and monitor such mottled duck habitat in a manner that facilitates learning from the process of adaptive management. Through personal interactions with other private landowners and/or management agreements,

biologists working on private lands also have an opportunity to discourage releases of pen-raised mallards that potentially contribute to mottled duck hybridization problems.

State and federal agencies and nongovernmental conservation organizations have potential to contribute to management of mottled duck populations through carefully targeted fee title or conservation easement acquisitions. This approach would be particularly warranted if a willing seller's tract is known to support a high density of nesting mottled ducks, broods, or molting adults, and that productive situation is threatened by private ownership or could be substantially improved with habitat management resources available to the acquiring agency or organization.

Other priority actions include enhanced efforts to combat hybridization with mallards, site-specific mottled duck planning, and improved population monitoring. State agencies, in particular, should consider educational and/or regulatory efforts to minimize the potential for domesticated mallard releases near mottled duck habitats. All managers of mottled duck habitats are encouraged to explicitly consider the needs of mottled ducks as outlined in this document and to develop and implement site-specific actions to address those needs. Development and implementation of an improved rangewide survey of mottled ducks is needed to reliably assess trends in their abundance and habitats.



Mottled ducks.

Literature Cited

Anderson, W.L., S.P. Havera, and B.W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi Flyway. Journal of Wildlife Management 64(3):848-857.

Chabreck, R.H., and G. Linscombe. 1982. Changes in vegetative types in Louisiana coastal marshes over a 10-year period. Louisiana Academy of Science 1982:98-102.

Chu, D.S., J.D. Nicols, J.B. Hestbeck, and J.E. Hines. 1995. Banding reference areas and survival rates of green-winged teal, 1950-89. Journal of Wildlife Management 59:487-498.

Elsey, R.M., P.L. Trosclair, and J.T. Linscombe. 2004. The american alligator as a predator of mottled ducks. Southeastern Naturalist 3(3):381-390.

Florida Fish and Wildlife Conservation Commission. 1999. A conservation plan for the Florida mottled duck 1996-2001. Florida Fish and Wildlife Conservation Commission, Waterfowl Management Section, Tallahassee, FL. 22pp.

Haukos, D.A., J.E. Neaville, and J.E. Myers. 2001. Body condition of waterfowl harvested on the upper Gulf Coast of Texas, 1986-2000. U.S. Fish and Wildlife Service, Region 2, Migratory Bird Office, Albuquerque, NM. 76pp.

Hestbeck, J.B. 1993. Survival of northern pintails banded during winter in North America, 1950-88. Journal of Wildlife Management 57:590-597.

Johnson, F.A., D.H. Brakhage, R.E. Turnbull, and F. Montalbano, III. 1995. Variation in band-recovery and survival rates on mottled ducks in Florida. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:594-606.

Johnson, F.A., F. Montalbano, III, and T.C. Hines. 1984. Population dynamics and status of the mottled duck in Florida. Journal of Wildlife Management 48:1137-1143.

Klett, A.T., H.F. Duebbert, C.A. Faanes, and K.F. Higgins. 1986. Techniques for studying nest success of ducks in upland habitats in the prairie pothole region. U.S. Department of Interior, Fish and Wildlife Service Resource Publication 158, Washington, DC. 24pp.

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1998. Coast 2050: toward a sustainable coastal Louisiana. Louisiana Department of Natural Resources, Baton Rouge, LA. 161pp.

Martin, E.M., and P.I. Padding. 2002. Preliminary estimates of waterfowl harvest and hunter activity in the United Sates during the 2001 hunting season. U.S. Fish and Wildlife Service, Administrative Report, Division of Migratory Bird Management, Laurel, MD. 34pp.

McNease, L., and T. Joanen. 1977. Alligator diets in relation to marsh salinity. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 31:36-40.

Moorman, A.M., T.E. Moorman, G.A. Baldassarre, and D.R. Richard. 1991. Effects of saline water on growth and survival of mottled duck ducklings in Louisiana. Journal of Wildlife Management 55:471-476.

Moorman, T.E., and P.N. Gray. 1994. Mottled duck (*Anas fulvigula*). In A. Poole and F. Gill, editors. The Birds of North America, No. 81. Academy of Natural Sciences, Philadelphia, PA and The American Ornithologists' Union, Washington, DC. 20pp.

Moulton, D.W., T.E. Dahl, and D.M. Dall. 1997. Texas coastal wetlands: status and trends, mid-1950s to early 1990s. U.S. Department of the Interior, Fish and Wildlife Service, Southwestern Region, Albuquerque, NM. 32pp.

North American Waterfowl Management Plan, Plan Committee. 2004. North American Waterfowl Management Plan 2004, Strategic Guidance: Strengthening the Biological Foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales. 22pp.

Padding, P.I., E.M. Martin, and B.H. Powell. 2001. Age and sex composition of ducks and geese bagged in the 2000 hunting season in comparison with prior years. U.S. Fish and Wildlife Service Administration Report, Division of Migratory Bird Management, Laurel, Maryland. 46pp.

Sauer, J.R., J.E. Hines, and J. Fallon. 2003. The North American breeding bird survey, results and analysis 1966-2002, version 2003.1. USGS Patuxent Wildlife Research Center, Laurel, MD.

Smith, G.W. and R.E. Reynolds. 1992. Hunting and mallard survival, 1979-88. Journal of Wildlife Management 56:306-316.

Stutzenbaker, C.D. 1988. The mottled duck, its life history, ecology and management. Texas Parks and Wildlife Department, Austin. 209pp.

Szymczak, M.R., and E.A. Rexstad. 1991. Harvest distribution and survival of a gadwall population. Journal of Wildlife Management 55:592-600.

Valentine, J.M., J.R. Walther, K.M. McCartney, and L.M. Ivy. 1972. Alligator diets on the Sabine National Wildlife Refuge, Louisiana. Journal of Wildlife Management 36:809-815.

Wilson, B.C., S.D. Cordts, D.A. Haukos, T.J. Hess, C.E. Miller, and E.B. Moser. 2003. Annual survival, recovery rates, and recovery distributions of western gulf coast mottled ducks, 1994-2001. Third North American Duck Symposium, Sacramento, CA.

Mottled duck pair.

Appendix 1.

List of Participants in Gulf Coast Joint Venture Mottled Duck Working Group Meetings

Name	Affiliation	Meeting(s) Attended	
		Lafayette[1]	Port Arthur[2]
Bart Ballard	TAMUK[3]	X	
Frank Bowers	USFWS[4]	X	X
Steve Cordts	TPWD[5]		X
Chad Courville	DU[6]	X	
Bob Dew	DU	X	
Scott Durham	LDWF[7]	X	X
Greg Esslinger	USFWS/GCJV[8]	X	X
Jerry Grau	USGS[9]	X	
David Haukos	USFWS	X	X
Robert Helm	LDWF	X	X
Tom Hess	LDWF	X	X
Clinton Jeske	USGS	X	X
Kevin Kraai	TPWD	X	
Greg Linscombe	LDWF	X	
Jeb Linscombe	LDWF	X	X
David Lobpries	TPWD	X	X
Andy Loranger	USFWS	X	X
Stephanie Martinez	TTU[10]	X	
Kelly McDowell	USFWS	X	X
Todd Merendino	TPWD		X
Tommy Michot	USGS	X	X
Dave Morrison	TPWD	X	X
Jim Neaville		X	X
Wayne Norling	USGS	X	
Jeff Raasch	TPWD	X	X
Steven Reagan	USFWS	X	
Michael Rezsutek	TPWD	X	X
Fred Roetker	USFWS	X	
Frank Rohwer	LSU[11]		X
Kevin Roy	USFWS	X	
Pat Stinson	USFWS	X	X
Bob Strader	USFWS	X	
Charles Stutzenbaker			X
Jim Sutherlin	TPWD		X
Patrick Walther	USFWS	X	X
Matt Whitbeck	USFWS	X	
Brandon Wieme	DU	X	X
Barry Wilson	GCJV	X	X

[1] Lafayette, Louisiana, February 10, 2004
[2] Port Arthur, Texas, August 26-27, 2003
[3] Texas A&M University-Kingsville
[4] U.S. Fish & Wildlife Service
[5] Texas Parks & Wildlife Department
[6] Ducks Unlimited, Inc.
[7] Louisiana Department of Wildlife & Fisheries
[8] Gulf Coast Joint Venture
[9] U.S. Geological Survey
[10] Texas Tech University, Lubbock
[11] Louisiana State University, Baton Rouge

Appendix 2.

Copy of Questionnaire Given to Participants of the August 26-27, 2003, Gulf Coast Joint Venture Mottled Duck Working Group Meeting.

Post-Meeting Questionnaire
Gulf Coast Joint Venture
Mottled Duck Working Group Meeting
August 26-27, 2003
Port Arthur, Texas

Population Status/Conservation Concern
Rate the current population status of WGC Mottled Ducks on a scale of 1-10, with 1 being a stable population with no imminent threats and 10 being an endangered species (i.e., threatened with extinction).
_____(1-10)

Rate the importance of WGC Mottled Duck conservation on a scale of 1-10, with 1 requiring no special attention and 10 being an endangered species candidate.
____(1-10)

Rate the importance of WGC Mottled Duck conservation relative to other waterfowl/ wetland issues facing GCJV partners on a scale of 1-10, with 5.5 being average among GCJV waterfowl/wetland issues and 10 being the highest regional priority.
_____(1-10)

Potential Limiting Factors
Indicate your opinion of the relative likelihood of either recruitment or survival as the most likely limiting component of current mottled duck population growth. Assign a total of 10 points to recruitment and/or survival.
Recruitment____ Survival_____ (10 pts total)

Survival
Among the following components of survival, assign a total of 10 points indicating the relative likelihood that each component is currently limiting mottled duck populations. [If you assigned survival a zero in the above question, please skip this one.]

____Hunting mortality (including cripples & illegal kill)
____Non-hunting fall/winter mortality due to disease (including lead)
____Non-hunting fall/winter mortality due to limited food
____Non-hunting fall/winter mortality due to predators
____Spring/summer adult mortality due to disease (including lead)
____Spring/summer adult mortality due to limited food
____Spring/summer adult mortality due to predators
(10 pts total)

Interactive effects can all be assigned points according to your opinion of their relative importance, but only assign points to survival/mortality components that you think may be currently problematic. If you assign points to a category, then you believe that (to some extent) mitigating that single factor will lead to higher survival rates.

Recruitment

Among the following components of recruitment, assign a total of 10 points indicating the relative likelihood that each component is currently limiting mottled duck populations. [If you assigned recruitment a zero in the above question, please skip this one.]

_____Breeding propensity (including renesting)
_____Clutch size
_____Egg viability
_____Nest success
_____Brood survival
(10 pts total)

Survival/Recruitment

Among the following factors that potentially contribute to survival or recruitment, assign a total of 10 points indicating the relative likelihood that each factor is currently limiting survival or recruitment of mottled duck populations.

_____Weather (e.g., precipitation)
_____Lead
_____Hunting (including crippling & illegal kill)
_____Predators
_____Fall/winter habitat loss (i.e., quantity)
_____Fall/winter habitat degradation (i.e., quality, including fragmentation)
_____Spring/summer habitat loss (i.e., quantity)
_____Spring/summer habitat degradation (i.e., quality, including fragmentation)
_____Disturbance
_____Other_____
(10 pts total)

Population Objective

If mottled duck population objectives are developed, would you favor a population objective for Western Gulf Coast (WGC) mottled ducks (i.e., Tx, La, Ms, & Al) that is distinct from other regions (i.e., Fl & SC)?

yes____ no____

Do you favor population objectives at a finer resolution than a WGC total (e.g., a Tx population objective that is distinct from La)?

yes____ no____

Residence (check one): **Tx_____ La_____ Other_____**

Member of GCJV Monitoring, Evaluation, & Research Team? **yes_____ no_____**

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