Achievement-Oriented Effects on Waterfowl-Hunt Quality at Mississippi Wildlife Management Areas

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Abstract: Waterfowl hunters participate in hunting for appreciative-, affiliative-, and achievement-oriented reasons. To investigate the influence of achievement-oriented factors on hunt quality, we analyzed post-hunt surveys completed by waterfowl hunters at four Mississippi Wildlife Management Areas (WMAs), 2008–2015. We used these questions to calculate a hunt quality score for each participant and tested whether variation in hunt quality was best explained by total number of ducks harvested, number of mallards harvested, total bag weight, or palatability of ducks. Hunt quality increased with total number of ducks and mallards harvested. Hunt quality scores increased with an increasing number of ducks harvested up to six total ducks (i.e., the daily allowable bag) and number of mallards up to 3 ducks (i.e., 1 less than the daily allowable bag during study). Our results indicate that harvesting ducks, especially mallards, is important to hunters at Mississippi WMAs. The importance of duck harvest to hunters should be considered in developing waterfowl management plans in Mississippi and elsewhere in the southeastern United States where these ducks are common.

Key words: duck hunting, harvest, human dimensions, hunter satisfaction, recruitment, retention

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Annual estimates of the number of U.S. waterfowl hunters and breeding waterfowl abundance were correlated until the late 1980s when numbers of waterfowl hunters began declining (Vrtiska et al. 2013). Hunter recruitment, retention, and reactivation have become priorities for waterfowl and wildlife conservation initiatives because hunters contribute to conserving waterfowl and wildlife populations and habitat and sustaining wildlife agencies through financial, political, and social support (NAWMP 2012). Beyond helping to fund conservation through a variety of mechanisms, hunters also are more likely to engage in pro-environmental behaviors than non-consumptive recreationists (Organ et al. 2010, Cooper et al. 2015). The economic impact in 2011 of the estimated 1.5 million people who participated in waterfowl hunting in the United States was $663 million on trips and $699 million on equipment expenditures (Carver 2015). In 2009, waterfowl-hunter expenditures in Mississippi had an unadjusted impact of nearly $150 million (Grado et al. 2011). Thus, recruitment, retention, and reactivation of waterfowl and other hunters are important for waterfowl and other wildlife conservation efforts as well as economies at local, state, national, and international levels (NAWMP 2012).

Most waterfowl hunters say hunting is one of their most important recreational activities (National Flyway Council 2006, Slagle and Dietsch 2018). People hunt for many reasons, including being outdoors, spending time with friends and hunting dogs, and seeing an abundance of waterfowl and other wildlife (i.e., affiliative- and appreciative-oriented reasons; Hendee 1974, Vaske et al. 1986). Hunters also engage for achievement-oriented reasons, such as obtaining food and reaching the daily bag limit. Seeing

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waterfowl and having shooting opportunities increase hunt satisfaction, as do harvesting game for food and trophy (Hendee 1974, Vaske et al. 1986, Gigliotti 2000, Brunke and Hunt 2008). However, in the 2005 National Duck Hunter Survey, the majority of hunters in the lower Mississippi Flyway indicated that overall hunting quality had worsened in the past five years, citing reasons including decreases in "overall duck numbers," which influences harvest and achievement-oriented hunt quality (National Flyway Council 2006). From 2005–2015, total duck population estimates increased to a high of nearly 50 million, estimates then declined through 2018 but still remained above the North American Waterfowl Management Plan goal of 40 million breeding ducks (NAWMP 2012, USFWS 2018). Population estimates of mallards (*Anas platyrhynchos*), a highly-sought duck species (Slagle and Dietsch 2018), also reached an all-time high during the last decade (USFWS 2018). However, the 2017 National Duck Hunter Survey indicated that only approximately half of hunters (56.1%) in the Mississippi Flyway were somewhat or very satisfied with their overall hunting experience. Further, only 30.6% of hunters were somewhat or very satisfied with the number of ducks seen during the season; slightly less were satisfied with the number of ducks harvested during the season (28.9%; Slagle and Dietsch 2018). Satisfaction is defined as the similarity between expectations and outcomes measured after a period of reflection (Manning 1999), whereas hunt quality is measured immediately following the hunt with no prior expectations known and may be a strong predictor of satisfaction in waterfowl hunting (Hendee 1974, National Flyway Council 2006, Brunke and Hunt 2008). However, the importance of harvest on hunt quality might not be openly discussed in focus group studies or captured in surveys, even though it may be important to recruitment, retention and reactivation of waterfowl hunters (Vaske et al. 1986, Kaltenborn and Andersen 2009, Child and Darimont 2015).

Wildlife managers may be unable to enhance some or all appreciative- and affiliative-oriented factors, but they can manage water, food, cover, refuge, and hunting regulations to aid hunters in meeting their achievement-oriented goals (St. James et al. 2015). Understanding how achievement-oriented factors influence hunt quality may help inform future efforts by managers to increase hunter participation and retention. Generally, total number of ducks harvested, bag weight, and number of mallards harvested is important to hunters and influences hunt quality (St. James 2011, Kaminski et al. 2005, Slagle and Dietsch 2018). Thus, harvesting an increased number of mallards per hunt may result in a greater sense of achievement. Finally, hunters may perceive certain species as more palatable for consumption than others (Hibler 1998, Shaw 2013), and harvesting those species also may result in a greater sense of achievement. Thus, our objective was to test competing achievement-oriented models we hypothesized to influence variation in hunt quality including 1) total number of ducks harvested, 2) total weight of ducks harvested, 3) number of harvested mallards, and 4) palatability of harvested ducks.

Study Areas

Our study areas were four WMAs operated by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). Howard Miller, Muscadine Farms, and Mahannah WMAs are located in the Mississippi Alluvial Valley, and Trim Cane WMA is in east-central Mississippi. As part of a larger study from 2008–2010 (St. James et al. 2013, 2015), we divided Howard Miller, Muscadine Farms, and Trim Cane WMAs into two experimental treatment zones of equal area and similar cover types and randomly-assigned a hunting frequency of two- or four-days per week. After 2010, Trim Cane WMA reverted to hunting two days week, but others remained at four days per week. Mahannah WMA was hunted four days per week throughout the study. MDWFP distributed hunting opportunity using a lottery system that allowed hunters to apply for a reservation only once per five time periods of equal length during the hunting season per WMA. On the morning of a hunt, following reservation holders choosing locations to hunt, the remaining positions were allocated by random lottery. One party of up to four hunters was allowed to hunt each assigned hunt unit within the WMA per day.

Methods

To determine hunt quality, the Mississippi Department of Wildlife, Fisheries, and Parks asked hunters to respond to a questionnaire printed on their Mississippi Waterfowl Hunting Permits immediately after every hunt, 2008–2015 ($n = 22{,}454$ returned questionnaires; St. James 2011). An unknown number of waterfowl hunters may have completed post-hunt surveys multiple times, coincident with their possibly hunting multiple times at a WMA. Hunters were randomly selected each time they hunted; hence, we assumed their survey responses for each specific hunt were independent of those for other hunts they may have experienced. Survey respondents were anonymous, so we could not link their responses to their identity. Although sampling hunters multiple times may have caused hunter-specific bias, we had no way to adjust for such possible bias and included all survey respondents' answers to questions in our analyses.

The questionnaire included six statements: "I got plenty of shooting opportunities," "I had an enjoyable hunting experience," "I saw plenty of ducks," "I harvested a sufficient number of ducks," "I hunted in well managed waterfowl habitat," and "Other parties

interfered with my hunt." Hunters responded to each statement on a 1 to 5 scale, including "Strongly Disagree" (1), "Disagree," "Neutral," "Agree," and "Strongly Agree" (5). Hunting unit at the WMA and number of waterfowl harvested by species also were self-reported. We retained and analyzed data from correctly completed permits that included hunt quality responses, date, and hunt unit.

We recorded weights of individual ducks harvested in the study areas, 2008–2010. We used mean weights for each species recorded from that period to estimate total weight of ducks harvested per hunter and hunt day the harvest occurred (St. James 2011). To determine relative palatability of duck species, we consulted publications by professional chefs (i.e., Hibler 1998, Shaw 2013) and scored each species as either 1 "Fair"—northern shoveler (*Spatula clypeata*), ring-necked duck (*Aythya collaris*), lesser scaup (*A. affinis*), 2 "Good"—gadwall (*Mareca strepera*), American wigeon (*M. americana*), blue-winged teal (*Spatula discors*), green-winged teal (*Anas crecca*), redhead (*Aythya americana*), or 3 "Great"– wood duck (*Aix sponsa*), mallard, northern pintail (*Anas acuta*), canvasback (*Aythya valisineria*). We summed the palatability scores for duck harvested per hunter and hunt day the harvest occurred.

Data Analyses

We determined correlation among hunt-quality metrics using principal component analysis with Varimax rotation (PROC CORR; SAS Institute Inc. 2008). We retained individual survey questions within factors if its factor loading was >0.50 and if the question contributed to Cronbach's alpha >0.70 for all items in the factor (Table 1; Kim and Mueller 1978). Questions 1–5 factored together and had a Cronbach's alpha = 0.74; thus, responses to these questions were combined for a hunt quality score for each hunter (Table 1). We excluded Question 6 (i.e., "Other parties interfered with my hunt") from the hunt quality score, because its factor loading was <0.50 and it focused on social interactions; whereas, other questions were related to duck abundance, harvest, and management, all of which were achievement oriented. However, we report the percentage in each category to describe interference at our study sites that could affect duck harvest. We generated a correlation matrix of total number of ducks harvested, number of mallards harvested, total bag weight, and palatability. We included total number of ducks with number of mallards in our models ($r = 0.42$), but all other variables were correlated ($0.70 \leq r \leq 0.94$) and not combined in models to avoid multicollinearity among variables (Dormann et al. 2013).

We used an information-theoretic approach with mixed models to identify the model(s) that best explained variation in hunt quality (Burnham and Anderson 2004; PROC MIXED; SAS Institute Inc. 2008). We used Akaike's Information Criterion (AIC) and model weights (w_i) to compare models, and deemed those competitive when $\Delta AIC \leq 2.0$ (Burnham and Anderson 2004). Our models also included fixed effects of WMA hunt frequency (2 or 4 days/week). We included the number of non-duck waterfowl harvested (e.g., American coot [*Fulica americana*]) and hunt party size as covariates to control for their influence on hunt quality. We nested WMA in year as a repeated measure to account for sampling the same locations across years. We tested if hunt quality was best explained by linear or quadratic relationships for total number of ducks and mallards harvested, total bag weight, and palatability.

Although Mahannah WMA only had a single hunt frequency (4 days/week), St. James et al. (2015) reported that hunt frequency (i.e., 2 or 4 days/week) did not influence hunt quality; thus, we included data from Mahannah WMA in our analysis to increase sample size and demographics of waterfowl hunters surveyed. Further, inclusion and removal of this WMA from our analysis did not influence resulting model selection.

Table 1. Questions asked on the Mississippi Waterfowl Hunting Permit during waterfowl hunting seasons from 2008–2015 and Varimax rotated component matrix of factor loadings for hunter responses[a].

		Factor loading[b]	
Question	**Cronbach Alpha[b]**	**1**	**2**
1. "I got plenty of shooting opportunities"	0.725	0.771	0.379
2. "I had an enjoyable hunting experience"	0.726	0.776	0.108
3. "I saw plenty of ducks"	0.743	0.783	–0.272
4. "I harvested a sufficient number of ducks"	0.716	0.803	–0.381
5. "I hunted in well managed waterfowl habitat"	0.764	0.701	0.325
6. "Other parties interfered with my hunt[c]"	0.875	0.005	0.241

a. Responses were determined using a 5-point Likert type scale with the response format of 1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," 5 = "strongly agree."

b. Cronbach alpha = 0.735; Cronbach alpha is a measure of internal consistency or how closely related a set of items are as a group

c. Question was reverse coded.

Results

We retained 8,399 (37.4%) of 22,454 hunt surveys that met our criteria (i.e., that were complete and filled out correctly) for analysis (Howard Miller = 3,535 surveys, Muscadine Farms = 1,563, Mahannah = 2,809, and Trim Cane = 492). Hunters reported harvesting 15,687 ducks (1.86 ducks/hunter). Green-winged teal made up 35% of the harvest, followed by northern shoveler (24%), mallard (14%), and gadwall (9%); other species accounted for the remaining 18% and included wood duck, northern pintail, blue-winged teal, canvasback, redhead, ring-necked duck, and lesser scaup. Fifty-eight percent of hunters were successful, with 18% of them harvesting 1 duck, 12% 2 ducks, 7% 3 ducks, 5% 4 ducks, 4% 5 ducks, and 12% 6 ducks; the latter equaled the daily bag limit

Table 2. Mixed models result for factors influencing waterfowl hunt quality at Mississippi Wildlife Management Areas, 2008–2015.

Parameter	Degrees of freedom	Estimate (± SE)	90% Confidence interval
Intercept	515	3.01 ± 0.02	2.96 to 3.05
Total Ducks	8379	0.40 ± 0.02	0.37 to 0.43
Total Ducks ×Total Ducks	8373	−0.03 ± 0.00	−0.03 to −0.02
Non-waterfowl	8371	0.03 ± 0.02	−0.00 to 0.07
Mallard	8319	0.20 ± 0.03	0.13 to 0.27
Mallard×Mallard	8269	−0.04 ± 0.01	−0.07 to −0.02
Hunt frequency (2 days)	535	0.19 ± 0.04	0.11 to 0.26

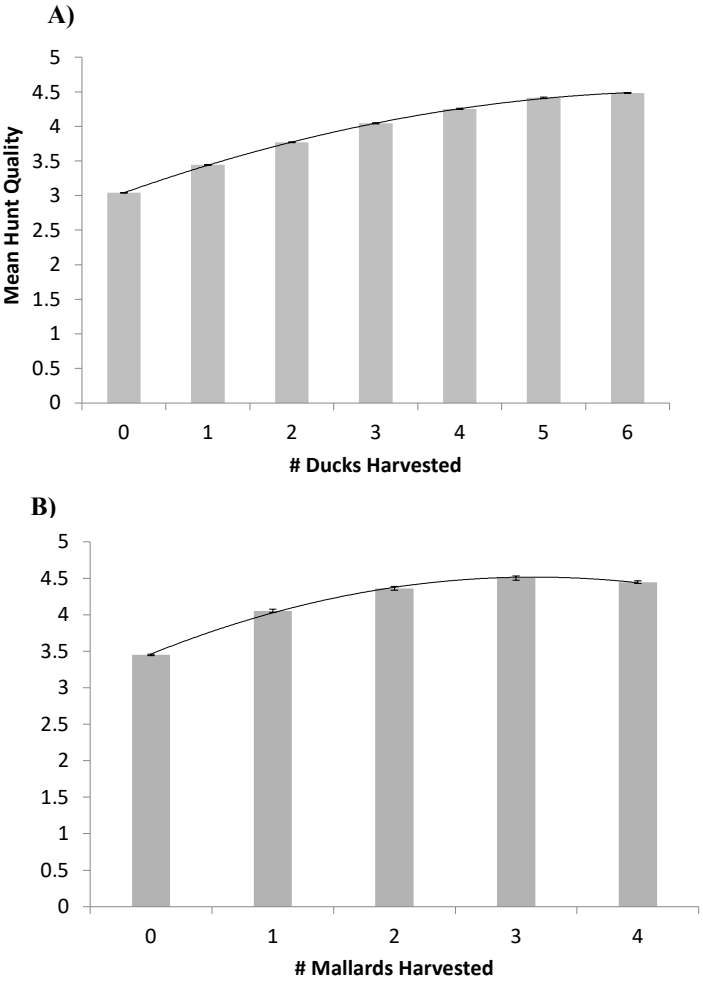

Figure 1. Model-predicted mean hunt quality for total number of ducks (A) and mallards (B) harvested per hunter at Mississippi Wildlife Management Areas, 2008–2015. Maximum hunt quality score = 5.00; maximum daily bag for all ducks = 6; maximum daily bag for mallards = 4.

during the study. Eighteen percent of hunters harvested 1 or more mallards; 11% harvested 1, 4% harvested 2, 1% harvested 3, and 2% harvested 4 mallards. More hunters strongly disagreed or disagreed (48.5%) than those that agreed or strongly agreed (34.5%) that other parties interfered with their hunt.

We detected a single model explaining variation in hunt quality ($w_i = 1.0$) that included quadratic relationships for total number of ducks harvested, number of mallards harvested, and hunt frequency (Table 2). Total bag weight, palatability score, and hunt party size were not included in final competitive models ($\Delta AIC > 2.0$). The null model was 3,158.2 ΔAIC units from the best model. Mean hunt quality varied positively with increasing number of ducks harvested (Figure 1A). Mean hunt quality increased by 13% from zero to 1 duck harvested and increased by 30% from 1 to 6 ducks harvested. There was no overlap of 90% confidence intervals in model-predicted scores from zero to 6 ducks. Although no overlap of confidence intervals existed, increases in hunt quality scores decreased for each additional duck harvested (1 to 2 ducks = 10%, 2 to 3 = 7%, 3 to 4 = 5%, 4 to 5 = 3%, and 5 to 6 = 2%).

Mean hunt quality varied positively with increasing number of mallards harvested up to 3 mallards but did not increase with a fourth mallard (Figure 1B). Mean hunt quality increased by 18% from zero to 1 mallard harvested and increased 11% from 1 to 3 mallards. There was no overlap of 90% confidence intervals in model-predicted scores from zero to 4 mallards. Mean hunt quality score (4.37 ± 0.04) of 15 hunters who harvested 3 mallards was 44% greater than the mean score (3.03 ± 0.06) of 412 hunters who did not harvest a mallard but harvested 3 other ducks. Mean hunt quality score (4.43 ± 0.09) of 99 hunters whose bag contained at least 1 mallard and other ducks was 45% greater than the mean score (3.05 ± 0.08) of 1,536 hunters who harvested 3 ducks exclusive of mallards.

Hunt frequency was included in our top model, but scores based on hunt frequency of two days/week (3.67 ± 0.54) and four days/week (3.55 ± 0.55) did not differ substantially. We retained this 3.3% in hunt quality difference attributable to hunt frequency in our candidate suite of models to account for its potential to influence model relationships, but do not interpret these results as they were relatively similar between two and four days/week.

Discussion

People are motivated to engage in hunting of waterfowl and other game species for appreciative-, affiliative-, and/or achievement-oriented reasons (Vaske et al. 1986, Brunke and Hunt 2008). Of these, achievement-oriented factors (e.g., harvest) are most easily measured by resource managers. Further, duck abundance and harvest may be influenced by WMA staff that can manage habitat to attract ducks or implement hunting strategies that retain ducks on WMAs. Our results indicated that managers should consider harvest important when making decisions about habitat and hunt management strategies on public waterfowl hunting lands.

Moreover, biologists making decisions regarding annual regulatory frameworks for bag limit and season length also should consider harvest important, within the context of adaptive harvest management (AHM) options (Slagle and Dietsch 2018). We also detected that hunt quality scores increased substantially by presence of mallards in the bag. Thus, managers may want to focus on attracting mallards in Mississippi and elsewhere where the species continues to winter naturally. Specifically, AHM options are based on mallard populations, and our results indicated that harvesting these mallards was important to hunters. Advancing models in the adaptive management process that include duck harvest, and specifically mallards, may provide increasingly important insight into methods to recruit, retain, and reactivate waterfowl hunters.

Total bag weight and palatability of ducks were not included in the final suite of supportive models. We suggest that variation in duck harvest was a better predictor of and more important to influencing hunt quality for hunters sampled in our study than were bag weight and palatability. However, we are not stating that bag weight and table fare were unimportant to hunt quality; instead, variation in hunt quality attributable to bag weight and palatability may have been included in our models because they were correlated with total duck harvest, and larger-bodied ducks (e.g., mallards and canvasbacks) were rated more palatable, respectively. Further, table fare is subjective and opinions among hunters differ greatly (Hibler 1998, Shaw 2013). To appropriately include palatability in future studies it would be important to survey individual hunters to determine how they rank the palatability of different species of ducks.

Hunt quality scores were greatest when hunters acquired their daily bag limit of six ducks, but each additional duck did not have a similar influence on these scores. Greatest increase in hunt quality scores occurred after a hunter bagged an initial duck. However, national duck hunter surveys reported only 3.0% (National Duck Hunters Survey 2005) to 9.7% (Slagle and Dietsch 2018) of hunters in the lower Mississippi Flyway were satisfied with harvesting 1 duck per day. The most recent national waterfowl survey indicated that 70.0% of hunters in the lower Mississippi Flyway said they would be satisfied if they harvested 1 to 4 ducks daily, whereas 5.0% and 8.3% said they needed 5 or 6 ducks, respectively, to be satisfied (Slagle and Dietsch 2018). Our results are similar because hunt quality continued to be influenced up to six ducks harvested, even if those increases became incrementally less with addition of fifth and sixth harvested ducks. Increased hunt quality with the addition of the fifth and sixth duck in the bag is consistent with the discrete-choice model experiment in the 2017 National Survey of Waterfowl Hunters which detected greatest utility, or relative desirability, in obtaining the six-duck daily bag limit (Slagle and Dietsch 2018). To gain the greatest increase in daily hunt quality at WMAs in Mississippi and possibly elsewhere in the southeast United States, managers should aim to ensure harvest of at least 1 duck per hunter, with further emphasis on maximizing harvest capacity. Managers could help accomplish this by only hunting areas with enough ducks to provide the opportunity to harvest ≥1 duck/hunter daily. Managers could aim to increase daily harvest and increase hunt quality and satisfaction by only allowing hunting the areas each day with enough ducks to provide the opportunity for harvest, actively managing habitats to attract ducks, limiting the number of hunters per unit area (about 1/3 of hunters thought that other parties interfered with their hunt in our study), providing temporal and spatial sanctuary, and restricting the number of shells a hunter can bring on WMAs (Humburg 2014).

Waterfowl hunt success in current and prior years are relevant determinants for hunters deciding whether to continue to hunt (Miller and Hay 1981). In a 2008 study of Mississippi waterfowl hunters, hunters expected to bag an average of 4 ducks/day during seasons with a daily bag limit of 6 ducks and 2.8 ducks/day with a daily bag limit of 3 ducks (Brunke and Hunt 2008). We detected that hunt quality increased with each duck harvested, up to 6 ducks/day, and abundance of mallards in the bag also increased hunt quality. Thus, expectations of waterfowl hunters detected by Brunke and Hunt (2008) also were evident in hunt quality scores immediately following hunts during our study. Similarly, the 2017 National Waterfowl Hunter Survey determined that 62.8% of waterfowl hunters in the lower Mississippi Flyway would be satisfied if they harvested ≥2 ducks/hunt. However, statewide average duck harvest for Mississippi was 1.93 ducks/day from 1980–2011 (Hunt 2012), and we recorded 1.86 ducks/day in our study, with 40% of hunters harvesting ≥2 ducks/hunt. These results suggest that duck harvest is important to waterfowl hunters in Mississippi and that the majority of duck hunters in Mississippi may be dissatisfied with their daily duck harvest (i.e., 60% harvested ≤2 ducks/hunt). Our results suggest that WMA managers should continue to focus on attracting ducks for potential harvest and to increase hunt quality, but managing expectations through public outreach to temper hunter expectations closer to reality also may increase hunter satisfaction and lead to recruitment, retention, and reactivation of hunters.

Anecdotal and empirical evidence suggests that arrival of mallards to Mississippi during autumn and winter may have been delayed in recent decades (Kaminski et al. 2005, Schummer et al. 2014, Schummer et al. 2017). Historically, the Mississippi Alluvial Valley wintered up to 2.5 million mallards (~25% of the continental population; Baldassarre 2014), and hunting and availability of mallards for harvest are culturally important in this region

(Kaminski et al. 2005, Brunke and Hunt 2008). However, in the 2005 National Duck Hunter survey, many hunters in the lower Mississippi Flyway characterized that quality of duck hunting had "gotten a little worse" (31%) or "gotten much worse" (51%) and the date for when ducks arrive in the area had "gotten somewhat worse" (34%) or "gotten much worse" (21%) (National Flyway Council 2006). The 2017 National Survey of Waterfowl Hunters suggests that satisfaction may have increased, but nearly half of respondents were still not satisfied with the number of ducks they saw during their season (Slagle and Dietsch 2018). Mallards are preferred by hunters (Slagle and Dietsch 2018), are one of the latest migrant species to southern latitudes (Baldassarre 2014, Van Den Elsen 2016, Schummer et al. 2017), and our results suggest hunt quality is influenced by their harvest. However, only 18% of hunters successfully harvested at least 1 mallard, and only 2% of hunters reached the daily bag limit of 4 during our study. We also detected that hunt quality increased from zero to six total ducks harvested, with a total bag most often comprised primarily of ducks other than mallards. Because evidence suggests that mallards are increasingly wintering farther north and migrating south later (Kaminski et al. 2005, Schummer et al. 2014, 2017) and only 2% of hunters in our study harvested these ducks at levels that would maximize hunt quality scores (3 or 4 mallards), managers on public lands could focus their efforts on habitat management to increase abundances of other species for hunters to harvest. Gadwall, American wigeon, northern shoveler, northern pintail, and blue-winged and green-winged teal are relatively earlier migrants, making them available to hunters for viewing and harvest prior to the arrival of mallards at mid-latitude and southern locales in the Atlantic and Mississippi Flyways (Van Den Elsen 2016, Schummer et al. 2017). Those charged with managing waterfowl hunting opportunities might consider increasingly focusing efforts on promoting early migrants as quality game species to increase hunt quality and possibly satisfaction. Further, managers of areas used by waterfowl and waterfowl hunters could focus habitat management to increase the abundance of early migrants for hunters to harvest, while ensuring habitats remain attractive to mallards later in the waterfowl season. Increased availability of natural wetlands containing moist-soil plants and submersed aquatic vegetation are commonly used by early-autumn migrating dabbling ducks, whereas flooded croplands are often used later and by mallards (Callicutt et al. 2011, Schummer et al. 2012, Fleming et al. 2015).

Our study provides valuable insight to managers about factors influencing hunt quality on Mississippi WMAs which may be applicable elsewhere in the southeastern United States and beyond. However, only 41% of states and provinces in North America collect post-hunt surveys of waterfowl hunters and these surveys are not standardized to enable comparisons among states and regions (M. L. Schummer, unpublished data). We believe these post-hunt surveys are critical to conduct throughout North America on public and private lands to understand the response of waterfowl hunters to varying management actions aimed at attracting and retaining ducks for hunters to see and harvest. Also, periodic measures of expectations of hunt quality are important when determining appropriate hunt management strategies and hunter outreach (e.g., Brunke and Hunt 2008).

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