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Research Article

Satisfaction of Public Land Hunters During Long-term Deer Population Decline

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ABSTRACT White-tailed deer (*Odocoileus virginianus*) populations and deer hunter participation on federal public lands within the Appalachian Mountains of the southeastern United States have been declining over the last 30 years. Our study focused on Chattahoochee National Forest hunters in North Georgia, a region that has sustained a 64% decline in buck harvest success rates and 68% decline in hunter participation during 1979–2018. To better understand factors influencing satisfaction of remaining hunters, we sent mail questionnaires to 1,271 hunters in February 2019. We received 441 completed questionnaires for a 36% adjusted response rate. First, we used principal component analysis to identify 4 unique motivations for deer hunting: 1) escaping the daily routine and spending time outdoors, 2) harvesting deer for food, 3) socializing with hunting partners, and 4) harvesting trophy bucks. Second, we used ordinal logistic regression, which indicated that perception of a low deer population density was associated with lower levels of satisfaction. Perception of the right number of hunters on the landscape was associated with higher levels of satisfaction. In addition, greater importance ratings of harvesting trophy bucks were associated with lower satisfaction levels. Last, we applied revised importance-performance analysis to 19 aspects of WMA deer hunting, which revealed that managers should focus on increasing opportunities for hunters to see deer and harvest bucks for the best chance at improving hunter satisfaction. Considering the 64% decline in harvest success rates between 1979 and 2018, the positive relationship between hunter satisfaction and perception of deer density, and hunter desires to see more deer and have more opportunities to harvest bucks, we recommend managing the deer population to increase numbers. Overall, our findings suggested that hunters and managers agree on the direction of deer management on North Georgia public lands for the near future.

KEY WORDS Appalachian, deer, forest, Georgia, human dimensions, hunting, management, motivations, preferences, satisfaction.

Human dimensions research is essential to help agencies understand hunter satisfaction and preferences. In 1935, Aldo Leopold identified the need for human-related research in wildlife management (Meine 1988) but the groundwork for human dimensions research was not laid until 1971 by Hendee and Potter (Manfredo 1989). Prior to the introduction of the multiple-satisfaction approach by Hendee (1974), managers assumed hunter satisfaction solely depended on harvest success (Hendee and Potter 1971). The multiple-satisfaction approach accounted for activity-general experiences (Fisher 1997) as sources of hunter

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satisfaction, including spending time with friends and family, experiencing the outdoors, appreciating nature, relaxing, and escaping everyday problems (Kennedy 1974, Decker et al. 1980, Decker and Connelly 1989, Gigliotti 2000, Mehmood et al. 2003). However, because activity-general experiences could be realized in any outdoor recreation activity and are relatively easy to fulfill, activity-specific experiences (Fisher 1997) to hunting, such as seeing and harvesting game, may contribute more to hunter motivations and satisfaction (Wynveen et al. 2005, Arlinghaus 2006). Furthermore, despite the contributions of activity-general experiences to hunter satisfaction, typically managers can manipulate only those factors related to harvest (Fisher 1997). Researchers have used expectation disconfirmation theory (Oliver 1980) to measure hunter satisfaction, which is based on whether hunter expectations are fulfilled, exceeded, or unmet (Brunke and Hunt 2007, Brunke and Hunt 2008). According to the model, managers should focus on factors that are positively correlated with satisfaction and are not being fulfilled in order to increase hunter satisfaction (Brunke and Hunt 2007). Brunke and Hunt (2008) found that seeing plenty of waterfowl and having opportunities to harvest birds were positively correlated with hunter satisfaction but that hunters had unrealistic expectations pertaining to both factors. To increase satisfaction, Brunke and Hunt (2008) suggested managers should work to increase harvest and provide more information to hunters, such as harvest rates per season and justification for season lengths and bag limits, to help bring their expectations closer to reality.

Multiple studies have applied 3-factor theory in customer satisfaction (Matzler et al. 2004, Deng 2007) to hunter satisfaction, which is based on measures of implicit importance (i.e., correlations between performance ratings and overall satisfaction), rather than traditional measures of explicit importance (i.e., self-reported; Schroeder et al. 2018; Schroeder et al. 2019*a, b*; Gruntorad et al. 2020). Seeing and harvesting deer, including trophy bucks, were fundamental expectations or basic factors (i.e., minimum requirements for satisfaction that lead to dissatisfaction if not fulfilled but not to satisfaction if fulfilled) in Nebraska deer hunter satisfaction (Gruntorad et al. 2020). Similarly, aspects related to harvesting ducks were basic factors for waterfowl hunter satisfaction, rather than performance factors (i.e., contribute to satisfaction if fulfilled and dissatisfaction if not fulfilled) or excitement factors (i.e., contribute to satisfaction if fulfilled but do not cause dissatisfaction if not fulfilled; Schroeder et al. 2019*b*).

The characteristics of hunter experiences, including their environment and success at bagging game, can influence which factors are important to satisfaction and motivations. Furthermore, importance of various factors to hunter satisfaction can depend on whether measurements were conducted explicitly or implicitly. For example, Schroeder et al. (2019*b*) found achievement factors (i.e., harvest-oriented), such as seeing and harvesting turkeys, were more important than affiliative (i.e., social-oriented) or appreciative factors (i.e., nature-oriented) in satisfaction for all Minnesota turkey hunters based on implicit importance (Decker and Connelly 1989). However, unsuccessful hunters explicitly rated achievement factors as less important compared to successful hunters (Schroeder et al. 2019*a*). In addition, factors related to seeing, attracting, and bagging ducks influenced satisfaction of Minnesota waterfowl hunters more than was indicated via self-reporting (Schroeder et al. 2019*b*).

A paucity of studies focused on factors influencing hunter motivations and satisfaction in settings with low populations of game and a history of population decline, especially using more recent techniques that incorporate implicit importance in satisfaction analysis. White-tailed deer (*Odocoileus virginianus*) populations in the Appalachian Mountain region of the southeastern United States have declined since the 1990s and early 2000s. For example, Virginia Department of Game and Inland Fisheries (2015) reported a 64% decrease in deer harvest on public lands west of the Blue Ridge, which mostly comprised the George Washington and Thomas Jefferson National Forests, and approximately 30% decrease in national forest hunters between the mid-1990s and 2014. In 2017, state wildlife agencies in Georgia, Kentucky, West Virginia, and Virginia reported low deer densities on public lands in the Appalachians that were unresponsive to changes in antlerless harvest (Georgia Department of Natural Resources, Kentucky Department of Fish and Wildlife Resources, West Virginia Division of Natural Resources, Virginia Department of Game and Inland Fisheries, unpublished reports). Degradation of habitat quality due to reductions in early successional plant communities and forest regeneration on national forest lands, along with increasing populations of predators, including black bears (*Ursus americanus*) and coyotes (*Canis latrans*), are among likely reasons for declines in deer populations (Little et al. 2018; Kentucky Department of Fish and Wildlife Resources, West Virginia Division of Natural Resources, Virginia Department of Game and Inland Fisheries, unpublished reports).

Our study focused on white-tailed deer hunters on 8 Wildlife Management Areas (WMAs) within the Chattahoochee National Forest of North Georgia, USA. Historically, the Appalachian Mountain region of North Georgia was a destination for hunters seeking abundant deer populations and a mountain hunting experience. However, from 1979 to 2018, total buck harvest declined 80% and harvest success rates (i.e., bucks harvested/hunter/day) declined 64% on the WMAs (C. Killmaster, Georgia Department of Natural Resources, unpublished data). Concurrently, the number of hunters on the WMAs decreased 68%, which constituted an 81% decrease in hunters/days available for buck harvest. In contrast, the estimate of active deer hunters in Georgia increased 12% from 1979 to 2017, strongly indicating hunters chose to stop participating in public land hunts in North Georgia rather than quitting hunting altogether. We evaluated why some hunters have decided to hunt the WMAs after 40 years of declines in hunter numbers and deer populations and what would contribute to increasing their hunt satisfaction. We used the

following objectives to gauge hunter satisfaction and to derive a prescription for increasing their satisfaction: 1) understand motivations to deer hunt, 2) determine the roles of activity-specific experiences and motivations in satisfaction of public land deer hunting experiences, and 3) identify preferences for public land deer hunting.

STUDY POPULATION AND AREA

We surveyed hunters from 8 WMAs, including Blue Ridge, Chattahoochee, Chestatee, Cohutta, Coopers Creek, Rich Mountain, Swallow Creek, and Warwoman, which collectively comprise 974 km^2 within the Chattahoochee National Forest in North Georgia, USA. Through a cooperative agreement, Georgia Department of Natural Resources maintained wildlife openings (i.e., food plots), set hunting regulations, and conducted hunts on the WMAs, whereas the USDA Forest Service (USFS) conducted the remaining management activities, including timber harvest and prescribed fire (S. Frazier, Georgia Department of Natural Resources, personal communication). The Chattahoochee National Forest was in the Blue Ridge physiographic province of the Appalachian Mountain Range and spanned 3,043 km^2. Elevations range 198–1,458 m ($\bar{x} = 688$, SD $\pm$ 217) and slopes range 0–89 degrees ($\bar{x} = 20$, SD $\pm$ 9; U.S. Geological Survey [USGS] 2013). The Chattahoochee National Forest was 96.8% forested (USGS 2019) with a forest age distribution of 77.9% late forest, 21.9% middle forest, and 0.2% early forest (USFS 2017). From 1979 to 2015, the frequency of timber harvest declined resulting in a mature forest age structure, as the 2 youngest age classes (0–10 years and 11–20 years) declined in coverage by 95% (Little et al. 2018). Fifteen percent of the Chattahoochee National Forest (470 km^2) was within the National Wilderness Preservation System with 287 km^2 within the WMAs included in our study (30% of the total WMA area; USFS 2020).

Following extirpation of white-tailed deer from North Georgia in 1895, restocking efforts began in 1928 (Little et al. 2018). The first deer hunt was held in 1940 (Little et al. 2018) and populations continued to increase until declines became evident during the early 2000s. Over the same time period, populations of black bears, coyotes, bobcats (*Lynx rufus*), and wild pigs (*Sus scrofa*) increased (Kilgo et al. 2010, Roberts and Crimmins 2010, Crimmins et al. 2012, Little et al. 2017, Lewis et al. 2019), while forests matured (Little et al. 2018). Predation, competition, and lack of early successional plant communities and early forest stages have been suggested as potential contributors to deer population declines (Little et al. 2018). Recent deer density estimates were 1.9–3.9 deer/km^2 compared to 7 deer/km^2 in 1953 (Little et al. 2018).

Dates and lengths of hunts varied among the WMAs (Table 1) and there was no limit to the number of hunters who could hunt on the WMAs during the 2015–2016, 2016–2017, and 2017–2018 hunting seasons. The statewide bag limit included 10 antlerless and 2 antlered deer. An antlered deer was considered one with antlers visible above the hairline but 1 of the 2 antlered deer harvested had to have ≥4 points (≥2.5 cm) on one side. For check-in deer hunts on the WMAs, hunters received bonus permits (i.e., not counted toward personal statewide bag limit) to harvest 2 deer that had to be taken to a WMA check-in station. A majority of check-in hunts were for antlered deer only, with few opportunities for antlerless harvest. For sign-in hunts, hunters were required to count deer harvested toward their personal state bag limits and report their harvest to Georgia Department of Natural Resources. No more than 2 deer could be harvested for hunts <10 days, whereas the statewide bag limit applied for hunts ≥10 days.

METHODS

Data Collection

We surveyed hunters who checked in or signed in for a deer hunt on ≥1 of the 8 WMAs during the 2015–2016, 2016–2017, and 2017–2018 hunting seasons. Georgia Department of Natural Resources provided a list of hunters with one WMA assigned to each individual. For hunters who participated in hunts on >1 WMA, Georgia Department of Natural Resources randomly assigned them to one of those WMAs for survey purposes. We excluded hunters <18 years of age. We designed a mail-based questionnaire to evaluate hunter satisfaction, motivations, and preferences for WMA deer hunting and management. We used a slightly modified version of the tailored design method (TDM, Dillman et al. 2014) with 3 mail contacts to administer the survey. The first mailing in February 2019 included the questionnaire, postage-paid return envelope,

Table 1. Number of days available for white-tailed deer hunting by weapon type on 8 Wildlife Management Areas (WMAs) within the Chattahoochee National Forest of North Georgia, USA, during the 2017–2018 hunting season. All hunts occurred from September to January and were also open for harvest of black bears and wild pigs.

WMA	Archery[a]	Primitive	Firearms[b]	Firearms[a]	Total
Blue Ridge	41	5[a]	8	0	54
Chattahoochee	41	0	8	9	58
Chestatee	41	0	8	6	55
Cohutta	41	0	9	0	50
Coopers Creek	41	4[b]	0	6	51
Rich Mountain	41	0	7	0	48
Swallow Creek	34	0	8	6	48
Warwoman	20	0	8	0	28

[a] Sign-in hunts; hunters required to count harvest toward statewide bag limit.
[b] Check-in hunts; hunters received 2 bonus harvest permits.

and a letter that described the study and asked for the hunter's participation. The second mailing was a reminder postcard sent to those who had not returned a completed questionnaire one week after the first mailing. The third mailing consisted of a second copy of the questionnaire, postage-paid return envelope, and letter which we sent to those who had not returned a completed questionnaire 6 weeks after the second mailing. As an incentive for participation, we informed hunters via the envelope, letter, and postcard of a prize drawing for participants who returned a completed questionnaire. We did not measure non-response bias because we lacked time to conduct an additional survey of nonrespondents prior to the start of the 2019–2020 hunting season and we did not keep records of questionnaire return dates. However, we measured the overall representativeness of our completed sample by comparing basic demographic information (i.e., age and gender) to that of the remaining members of the survey population (Armstrong and Overton 1977). Our study was approved by the University of Georgia Institutional Review Board (Protocol ID#STUDY00006843), ensuring that our methods relating to human subjects complied with applicable federal, state, and institutional policies and procedures.

Data Analyses

We analyzed data from WMA questionnaires using SPSS Version 26 (International Business Machines Corp., Armonk, NY, USA) and used an alpha level of 0.05 to determine statistical significance. We conducted 3 analyses corresponding to our 3 study objectives. First, we measured motivations for deer hunting by presenting a chart with a list of 16 motivations for deer hunting derived from Gigliotti (2000), input from Georgia Department of Natural Resources, and the authors' perceptions of issues pertinent to hunters and management within our study area. We asked respondents to rate the importance of reasons for why they deer hunt based on a 7-point Likert-type scale (Likert 1932) ranging from 1 = not at all important to 7 = very important. We used principal component analysis with varimax rotation to reduce the number of motivations and assign them to overarching latent constructs (Thompson 2004). We considered constructs with eigenvalues ≥1.0 and motivations with factor loadings ≥0.600 to be valid for analysis (Comrey and Lee 1992, Field 2013). We conducted Kaiser-Meyer-Olkin measure of sampling accuracy and Bartlett's test of sphericity to ensure the appropriateness of principal component analysis for our data (Hair et al. 2010). To determine the reliability of constructs, we calculated Cronbach's alpha and considered values ≥0.700 to be acceptable (Fornell and Larcker 1981, Cronbach 1984). We ranked constructs in order of importance based on the percentage of responses that included ratings of 5–7 in the corresponding original motivations. We also calculated the overall mean rating for each construct based on all corresponding original motivation responses on the 7-point scale.

Second, we performed ordinal logistic regression to determine the effects of motivations, years of hunting experience, and various activity-specific factors on responses to the question How satisfied are you with your overall deer hunting experience on [WMA name]? Potential responses to this question were based on a 5-point Likert-type scale ranging from 1 = completely dissatisfied to 5 = completely satisfied. To meet the required assumptions and model-fitting criteria of the ordinal logistic regression model, we used binary data dummy coded from ordinal data and continuous data as predictor variables (Table 2). We conducted tests of Pearson's correlation and Spearman's rank correlation for all pairs of variables to eliminate multicollinearity. Further, we tested our model to ensure it met the assumption of proportional odds and we conducted a likelihood ratio Chi-square test to compare the fit of our model to that of the null model. The null model stated that the predictor variables (i.e., motivations, years of hunting experience, and activity-specific experiences) were not correlated with deer hunting satisfaction. We also conducted deviance and Pearson's chi-square tests to determine additional measures of our model's goodness-of-fit to our data.

Third, we conducted revised importance-performance analysis (Matzler et al. 2003, Deng 2007) to identify

Table 2. Predictor variables used in ordinal logistic regression for hunter satisfaction. Variables were based on responses to a 2019 mail questionnaire for white-tailed deer hunters (n = 441) on 8 Wildlife Management Areas within the Chattahoochee National Forest of North Georgia, USA.

Description	Type
Deer population density: Too few (1), right number or too many (0)	Binary
Deer population density: Too many (1), right number or too few (0)	Binary
Hunter density: Right number (1), too few or too many (0)	Binary
Motivations for deer hunting: Mean importance on Likert scale ranging 1–7 for motivations related to escaping the daily routine and experiencing nature (Averages 6–7 were coded as 1 whereas averages <6 were coded as 0)	Binary
Motivations for deer hunting: Mean importance on Likert-type scale ranging 1–7 for motivations related to harvesting deer for meat consumption (Averages 6–7 were coded as 1 whereas averages <6 were coded as 0)	Binary
Motivations for deer hunting: Mean importance of Likert-type scale ranging 1–7 for motivations related to socializing with friends and family (Averages 6–7 were coded as 1 whereas averages <6 were coded as 0)	Binary
Motivations for deer hunting: Mean importance of Likert-type scale ranging 1–7 for motivations related to harvesting a trophy buck (Averages 6–7 were coded as 1 whereas averages <6 were coded as 0)	Binary
Number of years as a hunter	Continuous
Number of deer harvested/years hunted (2014–2018)	Continuous
Completely dissatisfied (1), Somewhat dissatisfied (2), Neither dissatisfied nor satisfied (3), Somewhat satisfied (4), Completely satisfied (5)[a]	Ordinal

[a] Dependent variable.

respondents' preferences for WMA deer hunting. We presented a chart with a list of 19 WMA deer hunting aspects based on input from Georgia Department of Natural Resources and the authors' perceptions of issues pertinent to hunters and management within our study area. We asked respondents to rate both the importance of individual aspects in providing a satisfying hunting experience and the performance of the WMA in providing that aspect. Importance ratings were based on a 7-point Likert-type scale ranging from 1 = not at all Important to 7 = very important. Performance ratings were also based on a 7-point Likert-type scale ranging from 1 = extremely poor to 7 = exceptional. We determined implicit importance for each aspect by calculating the partial correlation coefficient for the natural log of performance and overall satisfaction (Deng 2007). We plotted implicit importance versus performance for each aspect and demarcated 4 managerial-relevant quadrants based on the overall mean of implicit importance and performance (Deng 2007). Quadrants included concentrate here (high importance, low performance), keep up the good work (high importance, high performance), possible overkill (low importance, high performance), and low priority (low importance, low performance; Martilla and James 1977).

We used a Student's t-test to compare mean ages of respondents versus nonrespondents. Additionally, we used a Chi-square test to compare gender among respondents and nonrespondents. We conducted Spearman's rank correlation tests to determine if respondent ages were correlated to the main variables of our study, including overall satisfaction and average importance for each motivational construct. We used descriptive statistics to report all other results.

RESULTS

Our survey population included 1,271 individuals, of which we had 1,216 valid mailing addresses and 441 responses providing an adjusted response rate of 36%. The age of respondents ranged 19–87 years and averaged 46 years (SD ± 14). Most respondents were male (97.2%), which was similar to nonrespondents (95.8%, $\chi^2_1 = 1.270$, $P = 0.260$). Ages of nonrespondents ranged 18–86 years with an average of 39 years (SD ± 13), which differed from that of respondents by 7 years ($t_{1224} = 9.300$, $P < 0.001$). Respondent age and overall hunting satisfaction were not correlated ($r_s = -0.017$, $P = 0.725$). Respondent age was also not correlated with motivational constructs related to escaping the daily routine ($r_s = -0.081$, $P = 0.094$), socializing with hunting partners ($r_s = -0.016$, $P = 0.747$), or harvesting a trophy buck ($r_s = 0.005$, $P = 0.923$), and was weakly negatively correlated with the motivational construct related to obtaining meat ($r_s = -0.284$, $P < 0.001$). For years of hunting experience, respondents ranged 0–65 years with a mean of 31 years (SD ± 15). For years of hunting experience on the WMA for which they were surveyed (herein, the WMA), respondents ranged 0–56 years with a mean of 14 years (SD ± 13). Of those respondents who hunted at all on the WMA during 2014–2018, 74.5% ($n = 295$) harvested no deer, 16.2% ($n = 64$) harvested one deer, and 9.3% ($n = 37$) harvested ≥2 deer.

The majority of respondents reported that the current deer population on the WMA was too few (86.6%, $n = 368$) and the density of hunters was the right number (73.0%, $n = 314$). When asked to rate the quality of deer hunting on the WMA, 69.3% of respondents ($n = 298$) reported low ratings (i.e., extremely poor, poor, or below average), 20.9% ($n = 90$) reported a fair rating, and 9.8% ($n = 42$) reported high ratings (i.e., above average, good, or exceptional). For overall satisfaction of deer hunting experiences on the WMA, 45.5% of respondents ($n = 195$) were dissatisfied, 24.9% ($n = 107$) were neither dissatisfied nor satisfied, and 29.6% ($n = 127$) were satisfied. Most respondents (79.1%, $n = 349$) indicated they would likely return to hunt the WMA next year and only 20.9% ($n = 92$) indicated they were either unsure or unlikely to return.

In our principal component analysis, 3 deer hunting motivations had factor loadings <0.600 that we excluded from further analysis, which included contribute to conservation, experience excitement and adrenaline, and kill as many deer as possible. The remaining 13 motivations were assigned to 1 of 4 latent constructs, providing each construct with 2–5 original motivations (Table 3). Constructs collectively explained 62.7% of the variance in motivations. Eigenvalues ranged 1.774–3.219, factor loadings ranged 0.684–0.906,

Table 3. Motivational constructs derived from principal component analysis of 13 motivations for deer hunting with their associated values of significance. White-tailed deer hunters (n = 441) on 8 Wildlife Management Areas within the Chattahoochee National Forest of North Georgia, USA, rated motivations based on importance via mail questionnaires in 2019.

Constructs	Motivations	Factor loadings	Eigen-values	Cronbach's alpha
Escape	Have time to disconnect from technology	0.684	3.219	0.787
	Experience solitude	0.702		
	Get away from the regular routine	0.758		
	Get away from crowds of people	0.780		
	Be outdoors	0.723		
Meat	Kill deer for eating	0.813	2.385	0.825
	Be more sustainable/procure meat locally	0.771		
	Know where my meat comes from	0.767		
Socialization	Spend time with friends and family	0.822	2.650	0.843
	Be with others who enjoy the same things as me	0.881		
	Socialize with others in a hunting party	0.834		
Trophy	Kill a mature buck	0.906	1.774	0.810
	Kill a trophy buck	0.886		

and Cronbach's alpha ranged 0.787–0.843. Our Kaiser-Meyer-Olkin measure of sampling adequacy was 0.809 and Bartlett's test of sphericity was significant ($\chi^2_{120} = 2{,}619$, $P < 0.001$), indicating principal component analysis was appropriate for our data. Motivational constructs in order from greatest to least importance included the following: 1) escape (89.1% responses rated 5–7, $\bar{x} = 6.13$, SD $\pm$ 0.86), 2) meat (78.9% responses rated 5–7, $\bar{x} = 5.57$, SD $\pm$ 1.28), 3) socialization (68.7% responses rated 5–7, $\bar{x} = 5.02$, SD $\pm$ 1.51), and 4) trophy (68.2% responses rated 5–7, $\bar{x} = 4.98$, SD $\pm$ 1.50).

Our ordinal logistic regression model for satisfaction met the proportional odds assumption ($\chi^2_{27} = 21$, $P = 0.793$). Predictor variables had either nonsignificant correlation coefficients or significant correlation coefficients $\leq |0.285|$. Our regression model exhibited improved fit compared to the null model ($\chi^2_9 = 55$, $P < 0.001$). Our model passed the goodness-of-fit test of deviance ($\chi^2_{1123} = 864$, $P = 1.000$) but not the Pearson's Chi-square test ($\chi^2_{1123} = 1259$, $P = 0.003$). Three predictor variables had a statistically significant relationship with WMA hunt satisfaction: perception of deer population density, perception of hunter density, and trophy motivation (Table 4). Responses that indicated the deer population had too few deer were associated with lower satisfaction ratings. Responses that indicated hunter density was the right number were associated with higher satisfaction ratings. Importance ratings of trophy-related motivations were negatively associated with satisfaction ratings. The remaining predictor variables, which included harvest success rate, perception of deer population density as too many, motivations related to escape, socialization, and meat, and years of hunting experience, had no statistically significant relationship with WMA hunt satisfaction. However, harvest success rate during 2014–2018 was close to having a statistically significant positive relationship with satisfaction ($W = 3.642$, $P = 0.056$).

According to revised importance-performance analysis, implicit importance differed from explicit importance (Table 5). Seeing lots of deer and having the opportunity to harvest bonus bucks not included in the general bag limit were the most important implicit factors in hunter satisfaction, whereas safety and being close to nature were the most important explicit factors. Three of 19 hunting aspects fell within the concentrate here quadrant, including seeing lots of deer, opportunity to kill mature bucks, and opportunity to kill bonus bucks (Fig. 1). Two low priority aspects were close to falling within the concentrate here quadrant, including the opportunity to kill deer and seeing mature bucks. The opportunity to kill multiple deer and does were additional low priority factors. Six aspects fell within the potential overkill quadrant including tradition, ease of access to hunting spots, potential to kill a wild pig, potential to kill a bear, privacy from other hunters, and seeing non-game species. Six aspects fell within the keep up the good work quadrant, including having a safe hunting experience, convenient location close to home, open road access, seeing other game species, financial cost, and being close to nature.

DISCUSSION

Public land deer hunters in the Appalachian Mountains of the southeastern United States face similar issues with low deer populations and declining hunter participation as our sample of Chattahoochee National Forest hunters in North Georgia (Virginia Department of Game and Inland Fisheries 2015, Georgia Department of Natural Resources, Kentucky Department of Fish and Wildlife Resources, West Virginia Division of Natural Resources, unpublished reports). Our study provided insights on hunter satisfaction where deer populations have been declining over multiple decades and employed methods using implicit importance and revised importance-performance analysis. Only 30% of respondents were satisfied with their overall hunting experience. Satisfaction was correlated to respondents' perceptions of deer population density, where indications of an insufficient deer population were associated with lower levels of satisfaction. In addition, seeing deer was the most important factor in hunter satisfaction that was not being adequately provided for respondents on North Georgia WMAs. Harvest success rates were low with 75% of respondents harvesting no deer from 2014 to 2018. Our analysis indicated that harvest success was extremely close to having a positive relationship with satisfaction. Previous research has demonstrated the interrelatedness of harvest success and perception of deer density. For example, Pennsylvania hunters based their perception of deer population size on the harvest success of themselves and other hunters they knew (Miller and Graefe 2001). Therefore, it

Table 4. Results from ordinal logistic regression of hunter satisfaction. White-tailed deer hunters (n = 441) on 8 Wildlife Management Areas within the Chattahoochee National Forest of North Georgia, USA, rated their satisfaction on a scale 1–5 ranging from 1 = completely dissatisfied to 5 = completely satisfied via mail questionnaires in 2019.

Variable	Estimate (β)	Significance (P)	95% CI	
			Lower Bound	Upper Bound
Deer population density is too few	−1.637	<0.001	−2.210	−1.063
Deer population density is too many	−1.232	0.255	−3.353	0.888
Hunter density is the right number	0.850	<0.001	0.428	1.273
Motivations for deer hunting related to escaping the daily routine and experiencing nature	−0.258	0.318	−0.764	0.248
Motivations for deer hunting related to harvesting deer for meat consumption	−0.365	0.236	−0.969	0.239
Motivations for deer hunting related to socializing with friends and family	−0.260	0.484	−0.990	0.469
Motivations for deer hunting related to harvesting a trophy buck	−0.723	0.023	−1.347	−0.098
Number of years as a hunter	−0.009	0.164	−0.021	0.004
Number of deer harvested/years hunted (2014–2018)	0.758	0.056	−0.020	1.537

Table 5. Implicit (derived) versus explicit (self-reported) importance for 19 Wildlife Management Area (WMA) hunting-related aspects. Via mail questionnaires in 2019, white-tailed deer hunters (n = 441) on 8 WMAs in North Georgia, USA, rated the importance of each aspect in providing a satisfying hunting experience and the performance of the WMA in providing that aspect. Implicit importance was derived for each aspect by calculating the partial correlation coefficient for the natural log of performance and overall satisfaction.

Hunting aspects	Implicit importance	Implicit rank	Explicit importance	Explicit rank
Seeing lots of deer	0.270	1	5.18	10
Opportunity to kill bonus bucks	0.084	2	4.03	17
Financial cost	0.071	3	5.08	11
Being close to nature	0.070	4	6.30	2
Opportunity to kill mature bucks	0.055	5	5.60	5
Seeing other game species	0.046	6	5.57	8
Open road access	0.041	7	4.71	12
Convenient location	0.040	8	5.39	9
Safety	0.037	9	6.74	1
Opportunity to kill deer	0.031	10	5.58	7
Ease of access	0.029	11	4.23	16
Tradition	0.024	12	5.91	4
Seeing mature bucks	0.019	13	5.59	6
Opportunity to kill multiple deer	0.003	14	3.55	19
Seeing non-game species	0.001	15	4.41	14
Privacy	-0.016	16	6.07	3
Potential to kill a bear	-0.033	17	4.42	13
Potential to kill a wild pig	-0.057	18	4.38	15
Opportunity to kill does	−0.070	19	3.75	18

was only through perception of population size that harvest success influenced their satisfaction (Miller and Graefe 2001). Overall, our findings align with past studies in which hunter perceptions of deer population size and their ability to see deer played a significant and sometimes larger role in satisfaction than actually harvesting a deer (Decker et al. 1980, Hammitt et al. 1990, Gigliotti 2000). Declines in the deer population had a strong negative influence on hunter satisfaction in the Black Hills (Gigliotti 2000). Additionally, hunter perception of not enough game was a situational constraint to hunter effort in Illinois (Miller and Vaske 2003).

We applied revised importance-performance analysis to identify priorities on which managers should focus to increase hunter satisfaction, which included increasing opportunities for hunters to see deer and harvest bucks. Populations of black bears and wild pigs have increased and opportunities to harvest these species were being provided on the WMAs, however, these opportunities were of low importance to hunters. Respondents seemed to desire improvements in their ability to harvest deer within realistic and responsible limits. The motivation to kill as many deer as possible did not fit into any of the 4 motivational constructs. Additionally, opportunities to kill multiple deer and

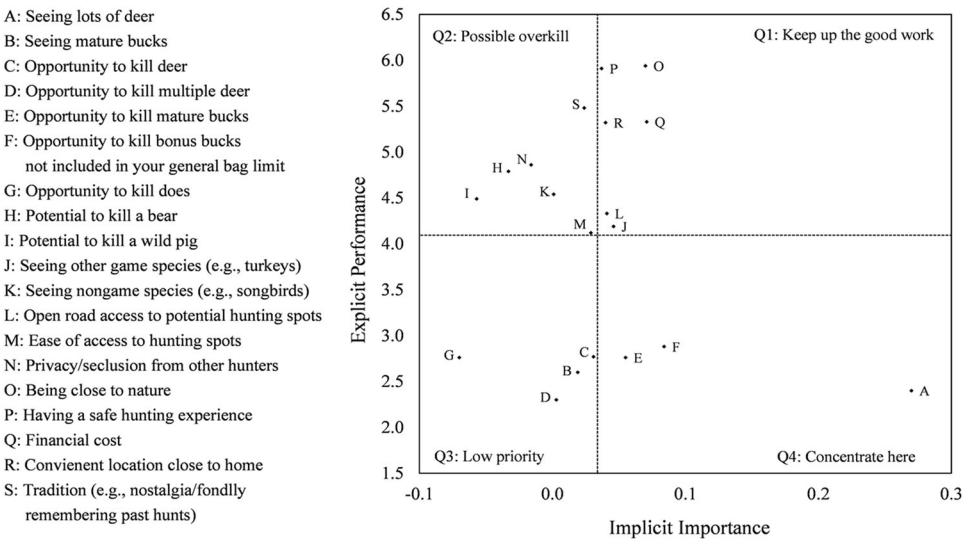

Figure 1. Results of revised importance–performance analysis for 19 aspects of Wildlife Management Area (WMA) hunting plotted within quadrants relevant to management. Via mail questionnaires in 2019, white-tailed deer hunters (n = 441) on 8 WMAs in North Georgia, USA, rated the performance of the WMA in providing each aspect. Implicit importance was derived for each aspect by calculating the partial correlation coefficient for the natural log of performance and overall satisfaction. The quadrants were demarcated based on the mean of all implicit importance values and the mean of all performance values reported by respondents. Improvements in aspects of Quadrant 4 (high importance, low performance) had the greatest likelihood of increasing respondents' satisfaction.

does had low importance and were low priority factors in hunter satisfaction. Management priorities for increasing hunter satisfaction were focused on activity-specific experiences, which is practical since it is difficult for agencies to manage for activity-general experiences, such as enjoying the outdoors and spending time with family (Fisher 1997). Although, Hammitt et al. (1990) suggested that because managers help produce the settings in which nature experiences occur via management of land and wildlife, they may influence the nature-related aspects of hunting. Furthermore, dissatisfaction with the number of deer seen may degrade the aspects of hunting related to experiencing nature, since game animals are part of nature (Hammitt et al. 1990).

Hunter experiences likely influenced their self-reported satisfaction and motivations (Schroeder et al. 2019*a*). Motivations for hunting related to escaping the daily routine, appreciating nature, and disconnecting from technology in the outdoors had the highest importance among our respondents compared to motivations related to harvest (i.e., obtaining meat, harvesting trophy bucks) or socialization (i.e., spending time with friends and family). However, only motivations related to harvesting a trophy buck were significantly correlated to hunt satisfaction. In particular, greater importance of trophy-related motivations was associated with lower levels of satisfaction. Getting outdoors and enjoying nature was also of primary importance in hunting satisfaction in a few past studies, but, despite a hunter's primary motivation for hunting, most go afield wanting a realistic chance at harvesting a deer (Decker et al. 1980, Gigliotti 2000). Previous research has also suggested that motivations self-reported by hunters can be a result of the coping mechanism of rationalization, where unsuccessful hunters may downgrade the importance of achievement factors, while upgrading the affiliative or appreciative factors (Schroeder et al. 2019*a*). Rationalization allows their motivations to more closely match their experiences and prevents internal conflict (Manning and Valliere 2001, Miller and McCool 2003). Arlinghaus (2006) found that most anglers claim that catch-related motives are of little importance in their satisfaction, but, in reality, their satisfaction is mainly catch dependent. The mismatch in implicit and explicit importance of catch-related motives may be rooted in the fundamental conceptual differences between motivations and satisfaction and to the relative ease with which activity-general experiences can be fulfilled (Arlinghaus 2006). Our respondents' hunting experiences on North Georgia WMAs did not provide adequate opportunities to see and harvest deer. The lack of opportunities combined with their perceptions of low deer numbers may help explain why certain aspects, such as the opportunity to kill does, were among the last ranked in implicit and explicit importance. Perhaps, hunters do not want to harvest does in the region given the negative effect it might have on an already low deer population.

Respondents in our study expressed receiving a number of benefits from hunting, providing support for the multiple-satisfaction approach concept (Hendee 1974, Decker et al. 1980, Hammitt et al. 1990, Gigliotti 2000). Factors such as tradition, being close to nature, convenient location close to home, financial cost, and spending time with hunting companions were important for a satisfying hunting experience. We were also unable to assign respondents to 1 of the 4 motivational constructs (i.e., escape, meat, socialization, and trophy), demonstrating the plurality of hunter motives involving both activity-specific and activity-general factors. Moreover, despite only 30% of respondents being satisfied with their hunting experience, 80% indicated they would likely return to hunt the WMA next year. The importance of variables not related to activity-specific factors, such as nostalgia, financial cost, convenient location, etc., may have contributed to responses indicating a high likelihood to return. Perhaps hunters who remained on the WMAs after significant declines in deer numbers were those who were loyal to hunting in these areas or those seeking a mountain setting for deer hunting. We were not able to survey hunters who stopped hunting the WMAs, but this would have potentially provided additional insights.

We identified 2 potential limitations to our study. First, we could not conduct nonresponse bias checks, as found in Connelly et al. (2000) and Brunke and Hunt (2007), which would have strengthened the applicability of our results to the entire survey population. We determined that our completed sample represented the survey population in terms of gender, but not in terms of age. However, respondent age was not correlated with key variables in our study, including overall hunting satisfaction and motivational constructs. We recognize that our results are based on the 441 hunters who responded, but we also acknowledge that nonresponse error is not inherent to low response rates. Nonresponse error only occurs when those who were part of the completed sample differ in items of interest compared to the entire survey population, making the propensity to respond non-random (Dillman et al. 2014). The second limitation is that our study does not provide direct evidence for why participation in WMA hunts in North Georgia decreased by 68% during 1979–2018. Because we could not survey hunters who stopped hunting on the WMAs, we can speculate that the shortcomings of the WMAs, regarding respondents' abilities to see deer and harvest bucks, may have contributed to their withdrawal from hunting on these areas. Nonetheless, a residual population of hunters continues to hunt on Chattahoochee National Forest WMAs in North Georgia. Their satisfaction could be improved by increasing opportunities to see deer and harvest bucks. Our findings should serve as a reference for managers facing similar challenges, particularly on federal public lands throughout the Appalachian Mountains of the southeastern United States.

MANAGEMENT IMPLICATIONS

Given the 64% decline in buck harvest success rates over recent decades, the positive relationship between hunter satisfaction and perception of deer density, and hunter desires to see more deer and have more opportunities to harvest bucks, we recommend managing the deer population to

increase numbers. We also recommend that managers put considerable effort into educating hunters on the capabilities and limitations of state and federal agencies in managing national forest lands. Informing hunters about science-driven wildlife management and about the political process involved in managing national forests would improve their awareness and better equip hunters to participate in the public process for projects that impact deer populations and hunting. Overall, our findings suggested that hunters and managers agree on the direction of deer management on North Georgia public lands for the near future.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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