

Effects of COVID-19 on Wild Turkey Hunter Satisfaction and Behavior in Tennessee

Lindsey M. Phillips¹, School of Natural Resources, University of Tennessee, 2505 E.J. Chapman Drive, Knoxville, TN 37996

Vincent M. Johnson, School of Natural Resources, University of Tennessee, 2505 E.J. Chapman Drive, Knoxville, TN 37996

Craig A. Harper, School of Natural Resources, University of Tennessee, 2505 E.J. Chapman Drive, Knoxville, TN 37996

Neelam C. Poudyal, School of Natural Resources, University of Tennessee, 2505 E.J. Chapman Drive, Knoxville, TN 37996

Roger Shields, Tennessee Wildlife Resources Agency, 5107 Edmondson Pike, Nashville, TN 37211

David A. Buehler, School of Natural Resources, University of Tennessee, 2505 E.J. Chapman Drive, Knoxville, TN 37996

Abstract: Understanding hunter satisfaction and behavior under normal and abnormal situations is important for effective management of game species by state wildlife agencies. SARS-CoV-2 (COVID-19) created a global pandemic that coincided with the 2020 spring wild turkey hunting season. Concern was expressed by some wild turkey researchers and biologists that COVID-19 lockdown protocols could result in increased hunting effort and unsustainable harvests because of people having more free time. We assessed how COVID-19 and associated lockdown protocols affected hunter satisfaction and behavior during the spring 2020 wild turkey hunting season by using responses from 2,000 annual surveys of wild turkey hunters (2017–2020) among five focal counties (Bedford, Giles, Lawrence, Maury, and Wayne) in south-central Tennessee. COVID-19 did not result in changes to hunter satisfaction or an increase in hunter effort or harvest of every-year hunters but did result in a 26% increase in new license holders and returning hunters (i.e., hunters that had not hunted in the last 5 yr) compared to the previous 3 yr (2017–2019). Wild turkey harvest peaked at 40,137 birds during COVID-19, 27.8% greater than the previous 3-yr average (31,407 birds, 2017–2019). Wild turkey researchers and biologists were concerned that populations might have been overharvested. However, harvest in Tennessee during 2021–2023 returned to pre-COVID-19 levels. These harvest data indicate the wild turkey population in Tennessee was sufficiently resilient to withstand a significantly greater harvest in 2020. Furthermore, the greater harvest in 2020 was potentially good for the sport of wild turkey hunting considering the increased recruitment of new and returning hunters that were just as successful as every-year hunters.

Key words: COVID-19 impacts, hunter surveys, human dimensions

Journal of the Southeastern Association of Fish and Wildlife Agencies 11:92–101

The wild turkey (*Meleagris gallopavo*; hereinafter, turkey) is an important upland gamebird across the U.S. (Dickson 2001, Watkins et al. 2018). The number of turkey hunters (hereinafter, hunters) increased 450% from 1973 to 2003 (Wynveen et al. 2005). According to the 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, over 2 million turkey hunters hunted a total of 13 million days, making turkey the second-most hunted species in the U.S. (USFWS and USCB 2018). However, many southeastern states, including Tennessee, have reported recent declines in turkey harvest (Tapley et al. 2011, Bond et al. 2012, Eriksen et al. 2015). Chamberlain et al. (2022) reported that turkey harvest across the southeastern U.S. decreased 12% from 2014 to 2019. The Tennessee Wildlife Resources Agency's (TWRA) Administrative Region II reported spring turkey harvest declined approximately 30% from 2010 to 2018 (TWRA 2022; Figure 1A). Declines in turkey harvest across the southeastern U.S. likely are a result of declining turkey populations and productivity. Chamberlain et al.

(2022) estimated turkey populations across the southeastern U.S. have decreased 9–16% from 2004 to 2019. Byrne et al. (2015) reported declining productivity values in twelve southeastern states (100% of the states reported productivity data). In Tennessee, summer poults-per-hen ratios have declined substantially (69%) over the past 30 yr (Shields 2023). Understanding what is driving these declines in turkey populations and harvest, as well as understanding how these declines are influencing hunter effort and satisfaction, are a priority of turkey researchers and biologists.

Human dimensions research has historically identified that the number of turkeys harvested and hunting licenses sold are a way to measure hunter satisfaction and participation (Hammitt et al. 1989, Heberlein and Kuentzel 2002, Wynveen et al. 2005). However, the idea of “hunter satisfaction” has evolved beyond quantifying harvest and now includes factors such as hunter effort (number of days or hours afield), density of the species hunted, weapon used, past experiences, and hunter perceptions (Potter et al. 1973,

1. E-mail: lphill46@vols.utk.edu

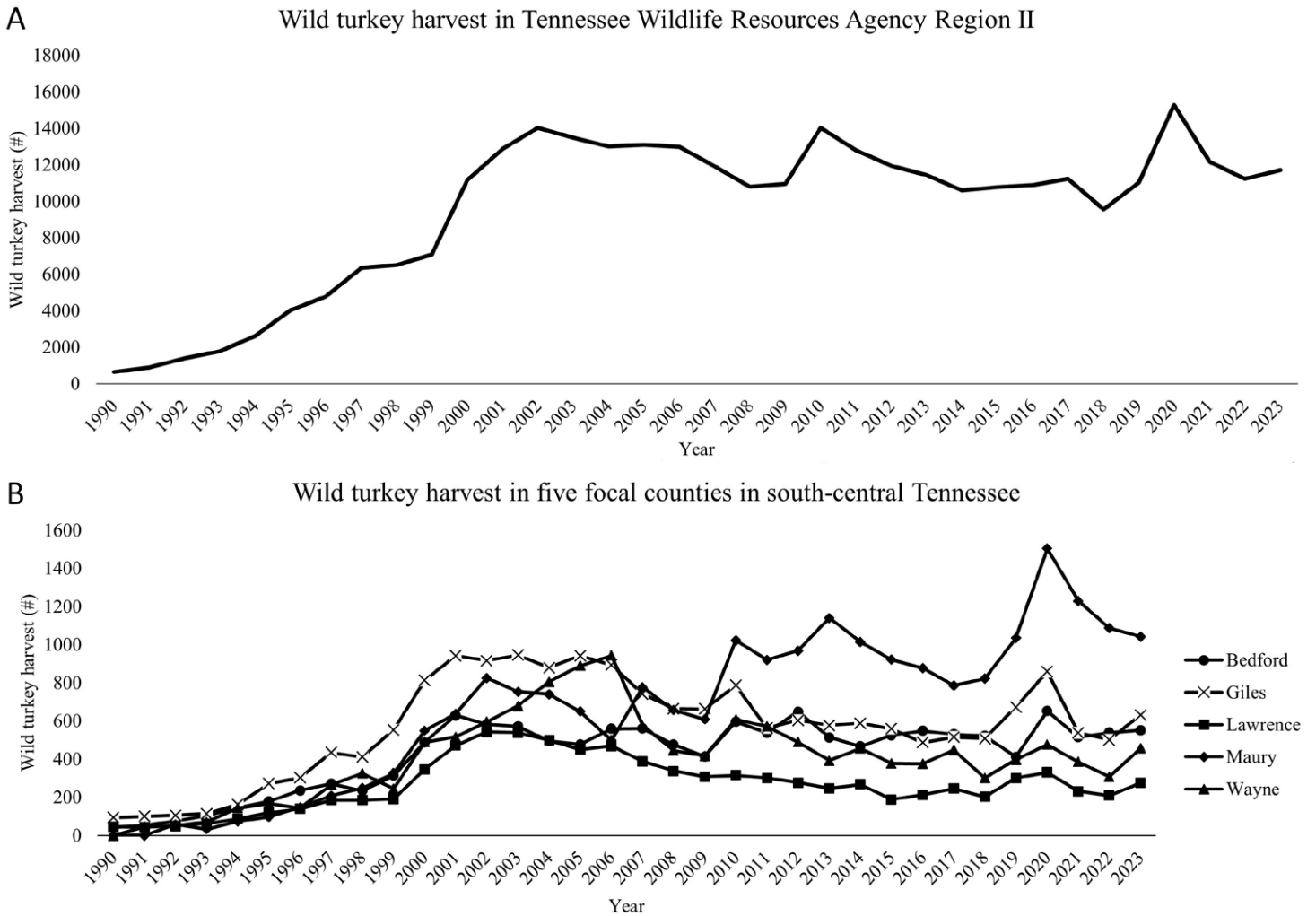


Figure 1. Number of turkeys harvested in A) Tennessee Wildlife Resources Agency's Administrative Region II and B) five focal counties (Bedford, Giles, Lawrence, Maury, and Wayne) in south-central Tennessee, 1990–2023.

Hazel et al. 1990, Wynveen et al. 2005, Harper et al. 2012). Understanding factors that influence hunter satisfaction and behavior helps guide state wildlife agencies managing turkey populations, especially during a period of potential population decline.

Uncontrollable and unpredictable factors (e.g., weather, societal issues) influence hunter behavior and satisfaction (Hammitt et al. 1989, Wynveen et al. 2005). An example was the worldwide spread of SARS-CoV-2 (hereinafter, COVID-19), which caused a global pandemic starting December 2019 (Bergquist et al. 2020, Liu et al. 2020, Velavan and Meyer 2020). The first individual tested positive for COVID-19 in the U.S. on 21 January 2020 (Bergquist et al. 2020, Velavan and Meyer 2020). The number of positive cases in the U.S. increased dramatically by March 2020, which prompted lockdown protocols across the country (Liu et al. 2020, Rutledge 2020). Lockdown protocols forced businesses to reduce hours or lay-off or terminate employees, which resulted in millions of unemployed Americans (Rutledge 2020). In Tennessee, the first

confirmed COVID-19 case was announced 5 March 2020, and a state of emergency was declared by the Tennessee governor 12 March 2020 followed soon thereafter by lockdown protocols from 13 March 2020 through 30 April 2020 (TN Office of the Governor 2023). By 1 May 2020, Tennessee businesses and restaurants were allowed to begin opening again with reduced capacity guidelines (TN Office of the Governor 2023).

Lockdown protocols coincided with the start of the spring 2020 turkey hunting season across much of the southeastern U.S. (Danks et al. 2022). In Tennessee, the 2020 spring turkey hunting season began 4 April 2020, two weeks after the governor announced all businesses should use “alternative business models,” which included employees working from home, and only five days after the announcement of “Safer at Home” guidelines, which minimized group gatherings (TN Office of the Governor 2023). Some wildlife biologists and researchers across the U.S. hypothesized that various lockdown protocols would increase the number of turkey

hunters and the amount of time they hunted. Increased hunting pressure could result in an increased harvest, potentially resulting in an overharvest of already declining turkey populations. Some researchers even called for states to impose emergency changes to the 2020 spring turkey hunting season, including limiting license sales, closing seasons early, and reducing bag limits (Goldman 2020, Chizinski et al. 2021, Danks et al. 2022). Fourteen of 47 state governments (30%) implemented some level of COVID-19 lockdown protocols (i.e., restrictions on public gatherings, state or county stay-at-home orders) that also involved changes to their 2020 spring turkey hunting season (i.e., license sale restrictions, restrictions to public hunting land; Danks et al. 2022). However, these lockdown protocols and changes were not implemented because of concerns related to overharvest of turkey populations, but rather were implemented to address potential human health and safety measures. Despite some lockdown protocols and changes limiting turkey hunting ability or access, some states saw record harvests of turkeys in 2020, including Tennessee. This indicates that Tennessee's increase in turkey harvest was related to COVID-19 given that many turkey populations across the southeastern US are reportedly declining (i.e., a 2020 turkey population boom was unlikely). However, it is unclear if the increased harvest resulted from changes in the hunter population (i.e., new hunters entering the sport, previous hunters returning to the sport), or from changes in hunter behavior in response to the COVID-19 restrictions.

From 2017–2020, we conducted a comprehensive mail-based hunter survey in south-central Tennessee to quantify hunter satisfaction and behavior, and to assess how changes in the hunter population influenced harvest during the COVID-19 pandemic (2020). Our first objective was to measure hunter satisfaction and perceptions about the season framework, quantify hunter effort, determine variables that affected hunter effort, and evaluate how the COVID-19 lockdown protocols affected these metrics. Our second objective was to evaluate whether the increase in overall harvest resulted from increased hunting license sales, increased hunter effort, or both.

Methods

Study Area

This study was conducted in five focal counties (Bedford, Giles, Lawrence, Maury, and Wayne) in south-central Tennessee during the 2017–2020 spring turkey hunting seasons. We selected these five focal counties because they historically have had the greatest harvest in Tennessee, but since the early 2000's, the spring harvest in three of the five focal counties (Giles, Lawrence, and Wayne) had declined (TWRA 2022; Figure 1B).

The season framework was the same for all spring turkey hunting seasons included in our study (2017–2020). Statewide spring turkey hunting season opened on the Saturday closest to 1 April, with a 2-day young sportsman (i.e., youth) hunting season the weekend before the statewide season. Spring turkey hunting season was open for 44 days. All bearded turkeys, regardless of sex or age, were legal to harvest. The daily bag limit for bearded turkey was one turkey per day, with a season bag limit of four turkey (TWRA 2021).

Our target survey population was individuals who hunted turkey in the five focal counties during the 2017 spring hunting season. We used hunting license information from TWRA to generate our list of potential sample individuals (Dillman 2007, Vaske 2008). All individuals who met one of the following criteria for the 2017 spring hunting season were included: 1) individuals residing in one of the five focal counties and purchased a hunting license allowing them to hunt turkeys or 2) individuals who purchased a hunting license that allowed them to hunt turkeys and checked-in a turkey in one of the five focal counties through the TWRA's mandatory harvest reporting system. We then used simple random sampling for each county to select 2000 individuals (400 per focal county) for surveys. We re-sampled the same individuals each year to track changes in attitudes and hunting behavior.

Survey Development, Implementation, and Quality Control

We developed a six-page paper survey for the sampling unit each year (UTK IRB-17-03689-XM). The survey asked questions related to turkey hunting effort, success, and experience. We measured hunter satisfaction on a Likert scale (1 = very dissatisfied, 2 = somewhat dissatisfied, 3 = neither satisfied nor dissatisfied, 4 = somewhat satisfied, 5 = very satisfied). Following Dillman (2007) and Dillman et al. (2014), we mailed the survey packet, which included the survey, a personalized cover letter detailing the purpose of the survey, and a pre-paid return envelope within ten days of the conclusion of the spring hunting season. Two weeks after mailing the initial survey, we mailed a thank you/reminder postcard to each respondent to thank respondents who completed the survey and encourage other respondents to complete the survey. Two weeks after mailing the postcard, we mailed a second survey packet to those who had not returned a survey.

If a hunter returned two surveys, we used the survey returned closest to the end of the spring hunting season to minimize the amount of error introduced through recall bias (Vaske 2008). Any responses that were illegible, reported erroneous values outside the bounds of the hunting season, or left blank, such that calculations could not be performed to obtain hunter effort, were removed from the data set.

Statistical Analysis

We used descriptive statistics to analyze hunter demographics as well as satisfaction relative to the 2017–2020 spring hunting season quality and regulations, and proposed regulation changes (Hammit et al. 1989, Heberlein and Kuentzel 2002, Shrestha and Burns 2012). We performed Pearson’s chi-square tests to compare opinions about turkey population size over multiple years and satisfaction between hunters before COVID-19 (2017–2019) to hunters during COVID-19 (2020).

To determine if hunter effort changed in response to lockdown protocols, we regressed hunter effort for all hunters and only successful hunters as a function of year using a linear mixed effects model analysis of variance with respondent identification number included in the model as a random effect because we monitored the same hunters each year. We calculated hunter effort, hunter effort per harvested bird for successful hunters, total number of birds harvested, take per unit effort, and total number of days hunted for the spring turkey hunting season. We defined hunter effort as the total number of hours hunted by each respondent in any given year and calculated this by multiplying each respondent’s answers to the following questions: 1) “How many trips did you go turkey hunting?”, and 2) “In a typical hunt, how many hours did you spend hunting (not counting travel time)?” We calculated hunter effort per harvested bird by dividing the total hunter effort (total number of hours hunted) by the number of birds harvested for successful

hunters only. We calculated take per unit effort by dividing the number of harvested birds by the total number of days hunted for all hunters. We defined hunter days as the total number of days all respondents reported hunting; a single hunter-day could include multiple hunting trips. We used orthogonal planned contrasts post-hoc to compare hunter effort before COVID-19 to hunter effort during COVID-19. Analyzing 2020 (COVID-19) against a combination of previous years (2017–2019) before COVID-19 allowed comparison between a “normal” spring hunting season and the COVID-19-affected spring hunting season.

We used path analysis to determine factors predicting hunter effort in years before COVID-19 and during COVID-19. Path analysis is a multivariate linear model whereby causal relationships between one dependent (i.e., hunter effort) and two or more independent variables can be determined (Heberlein and Kuentzel 2002, Frey et al. 2003, Lleras 2005, Suhr 2008, Kerr 2017). We developed the original model (Figure 2) tested in the path analysis based on literature review and suspected causal relationships among variables included in the survey. Subsequent models were developed through model modification (Suhr 2008). We used Akaike’s Information Criterion (AIC), a comparative fit index (CFI), and a chi-square summary statistic for model selection to identify the best-supported model. We considered models with the least AIC, CFI closest to 1.0, and the smallest chi-square value the top models. However, more confidence was placed on the model

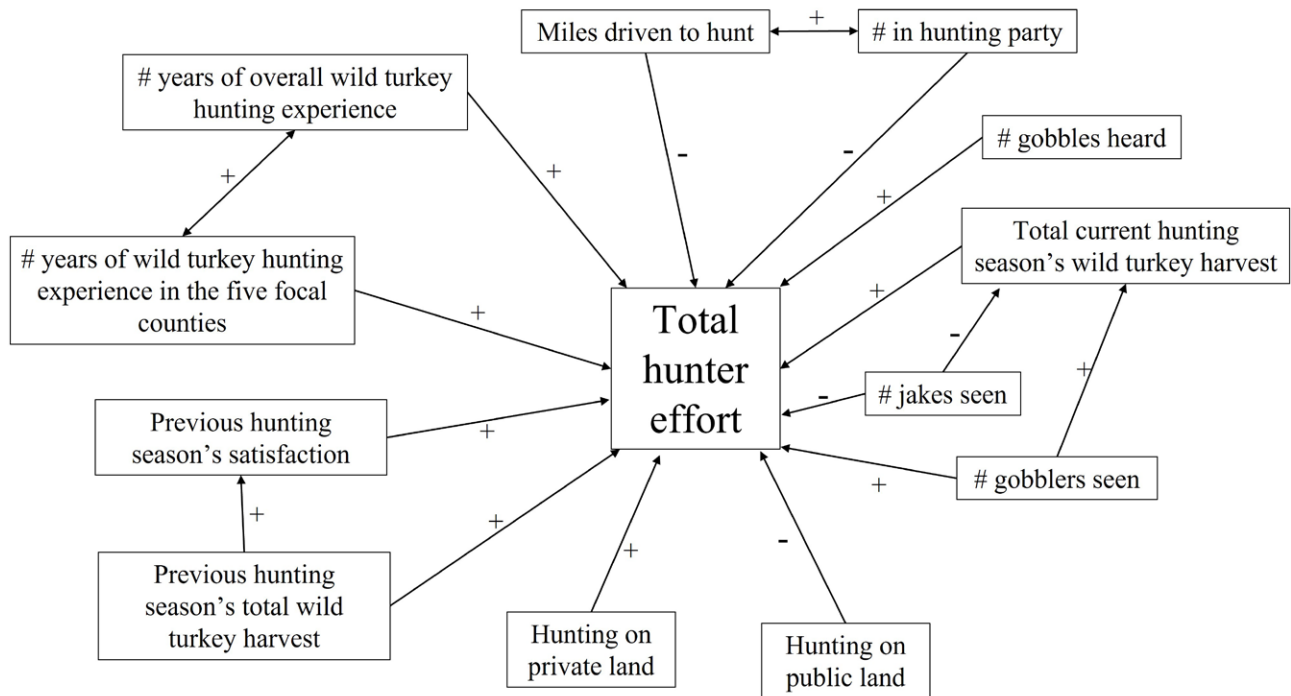


Figure 2. The original path analysis model developed and tested based on literature reviews and suspected causal relationships between the variables included in the turkey hunter effort survey, Tennessee, 2017–2020. The direction and power (+ or -) of the suspected causal relationships are indicated by the direction of the arrows and their associated signs.

AIC and CFI values compared with the chi-square summary statistic because achieving insignificance of the chi-square summary statistic is challenging when sample sizes are large, as in this study (Heberlein and Kuentzel 2002, Frey et al. 2003, Lleras 2005).

Wild Turkey Harvest and License Sales

Hunter-reported big game harvest data in Tennessee were available to the public through the TWRA Hunter's Toolbox, which was linked to TWRA's mandatory harvest reporting system (TWRA 2022). We obtained historical and current statewide spring turkey harvest totals, as well as harvest in the five focal counties through the TWRA Hunter's Toolbox and from TWRA harvest data sets (TWRA, unpublished data).

We obtained hunting license sales information from TWRA, which included the number of hunting licenses sold in each of the following categories that allowed the purchaser to hunt turkeys for each year (2017–2020): 1) new Tennessee resident and non-Tennessee resident hunters; 2) total non-Tennessee resident hunters (non-Tennessee residents who purchased a hunting license, regardless if this was their first Tennessee hunting license or not); and 3) returning Tennessee resident and non-Tennessee resident hunters (Tennessee residents and non-Tennessee residents who had previously purchased a hunting license, but not in the last 5 yr; TWRA unpublished data).

Results

General Survey and Respondent Characteristics

We mailed 8000 surveys (2000 surveys/year) to the same individual hunters selected in 2017 among our five focal counties. We received 2021 completed surveys (25% response rate), of which 1487 were from individuals who responded that they hunted at least one year in one of the five focal counties (19% response rate). Age of respondents ranged from 18–80 yr (median = 50, mean = 48). Most respondents were male (96%). Experience of respondents hunting turkeys in the five focal counties ranged from 1–63 yr (median = 18, mean = 17).

Wild Turkey Harvest

The 2020 statewide spring turkey harvest was the greatest ever recorded in Tennessee (40,137), representing a 29.0% increase above the 5-yr harvest average (31,123 birds, 2015–2019) and a 27.8% increase above the 3-yr harvest average during our survey study (31,407 birds, 2017–2019). Within the five focal counties, the record turkey harvest occurred in 2020 with 3827 birds reported, which was a 43.6% increase above the 5-yr harvest average (2663 birds, 2015–2019) and a 42.0% increase above the 3-yr harvest average during our survey study (2694 birds, 2017–2019; Figure 1B).

Hunter Satisfaction and Behavior in Response to COVID-19

For the following results, “current” refers to the year in which each survey was sent. Satisfaction with the current spring hunting season did not differ between before (median = 3 [neither satisfied nor dissatisfied]) and during COVID-19 (median = 3; $\chi^2 = 5.53$, $df = 4$, $P = 0.24$). However, 45% of respondents reported some level of dissatisfaction (responded with “somewhat dissatisfied” or “very dissatisfied”) with the current spring hunting season and 63% of respondents reported the quality of their current spring hunting season was worse compared with a spring season 5 yr ago (Table 1). COVID-19 did not affect hunter's opinions on the current spring hunting season regulations. When respondents were asked how they felt about the current spring hunting season regulations, on average, 65% reported some level of satisfaction (responded with “somewhat satisfied” or “very satisfied”) with the current season length, 55% reported some level of satisfaction with the season opening and closing dates, 53% reported some level of satisfaction with the current season bag limit, and 64% reported some level of satisfaction with the current daily bag limit. COVID-19 did not affect hunter's opinions on proposed spring hunting season regulations. When respondents were asked how willing they would be to support various proposed regulation changes, on average, 65% reported some level of satisfaction with reducing the season bag limit from four birds to three birds, and 68% reported some level of satisfaction with prohibiting harvest of juvenile males.

COVID-19 did not affect hunters' opinions about whether there were enough turkeys to allow ample opportunity to harvest a bird (median = 2 [no]; $\chi^2 = 1.70$, $df = 2$, $P = 0.43$; Table 2) and whether the turkey population had changed over the past 5 yr (median = 3 [decreased]; $\chi^2 = 23.72$, $df = 3$, $P = 0.30$). When respondents were asked if they knew about the decline in harvest prior to reading this survey, 81% of all respondents answered “yes,” and COVID-19 did not affect this ($\chi^2 = 2.54$, $df = 1$, $P = 0.11$). Ninety-seven percent of respondents reported some level of concern over declining turkey harvest, and this did not differ between before (median = 4 [extremely concerned]) and during (median = 4) COVID-19 ($\chi^2 = 3.64$, $df = 3$, $P = 0.30$). However, despite expressing concern over declining turkey populations, 70% of respondents reported they would not stop turkey hunting even if turkey populations continued to decline.

Average hunter effort during the spring hunting season did not differ before (31.0 h) and during (31.6 h) COVID-19 ($F_{3, 816.5} = 2.11$, $P = 0.70$; Table 3). Average hunter effort per harvested bird among successful hunters during the spring hunting season also did not differ before (26.6 h) and during (25.4 h) COVID-19 ($F_{3, 423.4} = 0.67$, $P = 0.62$). Successful hunters harvested an average of 1.5 birds per year during the spring hunting season before and

Table 1. Summary of hunter satisfaction (% of respondents) with current (year the survey was sent) hunting season quality and current and proposed hunting season regulations reported by turkey hunters in Bedford, Giles, Lawrence, Maury, and Wayne counties, south-central Tennessee, 2017–2020. Data were collected on Likert scales.

	Before COVID-19 (2017–2019)					During COVID-19 (2020)				
	1	2	3	4	5	1	2	3	4	5
Satisfaction with current hunting season ^a	25.1	19.6	10.2	29.2	15.9	23.8	24.2	6.2	28.2	17.6
Quality of current hunting season compared to 5 yr ago ^b	26.6	38.9	23.3	10.0	1.2	19.1	34.7	26.7	16.4	3.1
Satisfaction with current hunting season length	6.9	8.8	18.4	29.5	36.4	8.5	10.3	21.4	25.9	33.9
Satisfaction with current hunting season opening and closing dates	10.2	10.4	23.0	27.5	28.9	10.2	18.7	20.5	25.3	25.3
Satisfaction with current hunting season daily bag limit (1 bearded bird)	12.1	8.7	15.0	19.5	44.7	8.5	7.6	17.9	19.6	46.4
Satisfaction with current hunting season bag limit (4 bearded birds)	19.0	12.2	16.5	21.9	30.4	23.9	9.3	18.1	20.4	28.3
Satisfaction with proposed hunting season bag limit (3 bearded birds)	13.8	5.1	16.0	20.2	44.9	8.9	6.6	15.5	23.9	45.1
Satisfaction with proposal of removing immature males from harvest (except for youth hunts)	7.9	7.1	14.4	23.0	47.6	15.0	10.2	18.1	18.6	38.1

a. Scale for all questions except quality of current hunting season: 1 = very dissatisfied, 2 = somewhat dissatisfied, 3 = neither satisfied nor dissatisfied, 4 = somewhat satisfied, 5 = very satisfied.
 b. 1 = much worse, 2 = worse, 3 = same, 4 = better, 5 = much better.

Table 2. Summary of hunter opinion and behavior (% of respondents) reported by wild turkey hunters in Bedford, Giles, Lawrence, Maury, and Wayne counties, south-central Tennessee, 2017–2020.

	Before COVID-19 (2017–2019)	During COVID-19 (2020)
Enough turkeys to allow for ample harvest		
Yes	42.5	46.9
No	50.9	46.0
Don't know	6.6	7.1
Seen a turkey population change over the past 5 yr		
Increased	8.7	17.6
Stayed the same	16.2	21.6
Decreased	72.6	58.2
Don't know	2.5	2.6
Knew about harvest decline prior to this survey		
Yes	82.3	76.7
No	17.7	23.3
Concerned about harvest decline		
Not concerned	3.3	3.1
Somewhat concerned	11.2	14.7
Moderately concerned	23.7	26.7
Extremely concerned	61.8	55.5
If population declined where you hunt, would you continue to hunt there		
Yes	68.3	78.0
No	31.7	22.0

Table 3. Average hunter effort reported by turkey hunters before and during COVID-19 in Bedford, Giles, Lawrence, Maury, and Wayne counties, south-central Tennessee, 2017–2020.

	Before COVID-19 (2017–2019)			During COVID-19 (2020)		
	n	Mean	SE	n	Mean	SE
Hunter effort (h) for all hunters	1112	31.0	1.1	214	31.6	1.1
Hunter effort (h) per harvested bird for successful hunters	546	26.6	1.1	114	25.4	1.1
Average birds harvested for successful hunters	544	1.5	1.0	113	1.5	1.1
Take per unit effort for all hunters	1094	0.11	0.01	209	0.11	0.01
Average days hunted for all hunters	1099	7.3	1.0	210	7.6	1.1

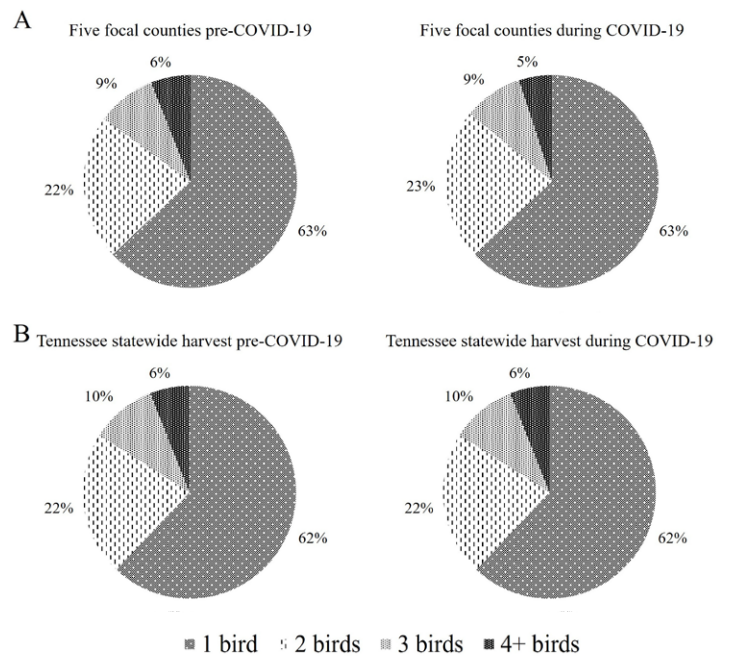


Figure 3. Proportion of hunters that harvested 1, 2, 3, or 4+ birds in A) five focal counties (Bedford, Giles, Lawrence, Maury, and Wayne) pre-COVID-19 and during COVID-19 and B) statewide pre-COVID-19 and during COVID-19 in Tennessee, 2017–2020.

during COVID-19 ($F_{3, 482.0} = 0.23, P = 0.53$). Take per unit effort during the spring hunting season also did not differ before and during COVID-19 ($F_{3, 883.7} = 1.0, P = 0.39$). Hunters reported hunting 7.3 days before COVID-19 and 7.6 days during COVID-19 ($F_{3, 775.7} = 0.83, P = 0.37$) during the spring hunting season. Based on reported harvest in the mail surveys, the proportion of individuals who reported killing 1, 2, 3, or 4+ birds during the spring hunting season was similar before and during COVID-19

(Figure 3A). The Tennessee statewide harvest exhibited the same harvest pattern as well (Figure 3B).

During COVID-19, survey respondents were asked, “Because of the COVID-19 pandemic, my wild turkey hunting in the five focal counties has: a) decreased by _____ trips, b) remained about the same, or c) increased by _____ trips.” Of the hunters who answered this question ($n = 275$), 75% reported their effort did not change, 16% reported their effort increased, and 9% reported their effort decreased. We note that for hunters who responded to the survey over multiple years, this reported change in effort by hunters was only a perceived change, as only 37% of respondents’ hunting effort during the spring hunting season prior to and during COVID-19 accurately reflected their reported change.

Despite reporting yearly turkey harvest values prior to 2017, we only report license sale information from 2017–2020 because of a change in the TWRA system responsible for handling the sale of hunting licenses between 2016 and 2017. The sale of new hunting licenses (resident and non-resident) peaked in 2020 (Figure 4A), whereas the sale of non-resident hunting licenses was at a 4-yr low in 2020 (Figure 4B). The sale of hunting licenses to resident and non-resident returning hunters increased from the previous 3-yr average by 47% in 2020 (Figure 4C).

The original model developed for the path analysis (Figure 2) did not satisfy the goodness-of-fit tests (chi-square summary statistic or CFI) for the spring hunting season either before or during COVID-19. Therefore, additional models were developed using model modification by removing insignificant or unsupported model parameters (Suhr 2008). Before COVID-19 ($\chi^2 = 159.38, df = 18, P < 0.001$), hunter effort during the spring hunting season was more likely to be positively influenced by harvest during the current hunting season ($P < 0.001$) or previous hunting season ($P < 0.001$) compared to the number of gobblers heard ($P = 0.02$) (Figure 5A). Hunter effort during the spring hunting season was negatively related to hunting on public land ($P = 0.01$; Figure 5A). During COVID-19 ($\chi^2 = 56.3, df = 31, P = 0.004$), hunter effort during the spring hunting season was positively influenced by the distance individuals drove to hunt ($P = 0.02$), which was positively influenced by the number of people in their hunting party ($P = 0.03$; Figure 5B). Hunter effort during the spring hunting season also was positively influenced by the previous hunting season harvest ($P = 0.004$; Figure 5B).

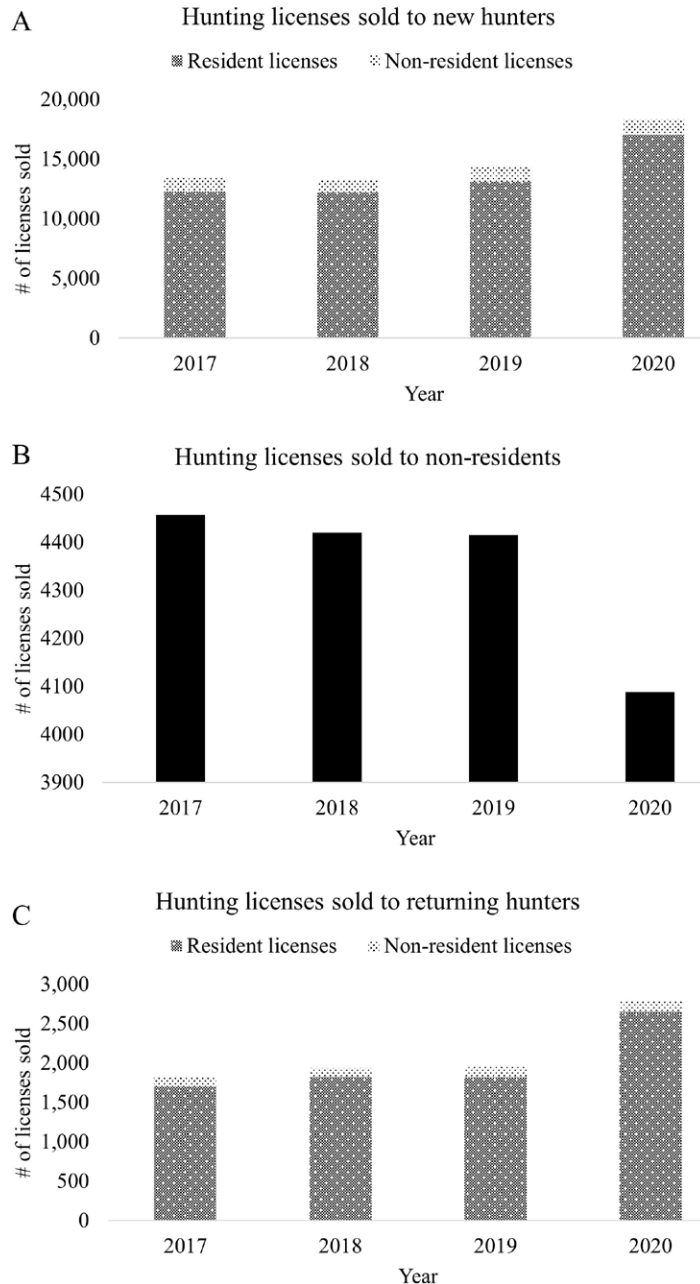


Figure 4. Number of Tennessee hunting licenses sold, 2017–2020, to Tennessee resident and non-Tennessee resident new hunters (A) and returning hunters (C), and overall non-Tennessee resident hunters (B).

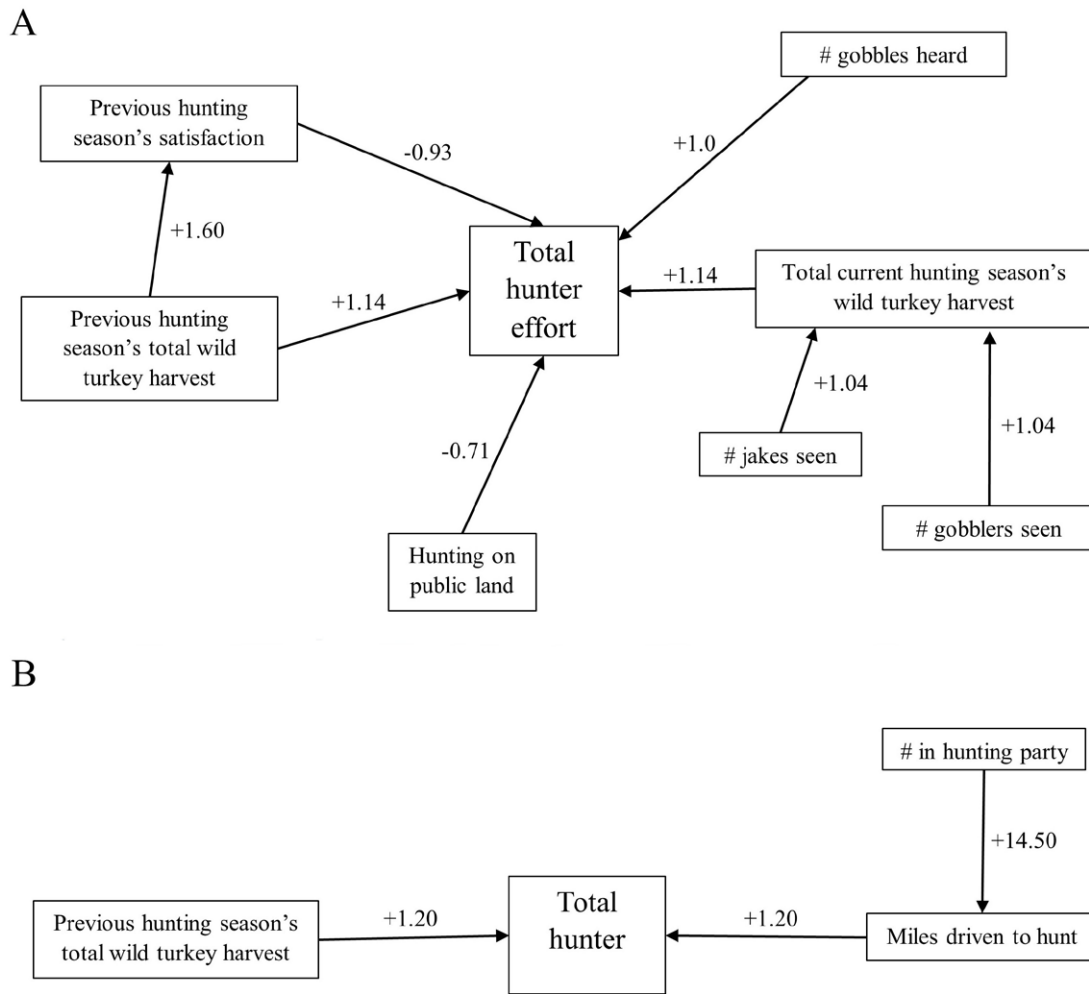


Figure 5. The final path analysis models showing significant ($P < 0.05$) causal relationships for A) before COVID-19 (2017–2019) and B) during COVID-19 (2020) between the variables included in the turkey hunter effort survey and hunter effort, Tennessee, 2017–2020. The direction and power (+ or -) of the causal relationships are indicated by the direction of the arrows and their associated signs.

Discussion

Hunter Satisfaction and Behavior in Response to COVID-19

The increased turkey harvest in Tennessee during COVID-19 (2020) was caused by an influx of ~25,000 new and returning hunters, not increased effort of every-year hunters because of more time resulting from lockdown restrictions. The influx of new and returning hunters in 2020 resulted in a 26.1% increase in license sales above the 3-yr license sale average (2017–2019), which equated to a 27.8% increase in the 2020 harvest above the 3-yr harvest average (2017–2019). Overall hunter effort, success, take per unit effort, and days afield of existing hunters in south-central Tennessee during the spring hunting season did not change during COVID-19. In contrast to our results, Danks et al. (2022) reported a nationwide decrease in take per unit effort for turkey hunters, suggesting increases in harvest in 2020 were a result of lockdown

protocols. Chizinski et al. (2021) reported a reduction in non-resident turkey hunters in Nebraska because the state suspended the sale of non-resident licenses attempting to minimize travel and the spread of COVID-19. This contradiction highlights the variation among states and regions, emphasizing the importance of conducting local studies.

Some turkey researchers expected hunter effort to increase because of the COVID-19 lockdown protocols (Goldman 2020, Chizinski et al. 2021, Danks et al. 2022). The every-year hunters in our study shared this expectation. However, such changes in hunter effort were only perceived by hunters and not actually reflected in the overall hunter effort survey responses. This perceived change is most likely a result of the high level of news and social media coverage of the COVID-19 lockdown protocols that repeatedly highlighted the unusual amount of free time that some

individuals suddenly had and the desire to occupy this time with more solitary, outdoor activities.

Although there were no significant changes in hunter satisfaction or behavior during the spring hunting season in Tennessee resulting from COVID-19, there was a shift in hunter motivation. Prior to COVID-19, hunter effort during the spring hunting season was driven by measurable hunting standards—the number of gobbles heard, current and previous season harvest, and land type hunted (public or private). During COVID-19, the only measurable hunting standard influencing hunter effort during the spring hunting season was the hunter's previous hunting season harvest. In addition to the previous season harvest, total miles driven to hunt positively influenced hunter effort during COVID-19. This shift in drivers of hunter effort highlights a change in the mindset of hunters during COVID-19. During COVID-19, hunters were possibly hunting more out of a desire to spend time outdoors and be active, rather than the more traditional goal of harvesting a turkey.

If the hypothesis was true that during COVID-19 hunters spent more time hunting and that directly translated into more birds being harvested, we would have expected an increase in the proportion of hunters who harvested 3 or 4+ birds compared to previous years, as individual hunters should have harvested more birds with their extra time to hunt. However, the proportion of hunters who killed 1, 2, 3, or 4+ turkeys during COVID-19 was identical to previous years. While it could be argued that these proportions did not change because the availability of turkeys to harvest did not change (i.e., turkey populations were not increasing; Chizinski et al. 2021), we believe the proportions did not change because the high influx of new and returning hunters entering the sport of turkey hunting apparently were as successful in harvesting turkeys as the existing hunters were. The increase of successful new and returning hunters is important for turkey hunting as it has been shown that seeing and successfully harvesting an animal increases hunter satisfaction, and hunters with higher satisfaction are more likely to continue in the sport (Gigliotti 2008, Mehmood 2011).

There was concern that the elevated harvest in 2020 may have contributed to further population decline. However, the Tennessee turkey harvest during 2021, 2022, and 2023 indicated the 2020 harvest did not adversely affect the population of males. In Tennessee, 32,770 birds were harvested in 2021, 30,000 birds were harvested in 2022, and 31,912 birds were harvested in 2023. The average harvest of these years was greater than the 3- and 5-yr pre-COVID-19 harvest averages. These data indicate that despite a concern about declining turkey populations, the turkey population in Tennessee was robust enough to withstand a record-high harvest without immediate negative repercussions. The data also

indicate the increased harvest in 2020 was positive for the sport of turkey hunting. Multiple studies have reported declining hunter population (Larson et al. 2014, USFWS and USCB 2018, RM/NSSF 2017, Bakner et al. 2022). Additional time resulting from COVID-19 lockdowns may have stimulated new and returning hunters that otherwise would not have participated in hunting or purchased a license. In Tennessee, the increase in hunter numbers that was seen during COVID-19 was maintained throughout the 2021 and 2022 hunting seasons (TWRA, unpublished data).

Our survey indicated hunters in south-central Tennessee were concerned about the declining turkey harvest, and the possibility that the declining harvest was the result of turkey population decline. Despite these concerns, hunters' willingness to support a change in season regulations or to change their own hunting activities was minimal. Hunters were supportive of lowering bag limits, but over two-thirds reported they would not stop turkey hunting even if turkey populations declined. This response suggests hunters place more value on the act or challenge of hunting and being in nature than successfully harvesting a turkey. Watkins et al. (2018) reported approximately 50% of hunters in Tennessee could be classified as "social harvesters" who put more importance on the overall challenge of hunting and knowing their peers also are hunting. Wynveen et al. (2005) reported interacting with wildlife (turkey and other wildlife species) while hunting was a top predictor of overall hunt quality. If state wildlife agencies wish to maintain hunter participation in the sport and hunter trust in the agency, they should use this information when setting hunting season regulations.

Management Implications

The turkey population in Tennessee was robust enough to withstand increased harvest during COVID-19 as hunter-reported harvest returned to pre-COVID-19 levels in 2021–2023. State wildlife agencies should continue to carefully consider potential emergency hunting season modifications in response to these unusual situations. State wildlife agencies should work to balance hunter safety and health with the resources being impacted and the money (agency and community) generated from that hunting season. Our survey indicates hunter attitudes and levels of satisfaction may differ from those in other regions, and this difference likely is strongly influenced by differences in turkey populations and harvest rates. Ideally, state wildlife agencies should rely on data collected in their state and region when responding to unusual societal situations that may affect hunting seasons.

Acknowledgments

We thank the TWRA for major funding for the study. Additional funding was provided by the National Wild Turkey Federation.

Literature Cited

- Bakner, N. W., H. T. Pittman, R. D. Shields, J. D. Wood, N. A. Morales, J. N. Rumble, and A. Leal. 2022. Characteristics, attitudes, and motivations of hunting mentors in Florida. *Human Dimensions of Wildlife* 46:e1275.
- Bergquist, S., T. Otten, and N. Sarich. 2020. COVID-19 pandemic in the United States. *Health Policy and Technology* 9:623–638.
- Bond, B. T., G. D. Balkom, C. D. Baumann, and D. K. Lowrey. 2012. Thirty-year case study showing a negative relationship between population and reproductive indices of eastern wild turkeys in Georgia. *Georgia Journal of Science* 70:164–171.
- Byrne, M. E., M. J. Chamberlain, and B. A. Collier. 2015. Potential density dependence in wild turkey productivity in the southeastern United States. *Proceedings of the National Wild Turkey Symposium* 11:329–351.
- Chamberlain, M. J., M. Hatfield, and B. A. Collier. 2022. Status and distribution of wild turkeys in the United States in 2019. *Wildlife Society Bulletin* 46:e1287.
- Chizinski, C. J., M. P. Gruntorad, J. J. Lusk, L. R. Meduna, W. M. Inselman, and J. J. Fontaine. 2021. The influence of the COVID-19 pandemic on spring turkey hunting. *Journal of Wildlife Management* 86:e22202.
- Danks, Z. D., M. V. Schiavone, A. B. Butler, K. Fricke, A. Davis, and D. T. Cobb. 2022. Effects of the COVID-19 pandemic on 2020 spring turkey hunting across the United States. *Wildlife Society Bulletin* 46:e1294.
- Dickson, J. G. 2001. *Wildlife of Southern forests: habitat and management*. Hancock House Publishers, Blaine, Washington.
- Dillman, D. A. 2007. *Mail and internet surveys: the tailored design method* (2nd edition): 2007 update with new internet, visual, and mixed-model guide. Wiley, Hoboken, New Jersey.
- _____, J. D. Smyth, and L. M. Christian. 2014. *Internet, phone, mail, and mixed-mode surveys: the tailored design method*. Fourth edition. Wiley, Hoboken, New Jersey.
- Eriksen, R. E., T. W. Hughes, T. A. Brown, M. D. Akridge, K. B. Scott, and C. S. Penner. 2015. Status and distribution of wild turkeys in the United States: 2014 status. *Proceedings of the National Wild Turkey Symposium* 11:7–18.
- Frey, S., M. Conover, J. Borgo, and T. Messmer. 2003. Factors influencing pheasant hunter harvest and satisfaction. *Human Dimensions of Wildlife* 8:277–286.
- Gigliotti, L. M. 2008. A classification scheme to better understand satisfaction of Black Hills deer hunters: the role of harvest success. *Human Dimensions of Wildlife* 5(1):32–51.
- Goldman, J. G. 2020. Pandemic-fueled surge in wild turkey hunting tests declining populations. <<https://www.audubon.org/news/pandemic-fueled-surge-wild-turkey-hunting-tests-declining-populations>> Accessed 20 May 2021.
- Hammit, W. E., C. D. McDonald, and F. P. Noe. 1989. Wildlife management: managing the hunt versus the hunting experience. *Environmental Management* 13:503–507.
- Harper, C. A., C. E. Shaw, J. M. Fly, and J. T. Beaver. 2012. Attitudes and motivations of Tennessee deer hunters toward quality deer management. *Wildlife Society Bulletin* 36:277–285.
- Hazel, K. L., E. E. Langenau, and R. L. Levine. 1990. Dimensions of hunting satisfaction: multiple-satisfactions of wild turkey hunting. *Leisure Sciences* 12:383–393.
- Heberlein, T. A. and W. F. Kuentzel. 2002. Too many hunters or not enough deer? Human and biological determinants of hunter satisfaction and quality. *Human Dimensions of Wildlife* 7:229–250.
- Kerr, G. N. 2017. Big game hunting satisfaction: a test of diminishing marginal satisfaction of harvest. *Land Environment and People, LEaP Research Report 45*, Lincoln University, New Zealand.
- Larson, L. R., R. C. Stedman, D. J. Decker, W. F. Siemer, and M. S. Baumer. 2014. Exploring the social habitat for hunting: toward a comprehensive framework for understanding hunter recruitment and retention. *Human Dimensions of Wildlife* 19:105–122.
- Liu, P., P. Beeler, and R. K. Chakrabarty. 2020. COVID-19 progression timeline and effectiveness of response-to-spread interventions across the United States. *medRxiv* 1:1–14.
- Lleras, C. 2005. Path analysis. *Encyclopedia of Social Measurement* 3:25–30.
- Mehmood, S., D. Zhang, and J. Armstrong. 2003. Factors associated with declining hunting license sales in Alabama. *Human Dimensions of Wildlife* 8:243–262.
- Potter, D. R., J. C. Hendee, and R. N. Clark. 1973. Hunting satisfaction: game, guns, or nature. Pages 62–71 in J.C. Hendee and C. Schoenfield, editors. *Human dimensions in wildlife programs*. Mercury Press, Washington, D.C.
- Responsive Management/National Shooting Sports Foundation (RM/NSSF). 2017. *Hunting, fishing, sport shooting, and archery recruitment, retention, and reactivation: a practitioner's guide*. Harrisonburg, Virginia.
- Rutledge, P. E. 2020. Trump, COVID-19, and the war on expertise. *American Review of Public Administration* 50:505–511.
- Shields, R. 2023. *Annual wild turkey status report: 2022*. Tennessee Wildlife Resources Agency Wildlife Technical Report 23-01, Nashville.
- Shrestha, S. K. and R. C. Burns. 2012. Big game hunting practices, meanings, motivations, and constraints: a survey of Oregon big game hunters. Pages 1–8 in C. L. Fisher and C. E. Watts, Jr., editors. *Proceedings of the 2010 Northeastern Recreation Research Symposium*. U.S. Forest Service General Technical Report NRS-P-94, Newtown Square, Pennsylvania.
- Suhr, D. 2008. *Step your way through path analysis*. University of Northern Colorado report, Greeley.
- Tapley, J. L., R. K. Abernethy, M. Hatfield, and J. E. Kennamer. 2011. Status and distribution of the wild turkey in 2009. *National Wild Turkey Symposium* 10:19–30.
- Tennessee Wildlife Resource Agency (TWRA). 2021. *Season regulations*. <<https://www.tn.gov/twra.html>> Accessed 28 August 2021.
- _____. 2022. *TWRA Hunter's Toolbox, wild turkey harvest reports*. <<https://huntertoolbox.gooutdoorstennessee.com/>> Accessed 23 July 2022.
- TN Office of the Governor. 2023. *COVID-19 timeline*. <<https://www.tn.gov/governor/covid-19/covid19timeline.html>> Accessed 1 September 2023.
- U.S. Fish and Wildlife Service and U.S. Census Bureau (USFWS and USCB). 2018. *2016 national survey of fishing, hunting, and wildlife-associated recreation*. Report FHW/16-NAT (RV). USFWS and USCB, Washington, D.C.
- Vaske, J. J. 2008. *Survey research and analysis: applications in parks, recreation, and human dimensions*. Venture Publishing, State College, Pennsylvania.
- Velavan, T. P. and C. G. Meyer. 2020. The COVID-19 epidemic. *Tropical Medicine and International Health* 25:278–280.
- Watkins, C., N. C. Poudyal, C. Caplenor, D. Buehler, and R. Applegate. 2018. Motivations and support for regulations: a typology of eastern wild turkey hunters. *Human Dimensions of Wildlife* 23:433–445.
- Wynveen, C. J., D. A. Cavin, B. A. Wright, and W. E. Hammit. 2005. Determinants of a quality wild turkey hunting season. *Environmental Management* 36:117–124.