Changes in Hunter Behavior, Success, and Satisfaction in Relation to Wild Turkey Season Opening Dates and Season Length

Joseph O. Quehl[1], *University of Tennessee-Knoxville, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

Lindsey M. Phillips, *University of Tennessee-Knoxville, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

Vincent M. Johnson[2], *University of Tennessee-Knoxville, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

Craig A. Harper, *University of Tennessee, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

Neelam C. Poudyal, *University of Tennessee-Knoxville, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

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

David A. Buehler[3], *University of Tennessee-Knoxville, 427 Plant Biotechnology Building, 2505 E.J. Chapman Drive, Knoxville, TN 37996*

Abstract: Many states throughout the range of wild turkeys (*Meleagris gallopavo*) have delayed their spring wild turkey hunting seasons to allow reproductively active males more time to breed before being harvested and to potentially increase population fecundity rates. Six states in the Southeast recently delayed their spring hunting season by 7 to 14 days. However, there are no published data indicating their previous season frameworks had a deleterious effect on wild turkey reproduction or that delaying the season increased fecundity. In addition to potentially affecting turkey reproduction, changing the season framework may impact hunter behavior (effort and efficiency), success, and satisfaction. Our objective was to see how hunter effort, success, efficiency, and satisfaction changed upon implementing a two-week season delay and a two-week reduction in season length to the spring wild turkey hunting season in south-middle Tennessee. We surveyed 2000 hunters in five focal counties from 2017 to 2022 to document effort, success, efficiency, and satisfaction among hunters. We surveyed the same respondents for all six years and received a total of 2539 surveys with a 22% response rate. We used a two-level structural model with generalized linear models for panel data to assess changes in hunter effort and experience, and then determined how the shift in season framework affected satisfaction. Hunter effort in the delayed counties declined 42% after the delay, and the average number of gobbles heard per trip decreased 39%. Harvest was not affected by the season delay, but hunter efficiency improved 37% following the delay. Hunter success, hunter efficiency, and gobbles heard were strong positive predictors of hunter satisfaction. Our survey highlights how hunter satisfaction should be considered when setting spring hunting season regulations because changes could have a negative impact on satisfaction and therefore, potentially impact agency goals related to hunter participation, retention, and recruitment.

Key words: hunter effort, hunter survey, hunting regulation changes, hunting season start date

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Hunter satisfaction with hunting seasons can strongly influence hunter recruitment and retention (Mehmood et al. 2003, Fulton and Manfredo 2004, Brunke and Hunt 2008, Everett and Nelson 2016) and is not driven only by success (Schroeder et al. 2019, Gruntorad et al. 2020). Hunter satisfaction can be impacted by sociocultural factors, such as tradition or comradery, and experiential factors, such as harvesting game (Hayslette et al. 2010, Watkins et al. 2018). Because conservation dollars are generated through license sales, which can be used to manage wild turkeys (*Meleagris gallopavo*) and many other species, state agencies and other stakeholder groups need to understand the factors that drive hunter satisfaction to generate revenue for conservation and provide high-quality hunting opportunities.

The number of wild turkey hunters has declined in terms of license sales. Chamberlain et al. (2022) reported a 16% decline in spring wild turkey license sales nationwide from 2013 to 2019. In 2016, the national survey of fishing, hunting, and wildlife recreation reported there were 2 million wild turkey hunters that accounted for 13 million hunter days, which is second only to deer hunters (8.1 million hunters and 133 million hunter days, USFWS and USCB 2018). There also was a 25% decline in annual revenue generated from hunting 2011 to 2016 (USFWS and USCB 2018).

1. Current address: Pheasants Forever, 130 Southgate Drive, Aiken, MN 56431
2. Current address: West Virginia Division of Natural Resources, 324 4th Ave. South Charleston, WV 25303
3. E-mail: dbuehler@utk.edu

Table 1. Hypothesized effects that a delay of the spring wild turkey hunting season would have on hunters from south-middle Tennessee, 2017–2022.

Metrics	Hypothesized effect on hunters	Justification
Hunter effort	Decrease	There are 14 fewer days in the hunting season for delayed counties and hunters may hunt elsewhere during that time period.
Hunter efficiency	Increase	Males will be more responsive to calls later in April because more hens have begun incubating a nest.
Toms seen per trip	Decrease	Birds might be gobbling less during this time of year and subsequently they may be more difficult to hunt.
Gobbles heard per trip	Decrease	A later hunting season may exclude peak gobbling.
Jakes seen per trip	Increase	The basis behind the hypothesis of a later start date is that there is a reproductive benefit to starting to hunt later in the breeding season, therefore this would increase the number of jakes each year.
Hunter satisfaction	No change	A negative association with gobbles heard and a positive association with hunter efficiency would result in no direct effect on hunter satisfaction as they would cancel each other out.

The decline in hunters and revenue is of concern to state wildlife agencies.

Experiential factors can influence hunter satisfaction, such as harvesting game, opportunities to harvest game, and seeing game (Brunke and Hunt 2008, Ryan and Shaw 2011, Gruntorad et al. 2020). Declining game population sizes also can negatively affect harvest rates (Roberts and Crimmins 2010), potentially reducing hunter satisfaction. Watkins et al. (2018) reported 65% of wild turkey hunters in Tennessee were concerned about a potential decline in the wild turkey population. This perceived decline was supported by Byrne et al. (2015) who reported a general decline in poult-per-hen ratios throughout the Southeast since 1990. In addition to the decline in turkey hunter participation, there is concern that the decline in wild turkey productivity is resulting in declining wild turkey numbers. Johnson et al. (2022) monitored productivity in south-middle Tennessee from 2017 to 2018 and reported relatively low estimates of initial nesting rates (nesting rate = 0.76) and nest success (nest success = 0.31), further suggesting productivity of wild turkeys is low in that area of Tennessee.

A hypothesis about the cause of the decline in productivity is that an early start to the spring turkey hunting season is negatively impacting productivity by harvesting males before they have a chance to breed, disrupting the flock's social hierarchy, and lowering male density too early in the breeding season (Isabelle et al. 2018). Six Southeastern states (Alabama, Arkansas, Georgia, Louisiana, Oklahoma, and Tennessee) have delayed their hunting seasons in response to this hypothesis. However, a later hunting season could negatively impact hunter experiences if the season is misaligned with peak gobbling. Gobbles heard has been identified as a leading factor associated with turkey hunter satisfaction (Wightman et al. 2019, Gruntorad et al. 2020, Wakefield et al. 2020). Therefore, a later hunting season may negatively impact hunter satisfaction if peak gobbling activity no longer occurs during the hunting season.

From 1986 through 2020, the Tennessee spring wild turkey hunting season began on the Saturday closest to 1 April. For the 2021 and 2022 spring wild turkey hunting seasons, the Tennessee Fish and Wildlife Commission voted to delay the spring turkey hunting season start date and reduce the season length by 14 days in Giles, Lawrence, and Wayne counties because of perceived population declines and to determine if delaying the season might increase reproduction and ultimately wild turkey population size. Our objective was to investigate how a 14-day delay in the season start date and a shortening of the spring wild turkey hunting season affected hunter effort (hours spent hunting), hunter success (number of turkeys harvested), hunter efficiency (hours spent to harvest a bird), and hunter satisfaction. We tested three specific hypotheses relative to hunter behavior and the season delay (Table 1):

1. Hunter effort would decrease because the season was delayed and reduced from 44 to 30 days.
2. Hunter success/efficiency would increase because male turkeys would be more responsive to calling in mid-April as more hens begin incubating.
3. Hunter satisfaction would remain the same because although hunter efficiency may increase (hypothesis #2), and thus increase hunter satisfaction, decreased gobbling activity, the shorter, delayed season, and reduced effort (hypothesis #1) would potentially decrease hunter satisfaction simultaneously.

Study Area

Our study area was five counties in south-middle Tennessee: Bedford, Giles, Lawrence, Maury, and Wayne. These five focal counties offered a mix of rural and urban communities with human population sizes ranging from 16,427 to 102,878, with 49.1% of the population male and 50.9% female (TDLWD 2022). The demographic characteristics of our respondents (Table 2) were typical for Tennessee turkey hunters (Watkins et al. 2018; R. Shields, Tennessee Wildlife Resource Agency, unpublished data). We chose to include the five focal counties in our study because spring turkey harvest in Giles, Lawrence, and Wayne counties (hereinafter, "delayed counties") had declined by >50% from 2005–2015, and

Table 2. Demographic information of the wild turkey hunters in Bedford, Giles, Lawrence, Maury and Wayne counties, Tennessee, that responded to our survey at least once from 2017 to 2022.

	2017		2018		2019		2020		2021		2022		Overall	
Group	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	**n**	%
Age (yr)														
≤45	234	43.5	138	38.4	94	33.7	89	32.2	55	33.1	42	30.0	652	37.1
46–60	241	44.8	164	45.7	129	46.2	123	44.6	61	36.7	53	37.9	771	43.9
61–70	57	10.6	55	15.3	50	17.9	57	20.7	45	27.1	38	27.1	302	17.2
71–80	4	0.7	2	0.6	6	2.2	7	2.5	2	1.2	7	5.0	28	1.6
>81	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	1	0.1
NA[a]	2	0.4	0	0.0	0	0.0	0	0.0	2	1.2	0	0.0	4	0.2
Gender														
Male	505	93.9	341	95.0	262	93.9	255	92.4	156	94.0	128	91.4	1647	93.7
Female	22	4.1	12	3.3	11	3.9	10	3.6	5	3.0	8	5.7	68	3.9
NA[a]	11	2.0	6	1.7	6	2.2	11	4.0	5	3.0	4	2.9	43	2.4
Income (US$)														
<50,000	163	30.3	83	23.1	62	22.2	58	21.0	27	16.3	33	23.6	426	24.2
50,000–99,999	188	34.9	135	37.6	108	38.7	95	34.4	52	31.3	31	22.1	609	34.6
100,000–149,999	92	17.1	60	16.7	50	17.9	41	14.9	37	22.3	33	23.6	313	17.8
150,000–199,999	26	4.8	18	5.0	11	3.9	25	9.1	9	5.4	7	5.0	96	5.5
200,000–249,999	4	0.7	3	0.8	6	2.2	2	0.7	2	1.2	2	1.4	19	1.1
≥250,000	9	1.7	7	2.0	7	2.5	6	2.2	6	3.6	6	4.3	41	2.3
NA[a]	56	10.4	53	14.8	35	12.5	49	17.8	33	19.9	28	20.0	254	14.4
Total	538	30.6	359	20.4	279	15.9	276	15.7	166	9.4	140	8	1758	

a. Declined to answer.

harvest in Bedford and Maury counties ("no-delay counties") were stable or increasing during the same period.

Tennessee has a spring wild turkey hunting season in all counties. In select counties, there is a fall hunting season. During the spring and fall turkey hunting seasons, only bearded turkeys can be harvested which include adult males (toms), juvenile males (jakes), and bearded hens. From 2017 to 2020 the spring bag limit was four bearded turkeys for all counties in Tennessee, but in 2021 and 2022 the bag limit was reduced from four to three for the five focal counties.

In 2022, there were approximately 95,905 wild turkey hunters (resident and non-resident hunters included) in Tennessee (R. Shields, unpublished data). Based on license sales from 2022, there were 23,650 hunters (24.7% of TN hunters) living in the five focal counties with a license enabling them to turkey hunt. During our study period there were 30,000–40,000 turkeys harvested each year in Tennessee, and 2550 birds were killed in the five focal counties in 2022, which represented 8.9% of the 2022 statewide harvest (Tennessee Wildlife Resource Agency, unpublished data).

Methods

We conducted a spring turkey hunter survey every year from 2017 to 2022. We randomly selected 1600 people (320 per county) who lived in one of the five focal counties and had a license to hunt wild turkeys in Tennessee. We also randomly selected 400 additional people (80 per county) who reported harvesting a bird in one of the five focal counties to ensure our sample contained successful hunters, unsuccessful hunters, and non-resident hunters. These same 2000 individuals who were randomly selected in 2016 were surveyed each consecutive year unless they specifically asked to be removed from the survey mailing list.

Our survey included 30–38 questions annually and was arranged in four sections. The first section focused on the hunter's current turkey hunting season in Tennessee. The second section assessed their opinions surrounding spring turkey hunting regulations. The third section documented their perceptions of turkey populations in the five focal counties, and the last section requested demographic information. Our surveys were modeled after Watkins et al. (2018), and questions in each section were modified each year to accommodate new regulatory changes, incorporate new researcher hypotheses, or address respondent confusion about specific questions.

The mailing protocol for our survey followed Dillman (2006). Surveys were mailed to respondents within ten days of the close of the spring turkey hunting season. We included a cover letter with the survey which outlined the purpose of the survey with

a pre-paid postage envelope to return the completed survey. We mailed a reminder postcard 1 wk after the initial mailing if we had not received a completed survey. We mailed an additional copy of the survey with a reminder letter if we had not received a completed survey 2 wk after sending the initial survey and cover letter. All mailings and surveys were conducted with an approved University of Tennessee Institutional Review Board human subjects research protocol (#UTK IRB-17-03689-XM).

Statistical Analysis

We calculated hunter effort and birds seen or heard on a per trip basis where a trip was defined as one individual leaving their place of residence to go hunting and returning. A hunter could have more than one trip per day if they returned home and went hunting again later that day. We derived hunter effort by taking the number of trips spent hunting in each county and multiplying it by the average time spent per trip. We calculated hunter efficiency by dividing the hunter's effort by the number of birds harvested which resulted in a metric of hours spent per harvested bird. Hunter success was the number of birds harvested by a hunter in a season. Each respondent reported the number of jakes and number of toms they saw, and how many individual gobbles they heard, on a typical trip. A typical trip was defined by the hunter and their experiences. We removed some surveys because of incomplete answers or individuals who reported implausible responses (e.g., a trip >24 hours, seeing >50 jakes or toms per trip, the number of gobbles heard per trip >200).

Our study was designed as a before-after (2017–2020, 2021–2022), control-impact (no-delay, delay) study (Smokorowski and Randall 2017). We used generalized linear models for panel data to maintain the longitudinal nature of the study which allowed responses to vary by the start date of the spring hunting season (Fulton and Manfredo 2004, Bartolucci et al. 2015). The models were run in a structured modeling framework with two levels of analysis (Fulton and Manfredo 2004, Watkins et al. 2021). The structured model framework allowed the assessment of the direct effects of the season delay (Level 1) and potential indirect effects of the season delay on hunter satisfaction (Level 2).

In Level 1 analyses, we examined a suite of *a priori* models, with one model per response metric (hunter effort, hunter success, hunter efficiency), and one model per experiential factor (toms seen per trip, gobbles heard per trip, jakes seen per trip). For each analysis, the independent variables were treatment group (delayed counties vs. no-delay counties) and timing (before the season delay vs. after the season delay). Our hypotheses were tested by evaluating the significance of the interaction between the two independent variables. For hunter effort and efficiency, if a hunter reported effort in both county groups (hunted in a delayed county and a no-delay county) within the same year / survey (11.1% of sample), we treated them as two separate hunters, one who hunted in no-delay counties and one who hunted in delayed counties. Hunter success was modeled with a single model of the number of birds harvested in a season. For each Level 1 analysis, we used a generalized linear model for panel data with a negative binomial distribution, fit with the pglm package (Croissant 2022) in Program R (R Core Team 2022). Additionally, we also assessed the direct effects of the season delay on hunter satisfaction using a generalized linear model for panel data with an ordinal logit distribution.

In our Level 2 analyses, we fit individual models with hunter satisfaction as the dependent variable and the above metrics as the independent variables. Hunter satisfaction was on a self-reported one to three ordinal scale with one being unsatisfied, two being neutral, and three being satisfied. Therefore, for hunter satisfaction analyses, we used a generalized linear model for panel data with an ordinal logit distribution. We tested the parallel assumption of logistic regression using the brant package (Schlegel and Steenbergen 2022) in Program R for all second-level models. We used $\alpha = 0.05$ for assessing significance in all analyses and referred to relationships as 'weak' for $0.05 < \alpha < 0.10$.

As part of our analyses, we checked for non-response and recall bias in our survey results. We checked for non-response bias by comparing hunter metrics (i.e., hunter effort, gobbles heard, and hunter satisfaction) and demographic information (i.e., age, gender, income) of the first 10% to return a response to the last 10% to return a response (Armstrong and Overton 1977, Watkins et al. 2021). We checked for recall bias by comparing the postmark dates of the completed surveys to the end date of the spring turkey hunting season in delayed and no-delay counties.

Results

We received 2539 surveys from 2017 to 2022, with an average of 423 surveys yr^{-1}, providing an average overall response rate of 22.0%. Of these responses, 1763 respondents hunted in one of the five focal counties, with an average of 294 hunters surveyed in our study area each year. If we adjust the response rates for hunters who hunted in these counties, we had a response rate of 15.2% for surveys from 2017 to 2022. After censoring surveys for inaccurate and unlikely responses, we used 1581 hunter surveys for analyses. In our checks for non-response bias, all statistical tests were insignificant except age where no-delay respondents were 7 yr older, on average, but this bias did not affect assignment to age bracket (i.e., 46–60 yr). We documented similar time-to-response rates in delayed and no-delay counties.

We received 562 surveys from hunters who reported hunting

in one of the two no-delay counties with 455 before the season delay (2017–2020) and 107 after the delay (2021–2022). We received 1019 surveys of hunters who reported hunting in a delayed county with 833 before the delay and 186 after the delay. In no-delay counties, we surveyed 342 individual hunters (Before 263 vs. After 79), while in delayed counties we surveyed 604 individual hunters (Before 463 vs. After 141).

Hunter Effort

Hunter effort was not impacted by the season delay in delayed counties, but there was a weak relationship between the two factors ($P = 0.07$), where hunters in delayed counties spent less time hunting throughout the season compared to hunters in no-delay counties (Table 3). Effort declined in all counties from the 2017–2020 hunting season to the 2021–2022 hunting seasons ($\beta = 0.41$ [95% CL: 0.29, 0.53], $P < 0.001$). Delayed-county hunters spent 44.5 (SE = 1.2) h hunting per season and spent 21.9 fewer h, on average, hunting after the season delay (Table 4; Figure 1). Hunters in no-delay counties averaged 38.3 h per season, with a decline of 4.2 h after the delayed season was implemented (Table 4). Hence, delayed counties experienced a 41.5% decline in hunter effort concomitant to an 11.0% decline in no-delay counties.

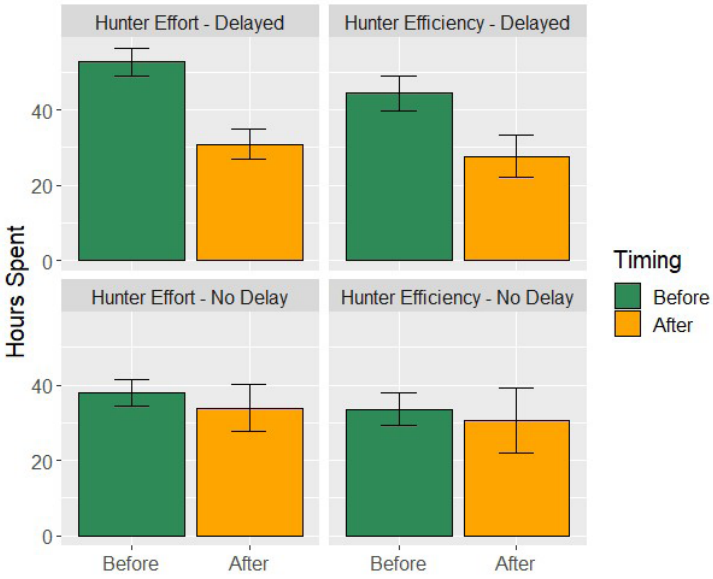

Figure 1. Wild turkey hunter effort (hours spent hunting) and hunter efficiency (hours spent to harvest a bird) during spring hunting season in south-middle Tennessee county groups with and without season delays, before (2017–2020) and after (2021–2022) delays were implemented. Error bars represent 95% confidence intervals.

Table 3. Models (generalized linear models for panel data) of hunter survey data in south-middle Tennessee, with model form, summary statistics, and significance. Timing: dummy variable signifying whether the survey was before (2017–2020) or after (2021–2022) the spring season delay. Treatment: dummy variable denoting whether the survey was from a hunter in a delayed or no-delay county. Bold indicates significant increase ($\beta > 0$) or decrease ($\beta < 0$) associated with season delay (Timing × Treatment models) or significant relationship between hunter satisfaction and predictor variable.

Model	df	β	P
Hunter effort ~ Timing × Treatment	1832	–0.17	0.07
Hunter success ~ Timing × Treatment	1577	–0.19	0.28
Hunter efficiency ~ Timing × Treatment	873	–0.06	0.68
Toms seen per trip ~ Timing × Treatment	1577	–0.25	0.07
Jakes seen per trip ~ Timing × Treatment	1577	0.10	0.54
Gobbles heard per trip ~ Timing × Treatment	1577	**–0.27**	**0.04**
Hunter satisfaction ~ Timing × Treatment	1577	–0.43	0.18
Satisfaction with season delay ~ Timing × Treatment	1630	**–0.84**	**0.004**
Hunter satisfaction ~ Hunter effort	1832	–0.002	0.15
Hunter satisfaction ~ Hunter success	1580	**0.92**	**<0.0001**
Hunter satisfaction ~ Hunter efficiency	873	**–0.01**	**<0.0001**
Hunter satisfaction ~ Toms seen per trip	1580	**0.18**	**<0.0001**
Hunter satisfaction ~ Jakes seen per trip	1580	**0.15**	**<0.0001**
Hunter satisfaction ~ Gobbles heard per trip	1580	**0.03**	**<0.0001**

Table 4. Wild turkey hunter metrics in south-middle Tennessee from 2017 to 2022. Delayed: county group that had a two-week delay in the 2021 and 2022 spring hunting season (Giles, Lawrence, and Wayne counties); No delay: county group without changes to the season start date in 2021 and 2022 (Bedford, and Maury counties). Before: 2017–2020; After: 2021–2022.

	Delayed						No delay					
	Before			After			Before			After		
Metric	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE
Hunter effort	932	52.8	1.9	189	30.9	2.1	587	38.1	1.8	128	33.9	3.2
Hunter efficiency	432	44.4	2.3	85	27.7	2.9	291	33.6	2.2	69	30.6	4.4
Hunter success	833	0.9	0.04	186	0.8	0.07	455	0.9	0.05	107	1.0	0.1
Toms seen	833	2.6	0.1	186	2.4	0.3	455	3.3	0.2	107	4.1	0.4
Gobbles heard	833	9.0	0.5	186	5.5	0.7	455	11.4	0.7	107	13.8	1.9
Jakes seen	833	2.9	0.2	186	3.1	0.5	455	4.1	0.2	107	4.2	0.5
Hunter satisfaction (1–3)	833	1.9	0.03	186	1.8	0.06	455	2.2	0.04	107	2.3	0.08
Season delay satisfaction (1–3)	854	2.2	0.03	201	2.1	0.06	477	2.1	0.04	102	2.4	0.06

Hunter success, efficiency, and experiential metrics

We received 855 surveys from hunters who reported harvesting at least one turkey. Out of the 1581 respondents, 50% reported harvesting zero turkeys per season, 28.3% reported harvesting one bird, 12.1% harvested two birds, and 9.6% harvested ≥ 3 birds per season (representing a season limit of turkeys). Hunter success did not decline because of the later start date in delayed counties (Table 3). Hunters in delayed counties harvested 0.1 fewer birds on average after the season delay, whereas no-delay hunters harvested 0.1 more birds after the delay (Table 4).

Hunter efficiency in delayed counties was not affected by the spring hunting season start date (Table 3) but did increase in the 2021 and 2022 hunting seasons for all counties surveyed ($\beta = 0.32$ [0.14, 0.51], $P < 0.001$). Spring turkey hunters spent 38.1 (SE = 1.4) h on average to harvest one turkey. Hunters in delayed counties reported 16.7 fewer h to harvest a bird after the season delay, a 37.6% decrease (Table 4; Figure 1). Hunter efficiency in no-delay counties also improved after the delay as hunters required 3.0 fewer h (–8.9%; Table 3; Figure 1) to harvest a bird.

The number of birds seen (toms or jakes) per trip by hunters in delayed counties remained similar after the season delay was implemented, but the number of gobbles heard per trip decreased (Table 3). We detected a weak relationship between the number of toms seen per trip and season start date ($P = 0.07$). Delayed-county hunters saw 0.2 fewer toms per trip after the delay (Table 4; Figure 2), whereas hunters in no-delay counties saw 0.8 more toms per trip after the delay (Table 4; Figure 2). Delayed-county hunters heard 3.5 fewer gobbles per trip, and in no-delay counties, hunters heard 2.4 more gobbles per trip (Table 4; Figure 2). In delayed counties, hunters saw 0.2 more jakes per trip after the delay and 0.1 more in no-delay counties (Table 3; Figure 2).

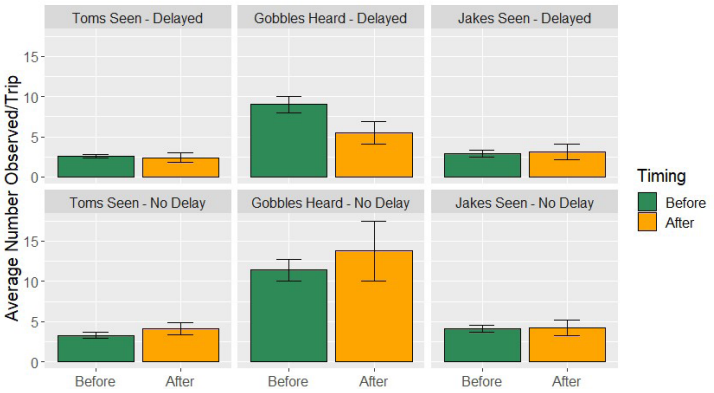

Figure 2. Experiential metrics (number of toms seen per trip, gobbles heard per trip, and jakes seen per trip) by wild turkey hunters during spring hunting season in south-middle Tennessee county groups with and without season delays, before (2017–2020) and after (2021–2022) delays were implemented. Error bars represent 95% confidence intervals.

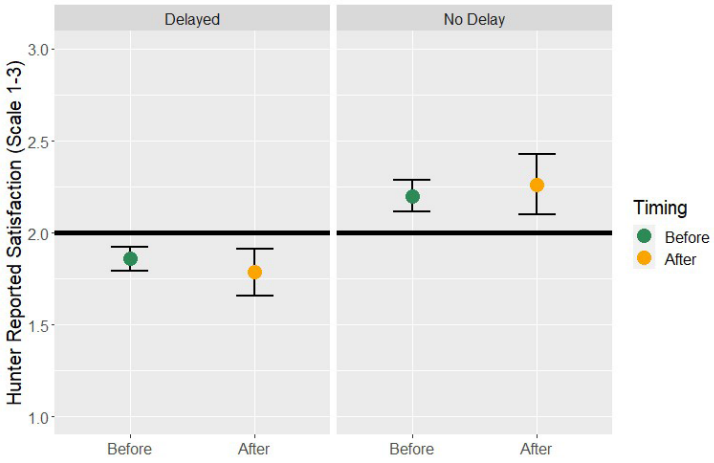

Figure 3. Average wild turkey hunter satisfaction on a 1–3 scale with 1 = "dissatisfied," 2 = "neutral" (thick black line), and 3 = "satisfied" for turkey hunters during the spring hunting season in south-middle Tennessee county groups with and without season delays, before (2017–2020) and after (2021–2022) delays were implemented. Error bars represent 95% confidence intervals.

Hunter Satisfaction

Hunter satisfaction was not directly impacted by the season delay (Table 3; Figure 3), but hunters in delayed counties were less satisfied than hunters in no-delay counties ($P < 0.001$). Hunter satisfaction across all hunters from 2017 to 2022 was 2.0, which equates to a neutral reaction to the hunting season (i.e., neither satisfied or dissatisfied). Hunter satisfaction in delayed counties decreased by 0.1 after the delay and stayed below 2.0, indicating dissatisfaction. Hunter satisfaction of no-delay hunters increased by 0.1 in 2021–2022 and remained above 2.0, denoting satisfied hunters (Figure 3).

Hunter satisfaction was not correlated with hunter effort but was positively correlated with hunter success, hunter efficiency, and all experiential metrics (Table 3). We documented negligible support for the relationship between hunter effort and satisfaction ($\beta = -0.002$ [95% CI: –0.005, 0.001]; Table 3). There was a positive relationship between hunter success and satisfaction where hunters who harvested more birds reported greater satisfaction ($\beta = 0.92$ [0.74, 1.10]; Table 3). An increase in hunter efficiency (i.e., less time required to harvest a bird) resulted in greater hunter satisfaction ($\beta = -0.01$ [–0.015, –0.005]; Table 3). We documented positive relationships with hunter satisfaction and toms seen ($\beta = 0.18$ [0.14, 0.23]), gobbles heard ($\beta = 0.03$ [0.02, 0.04]), and jakes seen ($\beta = 0.15$ [0.11, 0.18]).

From 2017 to 2022, 1634 hunters answered a question about their support for a season delay with 1055 delayed-county hunter surveys (Before 854 vs. After 201) and 579 from no-delay counties (Before 477 vs. After 102). Satisfaction with the regulation change was ranked on a scale of one (unacceptable/dissatisfied)

to three (acceptable/satisfied). Satisfaction with the season delay by delayed-county hunters dropped by 0.1 after the season delay occurred, whereas hunters in no-delay counties increased by 0.3 (Table 4). Satisfaction related to changing the season framework remained in the same category of "neutral" in delayed counties following the delay.

Discussion

Hunter satisfaction was positively correlated with gobbles heard per trip, which was correlated with the timing of the spring hunting season. Hunters were more satisfied with their hunting season if they saw or heard more turkeys or if the birds were easier to hunt successfully (i.e., greater efficiency). Schroeder et al. (2019) and Gruntorad et al. (2020) reported that seeing game had the greatest influence on satisfaction. However, these studies did not measure the impact of hunter effort or efficiency on hunter satisfaction. Hunter effort was not a strong predictor of hunter satisfaction in our study. Most successful turkey hunters in Tennessee harvest only one turkey (50% harvested no birds and 28.3% harvested one bird), so more time spent in the woods often equates to less efficiency (R. Shields, unpublished data). We observed a decline in hunter effort of 42% in delayed counties, but a decline also was observed in control counties (11%). Hours spent hunting was not an important predictor of satisfaction, so the decline in effort likely did not influence hunter satisfaction. The reduction in effort may have been a response to the 14-day season delay, the 14-day reduction in season length, or a combination of both. Hunter success did not change in response to the season delay as hunters in delayed counties harvested the same number of birds (approximately one) before and after the delay. Hunter satisfaction was more strongly related to harvest, which has been documented by others (Fulton and Manfredo 2004, Schroeder 2014, Gruntorad et al. 2020).

Hunter efficiency was a significant predictor of hunter satisfaction but was not explicitly affected by the season delay. We observed changes before and after the season delay in hunter efficiency, but these changes were observed in both county groups. There was a greater increase in efficiency in delayed counties compared to no-delay counties. By opening the season in mid-April, toms are likely more susceptible to calling by hunters because more hens are incubating. The majority of turkey hunters kill only one bird and may quit hunting after harvesting a bird, thus efficiency increased. The increase in hunter efficiency in no-delay counties might have reflected changes in hunting conditions and/or an increase in the number of toms.

Based on our experiential data, fewer gobbles were heard by hunters in delayed counties, whereas hunters in no-delay counties saw and heard more birds. These differences coincided with greater overall satisfaction in no-delay counties. The most substantial change in the experiential metrics was in the number of gobbles heard per typical trip. Hunters reported 39% fewer gobbles per trip in delayed counties, whereas hunters in no-delay counties reported a 21% increase. Previous research has identified factors such as weather (Wightman et al. 2022), changes in population size (Palumbo et al. 2019), and hunter activity (Wakefield et al. 2020, Wightman et al. 2023) as factors influencing gobbling activity. However, we documented no evidence that any of these factors accounted for the differences in gobbles heard between delayed and no-delay counties. Gobbling activity in both county groups was similar prior to the season delay, with hunters reporting 9.0 gobbles per trip in delayed counties and 11.4 in no-delay counties ($P = 0.17$). Therefore, a reduction in gobbling in delayed counties indicates the delayed hunting season began after peak gobbling activity. The decrease in gobbles heard supports our hypothesis that a later hunting season caused hunters to hear fewer gobbles per trip because a later hunting season may not coincide with peak gobbling activity. Gobbling activity (gobbles heard per trip) was correlated with hunter satisfaction similar to results reported elsewhere (Diefenbach et al. 2011, Schroeder 2014, Gruntorad et al. 2020).

We detected a positive relationship between gobbles heard and hunter satisfaction and a negative relationship between gobbles heard and season start date, but we did not see any direct changes to hunter satisfaction. There may be other confounding factors influencing hunter satisfaction that we did not test for such as, perceived population size (Watkins et al. 2018), crowding (Gruntorad et al. 2020) or hunter typology (i.e., appreciative-orientated, affiliation-orientated, and achievement-orientated, Watkins et al. 2018). After the season delay in 2021 and 2022, affected hunters were slightly less satisfied with the regulatory change, whereas hunters in no-delay counties were slightly more satisfied.

Management Implications

Wild turkey management is unique because the wild turkey is the only gamebird species in the U.S. hunted during the breeding season, thereby potentially affecting seasonal productivity negatively. Turkey hunting-season frameworks must be set such that they do not have a deleterious effect on the species' reproductive behavior or population growth. Beyond that, consideration for hunter satisfaction is important to maintain hunter involvement, recruitment, and for some species, management of the population. We documented that a two-week delay in the opening date and a reduction in length of the spring wild turkey season in three counties of south-middle Tennessee did not influence hunter satisfaction directly. However, these regulation changes could indirectly

affect satisfaction, as hunters heard fewer gobbles per trip (negative) and increased their hunter efficiency (positive), both of which are strong predictors of hunter satisfaction. There was a strong perception among turkey hunters in the delayed counties that the turkey population had declined considerably compared to several years prior, and hunters wanted some agency action to reverse the decline (R. Shields, unpublished data). However, after two years of the season delay, hunters in delayed counties were less accepting of the delay, likely because they heard fewer gobbles and did not perceive any net benefit from the delay. Based on our wild turkey productivity study, we documented no increase in productivity in delayed counties after the season delay (Quehl 2023), and in an online survey of hunters in the five focal counties in 2023, 69% said they would prefer the spring turkey hunting season reverted back to its historic framework (2020 and earlier) if there was no reproductive benefit for turkeys. We recommend state agencies use hunter satisfaction data when determining the timing of the hunting season, but primarily consider how the timing of the hunting season may affect reproductive success after analyzing vital rate data in relation to season-opening date and length.

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