

recreation

Comparing the Net Benefit of Forestland Access for Big-Game Hunting across Landownership Types in Georgia, USA

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Big-game hunting is a popular recreation activity on public and private land. No study in the forest economics literature has examined hunting demand by comparing price response and value across different land-ownership classes. By combining travel cost modeling with data collected from a mail survey of licensed big-game hunters, this study estimated and compared the economic value of hunting trips across land ownership types in Georgia, USA. Results indicated that hunting-trip demand was influenced by age, income, retirement status, experience, and the presence of food plots with price response differences across land access types. Hunters on public and nonleased private lands appeared more sensitive to price changes than hunters on leased and personally owned land. The net economic benefit of hunting access varied across access types, with hunting trips to leased and personally owned land yielding more than twice the benefit per trip as nonleased private land or public land. This difference generally increased as travel time costs were factored into the models. Findings will be useful in understanding the net economic benefit of big-game hunting, as well as preferences for and price response to access on hunting lands under different ownership regimes in the Southeast.

Keywords: travel-cost model, leased land, public land, hunting club, wildlife economics, nonmarket valuation

Hunting is a popular activity that contributes positively to the US economy. The US Fish and Wildlife Service, based on their 2011 national survey, reported that 13.7 million Americans hunted in 2011, and expenditures totaling \$33.7 billion consisted of trip (\$10.4 billion), equipment (\$14.0 billion), and other expenditures (\$9.3 billion) such as licenses and lease fees (US Department of the Interior 2011). Consistent with prior national surveys, big-game hunting claimed the most participants (11.6 million) and generated the largest amount of expenditures in 2011 (\$16.9 billion) (US Department of the Interior 2011). Like many other states in the southeastern US, Georgia is a popular hunting destination for both residents and nonresidents. In 2011, an estimated 392,000 residents and nonresidents hunted in Georgia, with 89 percent pursuing big game. Overall, hunting generated \$965 million in total expenditures (US Department of the Interior 2011).

Most hunters in Georgia (87 percent) hunted on some form of private land in 2011, whereas a smaller percentage (22 percent)

hunted on public land (US Department of the Interior 2011). From 1991 to 2011, the percentage of hunters in Georgia who hunted on private land remained stable near 90 percent. During this same period, the percentage of Georgia hunters who hunted on public land ranged from a low of 20 percent in 2001 to a high of 28 percent in 1996 (US Department of the Interior 1991, 1996, 2011). Hunters in Georgia and the Southeast often perceive public land as less desirable because of factors such as congestion and inferior game management (Hussain et al. 2004). In addition, the availability of public hunting land within a reasonable travel distance may be limited for many hunters (Mozumder et al. 2007).

Forest area in the southern states such as Georgia has remained stable for decades. However, factors such as urban sprawl and land-use conversion have decreased the amount of private forestland, and thus available recreation opportunities, in the United States (Best and Wayburn 2013). Kilgore et al. (2008) noted that the amount of private land open free to the public (i.e., not formally leased) for

Manuscript received March 29, 2018; accepted August 2, 2018; published online September 26 2019.

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Acknowledgments: Authors are thankful to USDA Forest Service, Southern Research Station and University of Georgia's Office of Vice President for Research for funding support, and Georgia Department of Natural Resources, Wildlife Resource Division for providing contact addresses of big game hunting license holders in Georgia.

recreation such as hunting has also decreased in recent years. For example, the percentage of private landowners who allowed free access to hunters declined from 25 percent in 1986 to 14.6 percent in 2006 (US Department of Agriculture 2010). This type of access varies considerably by region. For example, free access for traditional recreation like hunting has long been a tradition on private forestlands in the upper Northeast, whereas on private lands in the Southeast, access traditionally has required a fee (Gentle et al. 1999). Daigle et al. (2012) reports that most large private landowners (87 percent) in the Northern Forest, comprising Maine with smaller portions of New Hampshire, New York, and Vermont, allow free public access.

Literature on legal and economic issues surrounding hunting on private land asserts that landowners are often hesitant to provide access without adequate economic incentives or liability protection (Mozumder et al. 2007). However, many states in the Southeast, including Georgia, have landowner liability laws protecting landowners from lawsuits arising from recreational use of private lands. Additional constraints frequently cited include safety concerns, economic conditions, and legal restrictions (Cordell et al. 1999, Zhang et al. 2006).

As free accessibility to private land becomes more restrictive, and hunters seek alternatives to hunting public land, fee or lease hunting on private land has become a popular solution for many hunters, particularly in the Southeast (Mozumder et al. 2007). For instance, the percentage of forest industry land in the southeast leased to hunting clubs and individuals increased from 65 percent in 1994 to 77 percent in 1999 (Marsinko et al. 1998, Morrison et al. 2001). In Georgia, the estimated farm gate market value of hunting leases for white-tailed deer increased slightly from approximately \$93 million in 2002¹ to \$96 million in 2012 (Boatright and McKissick 2003, Wolfe and Stubbs 2013). The significance of lease hunting indicates that hunters are willing to pay a premium for a higher-quality hunting experience (Hussain et al. 2004). For landowners in the Southeast, leasing provides an additional source of income, access control, and reduced property damage because of trespassing (Marsinko et al. 1992, Hussain et al. 2007).

Literature on Hunting-Trip Demand

Previous studies have examined various aspects of big-game hunting economics. These include hunters' preferences for hunting-trip attributes (Gan and Luzar 1993), effect of hunting-site attributes on rural property price (Messonnier and Luzar 1990, Shrestha and Alavalapati 2004, Henderson and Moore 2006), and economic impacts of hunting-related expenditures on local economies (Hussain et al. 2012). Other studies have specifically focused on hunting-trip demand. For example, demand for public hunting sites has been addressed by Bergstrom and Cordell (1991), Creel and Loomis (1990), Creel and Loomis (1992), Luzar et al. (1992), Sarker and Surry (1998), and Hussain et al. (2016). Offenbach and Goodwin (1994) modeled Kansans' trips to their favorite hunting sites, but did not distinguish among land ownership or access types. No prior study has explicitly examined hunting demand by comparing price response and value across different land-ownership types.

Among the studies reported, many have used the travel-cost method to identify factors correlated with trip demand. Hunter age negatively affected trip demand (Bergstrom and Cordell 1991, Offenbach and Goodwin 1994), whereas education and hunting

experience had no effect (Balkan and Kahn 1988, Offenbach and Goodwin 1994). Household income was found to have mixed effects, either increasing (Balkan and Kahn 1988, Creel and Loomis 1990) or decreasing trip demand (Bergstrom and Cordell 1991, Creel and Loomis 1992, Hussain et al. 2016). Bergstrom and Cordell (1991) developed an outdoor recreation index and found that other forms of outdoor recreation could serve as hunting substitutes. However, a number of studies (Balkan and Kahn 1988, Luzar et al. 1992, Sarker and Surry 1998) either did not consider potential hunting substitutes or did not find a statistically significant relationship. Site-specific characteristics such as aesthetics (Offenbach and Goodwin 1994) and amount of prey (deer) seen (Creel and Loomis 1990) were also found to positively affect trip demand.

As human population growth continues, the number of hunting participants is expected to increase despite decreasing hunting participation rates (Bowker et al. 2012). Because of hunting's popularity and economic importance among recreation activities, a greater understanding of hunter preferences and the structure of hunting-trip demand is needed. Though previous studies have examined hunting-trip demand primarily on public land, a gap in the literature exists pertaining to hunting-trip demand to private sites specifically. In addition, prior studies have alluded to a general understanding that site quality impacts hunting-trip demand. For instance, Balkan and Kahn (1988) modeled nationwide hunting-trip demand and concluded that trip demand is sensitive to the quality of hunting, which might differ among access types (Hussain et al. 2004). The only study comparing access value among different types of publicly accessible hunting lands was Knoche and Lupi (2013), which found a comparatively higher per-trip value of hunting trips to state-owned lands than to federal and commercial forests. No other study has explicitly examined the effect of different private and public access options on hunting-trip demand. If hunting-trip demand is structurally different for public and private land access options, the price response and economic value of a hunting trip could vary significantly by access type. In addition, the effect of increasing trip costs or access fees on trip demand could vary significantly by access type user group. Therefore, to increase our understanding of hunter preferences for access types, the objective of this study was to estimate and compare the demand for and value of big-game hunting trips to different land access types in Georgia, including leased land, public land, land owned outright (exclusive free access), and nonleased private land (restricted free access).

Management and Policy Implications

Managers of private and public forestlands in Georgia and Southeastern US may benefit from a better understanding of the determinants of big-game hunting demand on respective lands and in predicting potential change in hunting market relative to site characteristics such as having wildlife food plots and hunter demographics. Results from this study inform how hunters of different access options value their recreational resource and respond to price changes. The considerably large size of benefit estimates associated with hunting on nonleased private land demonstrates that landowners may be able to take advantage of this untapped source of revenue. Managers of public hunting lands in Georgia and Southeastern US may also use the benefit estimates presented in this study as justification in adjusting the price of hunting access permit.

Materials and Methods

Theoretical Basis of the Travel-Cost Method

Valuation of access to outdoor recreation, particularly on public land, can be difficult because of a lack of market clearing prices. Travel-cost modeling (TCM) was initially conceptualized by Hotelling (1949) and later developed by Clawson (1959) to estimate demand and use value for recreation in natural areas using transportation cost as a price proxy. The basic assumption of TCM is that increasing trip costs decrease the number of trips by recreationists to a site, all else being equal (Pearse and Holmes 1993). As a result, trip takers maximize utility by choosing a quantity of trips within their budgetary limits, which may include time and personal preferences. Since the trip costs incurred while visiting a site may be considered a proxy for the price of the services offered by the site, individual trip behavior is affected by a change in travel cost in a manner similar to a change in admission costs (Freeman 2003). From this relationship between travel costs and trips taken, an ordinary demand curve can be derived.

Empirically, the travel-cost method has been applied using two conceptual frameworks: the individual travel-cost method (ITCM) and the zonal travel-cost method (ZTCM). The ZTCM approach models visitation rates as a function of each zone's (e.g., county) travel costs and aggregate population characteristics (Haab and McConnell 2002). ZTCM was designed to use existing information, e.g., entrance permits, aggregate data, county-level population, and demographic characteristics, to model aggregate or market level demand (Hellerstein 1991, Freeman 2003). ZTCM is generally less popular today because interest has grown toward understanding individual (household) behavior and understanding demand at the level of the individual consuming unit (Freeman 2003). The ITCM approach models individual (household) trip demand as a function of individual (household) travel costs, trip substitutes, and demographics, allowing inferences to be made at the individual level. Application of ITCM has been more popular in the hunting literature (Balkan and Kahn 1988, Creel and Loomis 1990, Creel and Loomis 1992, Luzar et al. 1992, Sarker and Surry 1998) than ZTCM (Bergstrom and Cordell 1991). For the present study, ITCM was used as our interest centered on drawing inferences about individual behavior.

Study Area

The study was conducted in the southeastern American state of Georgia where hunters have the opportunity to hunt three legal big-game species: white-tailed deer (*Odocoileus virginianus*), eastern wild turkey (*Meleagris gallopavo*), and American black bear (*Ursus americanus*). However, deer is the most popular game species, as 89 percent of hunters in Georgia pursued deer in 2011 (US Department of the Interior 2011). Many hunters simultaneously hunt feral hogs while deer hunting, or at other times of the year, although hogs are not officially considered a game animal by the Georgia Department of Natural Resources. Georgia was chosen for the study, being typical of the southeastern states and whitetail deer hunting among a mixture of predominantly private land with significant amounts of public land.

Survey and Sampling Design

A mail survey questionnaire was designed and implemented to collect hunting-trip data from licensed big-game hunters in Georgia.

A preliminary survey was pilot-tested among hunters, landowners, wildlife biologists, and private wildlife professionals familiar with big-game hunting and leasing in Georgia. One of the six sections in the survey asked respondents to provide information pertaining to their three most visited hunting sites in Georgia in 2012. Among the possibilities for the sites were hunting clubs, personally leased land, private land owned outright, private land with permitted access, and public land including state operated wildlife management areas (WMAs), National Forests, National Wildlife Refuges, State Parks, National Parks, and US Army Corps of Engineers lands. Although WMAs are primarily managed by the state, ownership of the land can vary among private, state, and federal entities.

The sampling frame included all licensed hunters (resident and nonresident) who had big-game hunting privileges in Georgia in 2012. Private landowners who hunt exclusively on their land are not required to possess a hunting license and could not be included in the sample. A database of 422,663 big-game license holders was obtained from the Georgia Department of Natural Resource (DNR) Wildlife Resource Division to create the big-game hunter sample.² Following Cochran (1977), and similar to Paudyal et al. (2015), a stratified random sampling approach was developed to ensure that the sample was representative of the Georgia big-game hunter population. This sampling procedure first involved determining the percentage of each of the 16 big-game license types out of the total population. Next, individuals from each license type were randomly selected based on their respective license type's share of the total population. The mailing sample consisted of 3,000 licensed Georgia hunters with big-game privileges in 2012. The three most common big-game license types were Resident Big Game (1 year), Resident Sportsman (1 year), and Senior (+65) Lifetime. Resident Big Game (1 year) license holders comprised 43 percent of the sample, whereas Resident Sportsman (1 year) and Senior (+65) Lifetime comprised 15.5 percent and 14 percent of the sample respectively.

The survey instrument was administered following a modified version of Dillman's Total Design Method (Dillman 2007, Daigle et al. 2012). The initial mailing consisted of a survey packet containing a personalized cover letter, the questionnaire, and a business-reply prepaid return envelope. The initial mailing was followed with a postcard reminder approximately three weeks later. A final mail-out to nonrespondents, including a packet with a followup cover letter and a copy of the questionnaire, was sent two weeks after the postcard reminder was mailed. No additional survey mailings or reminders were sent.

Model Specification

Since the objective of this study was to model big-game hunting-trip demand, the dependent variable was defined as the number of reported trips taken in 2012 in Georgia for the primary purpose of big-game hunting. This is consistent with the dependent variable used by various hunting studies (Balkan and Kahn 1988, Creel and Loomis 1990, 1992, Luzar et al. 1992, Sarker and Surry 1998).

Trip data were pooled across multiple sites (Siderelis and Moore 1995, Laymen et al. 1996, Englin and Moeltner 2004, Hesseln et al. 2004) to derive a demand curve. Sample-size concerns associated with separately modeling trip demand by land ownership type were alleviated through the use of a pooled model. In pooled or multisite models, variables differentiating quality across sites or users may be

Table 1. Definition and descriptive statistics of variables used in modeling big-game hunting-trip demand in Georgia in 2012 (n = 807).

Variable	Definition	Mean	SD
Individual TC* (\$)—no wage	Individual unit travel costs (\$) assuming zero opportunity cost of time	14.94	24.25
Individual TC* (\$)—0.25 wage	Individual unit travel costs (\$) assuming 0.25 wage rate opportunity cost of time	24.89	40.49
Trips	Trips taken in 2012 for primary purpose of big-game hunting	16.32	17.81
Own land	1 = hunting site was on individual's property, 0 = otherwise	0.18	0.39
Leased land	1 = hunting site associated with leased land or hunting club, 0 = otherwise	0.33	0.47
NLP† land	1 = hunting site was on relative's or friend's land, 0 = otherwise	0.35	0.48
Public land	1 = hunting site was on public land, 0 = otherwise	0.14	0.35
Lease price	Individual lease price or hunting club dues conditional on having a lease or club (\$)	830.25	704.75
Residence	1 = Georgia resident hunter, 0 = otherwise	0.93	0.25
Food plots	1 = site contained food plots, 0 = otherwise	73.78	0.44
Party size	Typical hunting party size	2.04	0.93
Hunting experience	Years respondent hunted big game in Georgia	28.05	0.13
Age	Respondent's age (years)	49.99	0.13
Retired	1 = retired, 0 = otherwise	0.21	0.40
Population density	Respondent's zip code population density (1,000 people/sq. miles)	0.51	0.84
Household income	Respondent's household income (\$1,000s)	79.93	42.30

*TC indicates travel costs.

†NLP land indicates nonleased private land.

included (Englin and Moeltner 2004, Hesseln et al. 2004). Here, variables differentiating among access to land-ownership types were created. Specific demand shifters included Public land, Own land, Nonleased private land (NLP), and Leased land (Table 1). Own land indicated land owned outright by the hunter, NLP land indicated private land owned by friend or family member of the hunter, and Leased land indicated private hunting land associated with a hunting club or an independently purchased lease. Each access binary variable was interacted with travel cost to accommodate differences in price effects, with Leased land as the reference category.

The individual is the most common unit of consumption used recreation demand studies (Hynes and Greene 2013, Hill et al. 2014). However, the group or traveling party unit specification has been used as well (Edwards et al. 2011, Sardana et al. 2016). With a group specification, individual characteristics or preferences of the surveyed person in the group are assumed to be representative of the group. Though both consumption unit approaches have been used extensively in the literature, the individual approach was specified for the purposes of this paper to derive interpreted consumer surplus estimates more easily.

According to Freeman (2003), a full specification of travel cost includes admission or specific access fees, out-of-pocket round-trip transportation costs to the site, and time costs associated with traveling to and from the site. Since hunters in Georgia typically do not face per-trip admission costs, travel costs for this study were defined as round-trip transportation costs plus round-trip time costs. Fixed costs such as lease price are paid upfront and cannot be considered part of the variable costs for a hunting trip. In some cases, these fixed costs are considered part of longer run demand and omitted completely from the demand model specification (Englin and Moeltner 2004). Though not previously explored in the literature, fixed costs such as lease price may be incorporated into annual consumer surplus estimates using postestimation approaches.

To estimate transportation costs, the 2012 edition of AAA's *Your Driving Costs* (AAA Association Communication 2012) was used to estimate per-mile vehicle operating costs for each trip. The four-wheel-drive SUV vehicle category was chosen to represent the sample because hunters need the ability to transport hunting equipment to and from a hunting site, and AAA did not provide operating-cost information for pick-up trucks. The operating cost per mile for this

category was \$0.248 (AAA Association Communication 2012), the highest among the reported AAA classes. To calculate round-trip transportation costs for each individual, per-mile operating costs were multiplied by round-trip travel distance (in miles) for each observation (Edwards et al. 2011). This product was then divided by the size of each observation's hunting party (Taylor et al. 2004, Hynes and Greene 2013) to obtain individual travel costs.

Most TCM studies account for the opportunity cost of travel time as the product of round-trip travel time and an assumed portion of the individual's or household's wage rate (Haab and McConnell 2002). To specify time costs, round-trip travel time for each observation was first multiplied by a fraction of the individual's household wage rate (Englin et al. 1998, Edwards et al. 2011). This estimate was then divided by the number of individuals of working age in the household (Loomis and McTernan 2014). Following Bowker et al. (1996) and Zawacki et al. (2000), two wage rate multipliers (0 and 0.25) were used. Similar to previous studies (Taylor et al. 2004, Loomis and McTernan 2014), wage rate estimates were obtained by dividing household income by a full time 2,080-h work year. To calculate round-trip travel time for each observation, round-trip travel distance (in miles) was divided by a rate of travel of 50 miles per hour (Zawacki et al. 2000, Taylor et al. 2004).

Additional covariates considered for the pooled hunting site model include Party size, Hunting experience, and Food plots (Table 1). Party size represented the size of the hunting trip traveling unit (Sardana et al. 2016). Hunting experience was used to account for big-game hunting experience, whereas Food plots was used as a general measure of site quality. Similar measures of site quality used in wildlife recreation demand studies include number of deer seen (Creel and Loomis 1990) and amount of available forestland (Rockel and Kealy 1991). To account for possible trip demand differences between resident and nonresident hunters, the binary variable Residence was also included (Hussain et al. 2016).

The specification of substitute variables in the travel-cost literature is highly varied. A common specification involves estimating each observation's travel costs to a potential substitute site (Loomis et al. 2000, Hynes and Greene 2013). However, price or distance information for potential substitute sites is not always available. A number of hunting TCM studies have failed to account for potential substitutes (Balkan and Kahn 1988, Luzar et al. 1992,

Sarker and Surry 1998). As an alternative to specifying the price of substitutes, binary variables have been used to account for substitution behavior (Bowker and Leeworthy 1998). Because of data limitations, only substitutes associated with hunting on different access options were specified.

Following previous studies, socioeconomic variables included Age, Retired, Population density, and Household income (Table 1). Retired has not been previously used in hunting studies and was considered to take into account Georgia's growing population of aging hunters. Population density was used to account for rural vs urban differences in hunter preferences (Tobias and Mendelsohn 1991). Respondents were asked to specify their household income by checking one of seven ordered categories containing different income ranges. Categories were used for respondent convenience over open-ended responses. For analysis, household income was treated as a uniformly continuous variable within each interval, and the midpoint for each income category was employed (Sun et al. 2015).

Empirically, the model specification can be demonstrated using the following formula:

$$\text{Trips}_{ij} = (\text{TC}_{ij} + \text{AccessType}_j + \text{AccessType}_j \times \text{TC}_{ij} + \text{SiteSpecific}_j + \text{Demographics}_i) \quad (1)$$

where Trips_{ij} is the number of big-game hunting trips by the i th individual to site j , TC_{ij} is the travel cost of the i th's individual trip to site j , AccessType_j is the land-ownership type associated with site j , SiteSpecific_j is site-specific information associated with site j such as the presence of food plots, and Demographics_i is a vector of socioeconomic variables associated with individual i such as age, retirement status, and household income. Interacting Access Type and TC allows for price response to differ across land-ownership classes (Bowker and Leeworthy 1998, Zawacki et al. 2000, Loomis 2006). The econometric specification of a complete model is given as:

$$\begin{aligned} \text{Trips} = & B_0 + B_1 \text{TC} + B_2 \text{TC} \times \text{OwnLand} + B_3 \text{TC} \times \text{NLPLand} \\ & + B_4 \text{TC} \times \text{PubLand} + B_5 \text{OwnLand} + B_6 \text{NLPLand} \\ & + B_7 \text{PubLand} + B_8 \text{Residence} + B_9 \text{PartySize} \\ & + B_{10} \text{HuntingExperience} + B_{11} \text{FoodPlot} + B_{12} \text{Age} \\ & + B_{13} \text{Retired} + B_{14} \text{PopulationDensity} \\ & + B_{15} \text{HouseholdIncome} \end{aligned} \quad (2)$$

Estimation Technique

Because of the discrete, nonnegative nature of the dependent variable (i.e., number of trips), count data models have become standard practice for TCM studies (Hynes and Greene 2013, Sardana et al. 2016). With count data models, a discrete probability distribution is assumed for the dependent variable. Popular count data models include Poisson and negative binomial regression. The Poisson's restrictive assumption that the mean and variance are equal generally does not hold with recreation data, where the number of annual visits may be very high for some and low for others, and thus the negative binomial is typically used to account for this overdispersion.

A mail questionnaire was used to obtain information from respondents, so all licensed hunters had an equal chance of being included in the sample, and thus endogenous stratification, common for on-site samples, was avoided. Few respondents reported zero trips, and for those who did, limited information was available

(e.g., distance, management practice, land ownership type, etc.). Hence, only respondents who took at least one trip were included in the estimation sample, which necessitated the use of truncated estimators. Zero-truncated data occur when information on non-participants is unknown, and the probability distribution only applies to values above zero (Zawacki et al. 2000). If an untruncated estimator is used to model truncated data, parameter estimates will be "biased and inconsistent" (Creel and Loomis 1990).

Economic Values

Consumer surplus (CS) can be calculated from the estimated trip demand models. With count data models, a point estimate of per-trip CS is estimated by calculating the negative reciprocal of the travel-cost coefficient (Creel and Loomis 1990). When travel-cost interaction terms are used, per-trip CS associated with the interaction term is estimated using the following formula:

$$\text{CS}_{\text{INT}} = \frac{1}{-(\beta_1 + \beta_{\text{INT}})} \quad (3)$$

where β_1 is the coefficient associated with the trip cost variable, and β_{INT} is the coefficient associated with the respective travel-cost interaction term (i.e., $\beta_2, \beta_3, \beta_4$). Confidence intervals around the CS point estimates can be calculated using the Delta method (Englin and Shonkwiler 1995, Englin and Moeltner 2004).

Estimates of price elasticity from count data models are obtained using the following formula (Bowker et al. 2007):

$$\epsilon_p = \beta_1 \times \overline{\text{TC}} \quad (4)$$

where ϵ_p is the price elasticity, β_1 is the travel-cost coefficient, and $\overline{\text{TC}}$ is the average travel cost. To calculate price elasticity associated with a travel-cost interaction term, the following formula can be used (Bowker and Leeworthy 1998):

$$\epsilon_{\text{INT}} = (\beta_1 + \beta_{\text{INT}}) \times \overline{\text{TC}_{\text{INT}}} \quad (5)$$

where ϵ_{INT} is the price elasticity for the access type, β_1 is the travel-cost coefficient, β_{INT} is the travel-cost interaction coefficient for alternative interaction types (i.e., $\beta_2, \beta_3, \beta_4$), and $\overline{\text{TC}_{\text{INT}}}$ is the average travel cost associated with the subgroup consistent with interaction term. Unlike average per-trip CS, which is static, price elasticity may vary with travel cost.

Results

Survey Responses

Of the 3,000 surveys mailed out, 663 were completed and returned, with 280 returned as undeliverable, netting a response rate of 24 percent. This response rate is consistent with several recent surveys of fishing/hunting license holders as the sampling frame (e.g., Kyle et al. 2007: 20 percent in South Carolina, Paudyal et al. 2015: 24 percent in Georgia, Shideler et al. 2015: 18 percent in Florida). Similar to the survey sample allocation percentages based on license type, 35 percent of respondents possessed a Resident Big Game (1 year) license, 18 percent had a Resident Sportsman (1 year) license, and 12 percent had a Senior (+65) Lifetime license. The population of interest was individuals who hunted big game in Georgia in 2012, so a screener question was used to remove 100 respondents from the sample/analysis who did not hunt big game in 2012.

Survey response rate may be considered an indicator of data quality. A particular concern with low response rates is the potential for nonresponse bias, i.e., the lower the response rate, the less likely the sample accurately represents the population of interest. [Meterko et al. \(2015\)](#), using a high response survey of health care leaders, returned in a number of waves, found no correlation between nonresponse bias and response rate. Similarly, [Groves and Peytcheva \(2008\)](#) performed a meta-analysis of 59 studies of nonresponse bias and found that response rate was not necessarily a good predictor of nonresponse bias.

Some researchers have attempted to look further into this issue by comparing the characteristics of early and late responders (e.g., [Pokharel et al. 2017](#)), but that approach does not, ultimately, collect information from nonresponders themselves. An alternative way to assess nonresponse bias is to attempt to re-sample mail nonrespondents, often by phone, with a set of abbreviated questions on certain characteristics, e.g., age, gender, education, and compare the respondents to nonrespondents across these characteristics ([Kuentzel et al. 2018](#)). We could not feasibly collect information from nonresponders to formally or informally test for bias this way. However, an ad hoc assessment of potential bias may be conducted if sufficient information is already available for the population of interest. Our sample characteristics are similar to those reported for Georgia hunters in the 2011 US Fish and Wildlife Service survey (FWS) ([US Department of the Interior, 2011](#), Table 15). For example, the sample was overwhelmingly male (94 percent to 90 percent FWS), white (98 percent to 95 percent FWS), and nonhispanic (99 percent to 100 percent FWS). Most came from a rural background (65 percent to 64 percent FWS), whereas nearly a third (32 percent to 31 percent FWS) possessed at least a bachelor's degree. The average age was 51 years, and nearly a quarter of the sample (23 percent) indicated they were retired. The FWS reported neither average age nor percentage retired for Georgia hunters, although the FWS reported that 64 percent of hunters were between 45 and 64 years of age. Less than 7 percent of respondents reported a household income less than \$25,000, and 21 percent and 20 percent of respondents specified a household income of \$25,000–\$50,000 and \$50,001–\$75,000 respectively. Nearly 17 percent of respondents specified a household income of \$75,001–\$100,000, 11 percent specified an income of \$100,001–\$125,000, 7 percent specified an income of \$125,001–\$150,000, and 9 percent specified an income of more than \$150,000. Income was not reported by 8 percent of respondents. Measured continuously using category midpoints, respondent average household income was roughly \$79,000. The FWS did not report average household income for Georgia, but the income category with the greatest percentage of respondents was \$75,000 to \$99,999.

Hunting-Trip Demand Dataset

Following previous studies ([Zawacki et al. 2000](#), [Englin and Moeltner 2004](#), [Sun et al. 2015](#)), multiple hunting site entries for each hunter were treated as additional observations. Though this practice greatly increased the number of hunting-site observations, the observations could no longer be considered strictly independent. Similar to [Haab et al. \(2001\)](#) and [Kim et al. \(2007\)](#), missing Household income values were imputed using a log-linear ordinary least-squares regression of household income on age, education, rural origin, and employment. Missing Age values were replaced with age information found in the license database obtained from the Georgia DNR.

Over 93 percent of observations were associated with residents of the state of Georgia. Nearly 6 percent of observations were associated with Florida residents, and the remaining observations were associated with residents of states such as North Carolina and Texas. Preliminary analysis indicated that a number of observations with excessively high travel costs had a considerable influence on results. Excessive travel costs can often be the result of multipurpose trips ([Mendelsohn et al. 1992](#)). Following procedures used by previous studies ([Zawacki et al. 2000](#), [Sun et al. 2015](#)), the top 1 percent of distance observations were removed from the sample. This procedure, in effect, removed each observation containing a round-trip distance greater than 1,000 miles, a procedure suggested by [Hellerstein \(1991\)](#). Observations dropped included ones associated with residents of Florida and Texas. Six observations that contained a very large number of trips taken (greater than 150) were also removed from the sample. Finally, for individuals who hunted on land where they resided, a one-way travel distance of 0.1 miles was added to each observation.

The resulting dataset ($n = 807$) detailing hunting-trip behavior was used to model big-game hunting-trip demand in Georgia. The average number of hunting trips to any site was approximately 16 with a standard deviation of 18 trips ([Table 1](#)). This number of trips is comparable with the FWS estimate for 2011 average annual big-game hunting trips in Georgia of 16.3 ([US Department of the Interior, 2011](#), table 14). Average individual travel costs ranged from \$14.94 to \$34.85. Leased land accounted for 33 percent of the observations and 42 percent of total trips; 18 percent of observations and 22 percent of total trips occurred on the respondent's own land, 35 percent of observations and 27 percent of total trips were on non-leased private land, and 14 percent of observations and 9 percent of total trips in the sample were on public land. The average lease price/club dues was \$830 per year. The average hunting party size was approximately two hunters, and the average big-game hunting experience of each hunter was 28 years. The average licensed hunter age was 50 years, and over 20 percent of the individuals in the sample were retired. The average household income was \$79,930.

TCM Model Results

Tests for overdispersion rejected the null hypothesis that the mean and variance of the dependent variable (trips) were equal, so the truncated negative binomial functional form was used. Estimated Pearson correlations and variance inflation factors indicated that multicollinearity was not an issue. Following [Englin and Moeltner \(2004\)](#), robust standard errors were used to account for possible model misspecification. Parameter estimates are presented based on each opportunity cost of time assumed ([Table 2](#)). Travel costs had a negative and significant effect on the number of trips taken by a hunter indicating that trip demand for big-game hunting decreased as travel costs increased. The reference category for hunting access type was Leased land. Parameter estimates related to hunting access type indicated that trip demand decreased on non-leased private land, public land, and land owned outright compared with leased land. The Travel costs \times Own land interaction term was insignificant across all wage rate specifications, whereas the Travel costs \times NLP land and Travel costs \times Public land interaction terms were negative and significant across all wage rate specifications. These results suggest that the slopes of the NLP land and public land trip demand curves were significantly different from that for leased land.

Table 2. Results from zero-truncated negative binomial regression of big-game hunting-trip demand based on alternative wage rate assumptions ($n = 755$)[†].

Independent variable	No wage		0.25 wage	
	Coef.*	P-value	Coef.*	P-value
Travel costs	-0.0145 (0.0023)	<.001	-0.0072 (0.0014)	<.001
TC × own land	0.0020 (0.0046)	.565	0.0007 (0.0020)	.714
TC × NLP land	-0.0102 (0.0046)	.025	-0.0088 (0.0026)	.001
TC × public land	-0.0207 (0.0103)	.045	-0.0193 (0.0074)	.009
Own land [‡]	-0.2186 (0.1145)	.056	-0.1988 (0.1133)	.079
NLP land	-0.5083 (0.1104)	<.001	-0.4487 (0.1096)	<.001
Public land	-0.4386 (0.1728)	.011	-0.3473 (0.1762)	.049
Residence	-0.5238 (0.1545)	.001	-0.4934 (0.1496)	.001
Party size	-0.1376 (0.0406)	.001	-0.0979 (0.0393)	.013
Hunting experience	0.0150 (0.0038)	<.001	0.0159 (0.0038)	<.001
Food plots	0.2881 (0.0910)	.002	0.2699 (0.0916)	.003
Age	-0.0186 (0.0043)	<.001	-0.0198 (0.0043)	<.001
Retired	0.4435 (0.1242)	<.001	0.4618 (0.1226)	<.001
Population density	-0.1027 (0.0481)	.033	-0.1077 (0.0464)	.020
Household income	-0.0016 (0.0009)	.090	-0.0005 (0.0010)	.607
Intercept	4.3258 (0.1545)	<.001	4.1361 (0.2723)	<.001
Overdispersion	0.8652		0.8612	
McFadden R ²	0.0352		0.0359	
Log-likelihood	-2742.89		-2740.98	

*Robust standard errors are reported in parentheses.

[†]Leased land was the base hunting access type.

[‡]Fifty-two observations were dropped because of missing data.

Party size was negative and significant, indicating that the size of the hunting group was negatively correlated with the number of trips taken. Food plots were positive and significant, indicating that hunters took more trips to sites with existing food plots. Hunting experience was positive and significant, suggesting that trip demand increased with greater hunter experience. Age was negative and significant, indicating that trip demand decreased with age. Retired was positive and significant, suggesting that retired hunters took more trips. Population density was negative and significant, indicating that hunters from rural, less populated areas took more trips. Residence was negative and significant, indicating that nonresident hunters took more trips than resident hunters. Household income was insignificant in the wage-based models but was negative and significant in the model that did not account for opportunity cost of time.

CS and Price Elasticity

Per-trip CS estimates from various models based on alternative wage rate assumptions are presented in Table 3. CS estimates increased when larger percentages of the wage rate were assumed for the opportunity cost of time. Leased land CS was equal to own

Table 3. Per-trip per-person consumer surplus estimates (\$) from TCM models based on alternative wage-rate specifications (95 percent confidence intervals).

Wage rate (%)	Leased land	NLP land*	Public land	Own land [†]
0	69.04 (50.20, 87.96)	40.48 (29.31, 51.66)	28.44 (13.61, 43.27)	69.04 (50.20, 87.96)
25	137.95 (85.39, 190.51)	62.23 (43.76, 80.71)	37.73 (15.69, 59.76)	137.95 (85.39, 190.51)

*NLP land indicates nonleased private land.

[†]Own-land CS estimates are considered equal to leased-land CS estimates because of the insignificance of the travel-cost interactions terms associated with own land.

land CS because the slope interaction coefficient was statistically insignificant (Table 2). Both leased and owned land CS were greater than public land and nonleased private land CS. Specifically, for the 0.25 wage rate specification, leased land CS estimates ranged from \$85.39 to \$190.51, whereas nonleased private land CS ranged from \$43.76 to \$80.71. Public land CS estimates ranged from \$15.69 to \$59.76. Fixed costs associated with lease and public land hunting can be incorporated into CS estimates by subtracting a hunter's lease (\$830.25 average) or WMA permit cost from their per-year CS estimate. Using this approach and assuming a 0.25 wage rate specification, the average per trip CS for a lease hunter was \$98.01, whereas the average per trip CS for a public-land hunter was \$36.93.

Estimated short-run price elasticities ranged from -0.440 to -0.278, indicating inelastic hunting-trip demand for all access types (Table 4). Previous price elasticity estimates include -1.76 to -2.40 for hunting in general (Herriges and Phaneuf 2002), -2.016 for moose hunting (Sarker and Surry 1998), -1.927 for deer hunting (Creel and Loomis 1992), and -1.030 for big-game hunting (Phaneuf and Smith 2005). Price elasticities associated with hunting on leased land were similar to, but consistently more inelastic than, elasticities associated with hunting on public land. For example, assuming the 0.25 wage rate specification, the price elasticity for lease hunters was -0.278, whereas the price elasticity for public-land hunters was -0.440. As a result, assuming the 0.25 wage rate specification, a 10 percent increase in individual travel costs to a lease site would result in a 2.78 percent decrease in hunting trips demanded. Similarly, a 10 percent increase in travel costs to a public site would result in a 4.40 percent decrease in trips demanded.

Aggregate CS Estimates

Aggregate CS estimates were calculated for leased-land hunters and public-land hunters only. The number of Georgia lease hunters in 2012 was estimated by first determining the percentage (85 percent) of survey respondents who hunted big game in 2012. Since the sample indicated that roughly a third of the hunting sites occurred on leased land, the number of Georgia lease hunters in 2012 was estimated at 118,418. Similarly, the number of Georgia public-land hunters in 2012 was estimated at 50,238. This ratio of public- to leased-land hunters (0.42) is somewhat larger than the ratio of public- to private-land hunters (0.25) reported in the 2011 FWS (US Department of the Interior, 2011, table 14). However, the FWS estimate includes both leased and nonleased categories of private land, which could explain the difference.

Aggregate CS estimates for leased-land hunting and public-land hunting were calculated using two approaches. The first approach did not incorporate fixed costs such as lease price or WMA stamp

Table 4. Travel-cost price elasticities obtained from TCM models based on alternative wage-rate specifications (mean travel cost [\$]).

Wage rate (%)	Leased land	NLP land*	Public land	Own land†
0	-0.330 (22.78)	-0.323 (13.09)	-0.358 (10.19)	-0.330 (7.39)
25	-0.278 (38.33)	-0.344 (21.40)	-0.440 (16.59)	-0.278 (13.61)

*NLP land indicates nonleased private land.

†Own-land price elasticities are considered equal to leased-land elasticities because of the insignificance of the travel-cost interactions terms associated with own land.

price. Leased-land aggregate estimates for the first approach were calculated by first multiplying the number of lease hunters by the average number of trips taken to a lease site. This product was then multiplied by per-trip CS estimates for leased-land hunting. A similar formula was used to estimate aggregate values for public-land hunting. In contrast to the first aggregation approach, the second approach incorporated lease price and WMA stamp price post estimation. For this approach, per-person CS was first multiplied by each observation's number of trips taken. Each observation's respective lease price or WMA stamp price was then subtracted from each observation's per year CS estimate. This process is justifiable, since, unlike trip cost items, fixed costs are annual expenditure items and therefore could be used in recovering net annual benefit estimates. The average of this difference was then multiplied by the estimated number of lease-land hunters (public-land hunters) to estimate aggregate CS.

Consistent with most TCM studies, aggregate CS estimates varied greatly with wage-rate assumptions. Nevertheless, for the same set of assumptions, the results show that the aggregate net economic value of lease hunting was greater than the value of public-land hunting. For example, assuming a 0.25 wage rate, the aggregate value of hunting on leased land was \$339 million using the approach that does not account for fixed costs and \$241 million when accounting for fixed costs. Using equivalent assumptions, the aggregate value of hunting on public land was \$26 million using the first approach and \$21 million when accounting for fixed costs (state game management area stamp). For lease hunting especially, the results show the importance of accounting for fixed access costs such as lease price.

Discussion

This study provides a number of insights into the economic value of big-game hunting and how this value is correlated with land-access type. Results indicate that big-game hunting trips to leased sites were valued more than hunting trips to public sites, even when fixed costs such as lease price were accounted for post estimation. These results suggest that hunters valued the benefits of leasing (e.g., controlled access, less crowding, potential control over management/rules) more than the benefits of hunting on public land (e.g., lower access costs, likely more congestion, less intense management, inability to establish season-long stand locations). CS estimates for hunting on other forms of private land such as land owned outright were also higher than estimates associated with public land.

CS estimates for big-game hunting in Georgia are generally consistent with prior estimates obtained for hunting in other study areas. Using the 0.25 wage-rate specification, per-trip per-person

CS estimates associated with leased land, nonleased private land, and public land were \$137.95, \$62.23, and \$37.73 respectively. [Offenbach and Goodwin \(1994\)](#) did not distinguish among access types and obtained per-trip per-person CS estimates of \$336.83 and \$369.84 for hunting in Kansas. [Creel and Loomis \(1990\)](#) calculated per-trip per-person estimates of \$141.62 and \$150.99 for deer hunting on public hunting sites in California, whereas [Bergstrom and Cordell \(1991\)](#) obtained a per-trip per-person CS estimate of \$58.55 for big-game hunting on public sites nationwide. Public-land CS estimates from this study were considerably more conservative than public-land estimates obtained for other study areas. No other Georgia specific hunting-trip demand study exists in the literature for comparison. The low public-land estimates likely reflect Georgia hunters' perception of the lower-quality big-game hunting opportunities on public land in Georgia.³

Findings related to access options for this study are consistent with literature examining hunter site preferences. For instance, [Luloff et al. \(2004\)](#) found that Pennsylvania hunters viewed hunter success and satisfaction as lower on public land. Similarly, [Brown et al. \(2001\)](#) found that nearly two-thirds of hunters in New York preferred to hunt on private land because of the perceived quality of habitat, crowding, and convenience. CS estimates for big-game hunters in Georgia were considerably higher for private land than for public land. For hunters willing to pay for access, private hunting land was preferred and valued more than public land. Despite the greater preference for private access options, public land remains an important, affordable option for hunters who can neither afford to purchase a lease or pay annual club dues, or for those simply not wanting to commit to a sizable annual fixed cost. A number of studies have found that free hunting access on private lands is declining ([Lauber and Brown 2000](#), [Brown et al. 2001](#), [Jagnow et al. 2006](#)). If declining free private-land hunting access occurs in Georgia, possibly for safety and liability issues affecting landowner perceptions of risk ([Kuentzel et al. 2018](#)), hunters who cannot afford to lease will likely turn to public-access options. This, in turn, could put added pressure on public hunting lands such as WMAs, further affecting hunting quality.

Hunting-trip demand on public land was slightly more elastic than hunting on other access types such as leased land. If, for example, rising fuel costs increased per-trip hunting costs for Georgia hunters by \$10, the number of trips taken by a typical hunter to a lease site would decrease from 20.78 to 19.27, or by about 1.5 trips. For public-land hunters, a per-trip price increase of \$10 would decrease the number of trips taken to a public site from 13.75 to 10.01, or nearly four trips. This example illustrates that public-land hunters are likely more sensitive to a price increase than lease hunters. This result, similar to the fixed-cost example above, suggests that public land is an important low-cost option for many hunters. A recent qualitative study examining Georgia WMA recreationists in general found that a majority of participants (55 percent) indicated they would decrease their hunting or other outdoor recreation activity participation if WMAs were no longer available in Georgia ([Southwick Associates, Inc. and Responsive Management 2014](#)). Similarly, one-half of WMA recreationists indicated their outdoor recreation expenditures would decrease if WMAs were no longer available in Georgia ([Southwick Associates, Inc. and Responsive Management 2014](#)).

Results from the aggregation approaches demonstrate the importance of accounting for fixed costs when estimating the value of a

recreational resource. Aggregate CS estimates indicate that the total net economic value of lease hunting in Georgia was over \$300 million when fixed costs were not assumed. For public land, aggregate CS was estimated to be near \$25 million. A dollar-per-acre aggregate comparison of hunting on leased versus public land provides more perspective on value of these access types. The total acreage of WMAs in Georgia is about 1.7 million acres (Georgia Department of Natural Resources 2017), whereas the total acreage of leases for big game in Georgia in 2012 was approximately 11.2 million acres (Wolfe and Stubbs 2015). Therefore, with a specification using a 0.25 wage rate and no fixed costs, the aggregate CS value of leased land was \$30.27 per acre per year, whereas that for public land was \$15.29 per acre per year. Accounting for fixed costs such as lease price and WMA fee, the aggregate CS value of leased land to hunters was \$21.52 per acre per year, compared with \$12.35 for public land. Estimates from all access options are larger than average per-acre lease costs in Georgia, demonstrating that hunting can contribute positively to land-value estimates. In addition, despite considerable differences in per-acre value between the access types, public land possesses a sizable value and remains an important free-access option for many hunters.

Conclusions and Implications

This study contributes to our understanding of hunting demand by quantifying how hunters choosing different access options value their recreational resource and respond to price changes. Prior studies have asserted that site quality impacts hunting-trip demand. To our knowledge, Knoche and Lupi (2012) and Knoche and Lupi (2013) are the only other studies that examined how hunting-trip demand varies across different land access options, and both focused on public land types. The present study explicitly examined how land-access options, public and private, can impact CS and price-elasticity estimates.

Results from this study present potential management and policy implication for both private leased land and public land. Although lease hunting in Georgia is popular and potentially lucrative, many landowners may be reluctant to provide fee-based hunting access to their lands. The large CS estimates associated with hunting on nonleased private land demonstrate that landowners potentially have an untapped source of revenue, although owners of nonleased private land may get more utility from supplying access to friends or family.

Concerning public land, Hussain et al. (2016) noted that CS associated with WMAs can be interpreted as a price hunters would be willing to pay to prevent the closure of any given WMA in a state. The cost for access to WMAs in Georgia is \$19 annually for residents (plus the cost of a hunting license). Therefore, CS estimates for public land demonstrate that Georgia hunters may be willing to pay more to ensure that public hunting opportunities continue in Georgia. However, with the passage of Georgia House Bill 208 in 2017, Georgia lawmakers decided not to increase the cost of a WMA stamp, despite raising fees for many other license types (Georgia General Assembly 2017). Based on CS estimates obtained from this study, policymakers in the future may have justification to raise the cost of a WMA license in order to raise revenue aimed at protecting and improving public hunting land in Georgia. House Bill 208 increased annual resident big-game licenses from \$9 to \$25 and annual resident sportsman licenses from \$55 to \$65

(Georgia General Assembly 2017). Although license fees are not exactly like entrance costs (e.g., park admission fee, ski lift ticket), one can assume, in the long run, that the price response to a change in license price and travel cost would be similar. Thus, the estimated price elasticities indicate that hunters would respond to a license increase by taking fewer trips. However, the relatively small increase in license costs should lead to an increase in total revenue for the state, since demand for both public and private hunting is relatively inelastic. Though the number of trips taken and the number of hunting participants could decrease, the revenue generated by the state from the new legislation would increase overall.

The estimated price elasticities also show that trip demand would be affected more for public-land hunters if costs associated with hunting increase because of policy changes or economic conditions. This presents potential equity concerns, since the only access option for many hunters may be public land. Since public hunters are more sensitive to price changes and often do not have access to alternative access options, the estimated elasticities demonstrate the importance of preserving public access options in Georgia. This is especially true for possible entrants to hunting who have no connections to private landowners or perhaps have no family members who hunt. This study found that income was either insignificant (wage rate models) or negative but marginally significant in explaining trip demand (no wage model), but hunting had previously been found to be a normal good (Sarker and Surry 1998). For lower-income hunters, public options such as WMAs are needed to provide affordable hunting opportunities.

While this study contributes to existing literature on hunting economics, potential limitations should also be acknowledged. First, the sample frame precluded collection of specific information from nonrespondents, so a formal test of potential nonresponse bias was not conducted. However, demographics from the sample are similar to the findings of recent iterations of the national survey on wildlife recreation (US Department of the Interior 2011). Second, an effort was made to include lease and WMA stamp costs in the models, but the literature is sparse with regard to the treatment of these longer-term fixed costs (e.g., season passes, package deals) in TCM models. Further research is needed to understand an appropriate specification of fixed costs in travel-cost models, perhaps in a two-stage framework. Moreover, more research is needed to understand the effects, in the short term, of paying the lease in advance (required) and trips for the given season, i.e., how do sunk costs affect trip behavior? Third, as with all TCM modeling, assumptions must be made regarding appropriate time costs, multipurpose trips, relevant substitutes, and the like. As we demonstrate by presenting results across the wage-rate fractions, results can be highly sensitive to these assumptions. Fourth, our results pertain only to current hunters in GA. Although GA may be considered representative of big-game hunting for white-tailed deer in the Southeast, the results should not be considered transferrable to places like the forests of the northeastern US with a long tradition of free access to private land, or to the West with vast expanses of public land.

Endnotes

1. All monetary values are presented in 2012 US dollars.
2. We note that the number of license holders in Georgia is 8 percent larger than the number of hunters in GA estimated by the United States Fish and Wildlife Service (USFWS). This difference is relatively small, and we would expect the number of license holders to be somewhat larger than the USFWS estimate of

- hunters for a number of reasons, e.g., estimation error by USFWS, as well as the fact that people holding licenses, particularly free (seniors, military) and lifetime licenses, may have chosen not to hunt in 2011. Moreover, some people purchase annual licenses with the intention to hunt but end up not going to the field. Alternatively, the USFWS estimate would likely pick up some hunters left out of our sample because we would not have captured hunters who do not need a license if hunting exclusively on their own land.
3. A map showing the location of WMAs with public hunting access can be found at <https://www.georgiaoutdoormap.com/>

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