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The influence of income and loss on hunters' attitudes towards wild pigs and their management

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Abstract

Wild pigs (*Sus scrofa*) are one of the most pervasive invasive species in North America. Wild pigs pose a threat to crops, livestock, and the environment, but also provide recreational hunting opportunities. There are avenues for some stakeholder groups to generate income from wild pigs, however, stakeholders vary in attitudes towards wild pigs and their management. We investigated whether financial loss and income resulting from wild pigs influenced hunter stakeholder attitudes towards their management in Texas. We examined how land use influenced hunting landowner attitudes towards wild pigs. We analyzed 22,176 responses (8,707 landowners, 13,469 nonlandowners) from Texas hunters to the Texas A&M Human Dimensions of Wild Pigs Survey. Attitudes towards wild pigs varied significantly based on landownership status and whether land was used for agricultural practices. In addition, landowners who received income from wild pigs on their land considered government or agency hunting to be a less acceptable method of control than those who did not generate such income. However, effect sizes for all our results were small ($\eta^2 \leq 0.05$, Adj. $R^2 \leq 0.09$, and McFadden's $R^2 \leq 0.07$) and, across all groups, attitudes towards wild pigs were negative. Few respondents (3.91% of landowners, 0.56% of non-landowners) reported generating income from

wild pigs, and reported losses were approximately 4 times greater than income.

KEYWORDS
attitudes, feral swine, human dimensions, income, invasive species, loss, management, *Sus scrofa*, Texas, wild pigs

Spanish explorers introduced wild pigs (*Sus scrofa*) to the Americas in the 1500s (Mayer and Brisbin 1991). Today, the wild pig's range extends across much of the United States, Mexico, and some regions of Canada. Wild pigs are estimated to cause in excess of US$1.5 billion in damages and control costs annually in the U.S. (Pimental 2007), though this estimate is likely low given inflation and the growth of wild pig populations in the 14 years since the study was published. Recent estimates of damage caused by wild pigs to 6 crop types totaled $272 million/year (McKee et al. 2020). Wild pigs also pose threats to livestock through transmissible diseases and predation (Bevins et al. 2014, Miller et al. 2017, Anderson et al. 2019), and can have negative impacts on ecosystems through rooting, wallowing, and feeding behaviors (Campbell and Long 2009, Barrios-Garcia and Ballari 2012, Brooks et al. 2020, McKee et al. 2021). Thus, the true impact of wild pigs from an economic and ecological standpoint is likely higher than current estimates.

Despite the negative effects on agriculture, human and livestock health, and natural resources, attitudes towards wild pigs and their management vary between stakeholder groups, which may be due in part to potential for both recreative and financial benefit. Wild pigs can provide recreational hunting opportunities; thus the expansion of the wild pig range is due in part to translocation of wild pigs for hunting purposes (Mayer and Brisbin 2009, Bevins et al. 2014, Grady et al. 2019). Further, the persistence of wild pigs on the landscape and wild pig hunting holds cultural significance in some areas, which can affect stakeholder opinions on acceptable management efforts and ideal population sizes (Kirch and O'Day 2003, Pfeiffer and Voeks 2008, Weeks and Packard 2009, Ditchkoff and Bodenchuk 2020). Additionally, there are avenues for some stakeholder groups to generate income from wild pigs. Revenue can be created via trap and sell programs, leased hunting, taxidermy, and guided hunts (Adams et al. 1973, Degner et al. 1983, Zivin et al. 2000). Despite concern over the cost-benefit dynamic of wild pigs, few studies have quantified the economic benefits of wild pigs (Beasley et al. 2018). There is significant variation in hunters' tolerance for wild pigs on the landscape, ranging from desire for eradication to increased numbers (McClean 2020). Hunters have often been praised for efforts to reduce wild pig abundance, yet revenue from hunting may encourage wild pig introduction to new, previously uninhabited areas (Zivin et al. 2000, Caudell et al. 2016). Human-mediated movement of wild pigs has been predicted by the number of captive game hunting farms, the number of wild pigs harvested by hunters, and the number of game outfitters in an area (Tabak et al. 2017). Thus, the presence of wild pigs on a landscape creates a dynamic scenario in which some stakeholders suffer financial loss, others receive revenue, while others suffer loss in addition to earning revenues. Despite widespread, coordinated efforts to reduce wild pig abundance and range expansion, research has yet to address how economic factors may play a role in stakeholder attitudes towards wild pigs and their management. Ultimately, successful management of wild pigs, particularly in large areas of private landholdings, will require a thorough understanding of whether and how financial loss and gain associated with wild pigs influences attitudes towards the species.

Texas presents a model opportunity to better understand the dynamics of wild pig-human interactions in the context of damages and revenues that impact tolerance for the species. Texas boasts a large and persistent population of wild pigs (Lewis et al. 2019). The estimated population of wild pigs in Texas varies widely, with estimates from 2.6 million as of 2013 (Higginbotham 2013), to a minimum of 3.6 million as of 2019 according to modeling estimates (Mellish et al. 2014). The wide variation is due in part to the difficulties of surveying wild pigs, and as such estimates are derived from harvest. Recent estimates of annual damages to a limited subset of agriculture in Texas due to wild pigs stands at an estimated cost of $116–$118.8 million

(Anderson et al. 2016, 2019; McKee et al. 2020). In an effort to manage the expanding population, state laws reduced restrictions on hunting wild pigs in Texas, so that hunting is permitted year-round with no hunting license required, and there are no restrictions in harvest method or bag limit (Texas Senate Bill 317 2019). Although minimal restrictions on hunting wild pigs may provide a measure of population control, there is also potential for this approach to contribute to the maintenance of the species or establishment of new populations across the state for economic incentives through activities such as leased hunting, guided hunts, contract trapping, or selling wild pigs for commercial slaughter (Mapston 2004, Caudell et al. 2016, Tabak et al. 2017). Given the varied avenues for wild pig-related revenue generation for landowners and nonlandowners, as well as the fact that landowners suffer losses due to wild pigs that nonlandowners do not, one might conclude that the dynamics of loss, revenue, and their interaction would differ between the 2 groups. Indeed, even within landowners, we may find variation in attitudes towards wild pigs based on whether their land is primarily used for recreation or agricultural production.

The goal of our study was to provide insight into the cost-benefit dynamic of wild pigs in Texas as both a model system and to improve coordinated management efforts among private and public stakeholders in the state. Our objectives were to examine how land use, and economic loss and income due to wild pigs, influence hunters' attitudes towards wild pigs among those who do and do not own land. Furthermore, we aimed to examine how land use, and economic loss and income due to wild pigs, influence hunters' attitudes towards the acceptability and perceived effectiveness of government/agency control efforts, trap/sell efforts, and leased hunting on controlling wild pig populations among those who do and do not own land. We hypothesized that hunters who generate income due to wild pigs will have a more positive attitude towards wild pigs and will show less support for government or agency hunting control measures than those who do not generate income due to wild pigs.

METHODS

We developed the Texas A&M Human Dimensions of Wild Pigs Survey (Figure S1, available in Supporting Information) using Qualtrics survey software (Qualtrics, Provo, UT, USA). The questionnaire consisted of 79 questions, although respondents were directed to only answer questions that were applicable to them. The questionnaire asked the respondents for answers to several questions related to wild pigs (e.g., knowledge, hunting practices, opinions on wild pigs and their management, income or loss due to wild pigs), landownership, and several demographic variables. The questionnaire was available online and we created a paper version that mirrored the online questionnaire and was distributed via physical mail upon respondent request.

We acquired contact information for all Texas hunting license holders above the age of 18 for 2018 from the Texas Parks and Wildlife Department (TPWD). Potential respondents received an invitation to participate in the survey through email on 4 June 2019, or via paper mail sent 5 June 2019. As per recommendations from Dillman et al. (2008), email respondents were sent up to 2 reminder messages 3 and 5 days after the initial invitation via email. For individuals who did not respond to the physical mail, a random sample of 1,000 nonrespondents were sent a reminder postcard 21 days after the initial invitation was sent. Reminders were sent to physical mail nonrespondents 21 days after the initial invitation to allow enough time to receive paper surveys. We sent reminders to only 1,000 nonrespondents from the paper mail group due to financial constraints (e.g., printing, mailing). Email nonrespondents were tracked through Qualtrics survey software and reminders sent at no additional cost. Data were collected between 4 June and 13 August 2019 for both mail and email respondents. For additional information on survey implementation, see Connally et al. (2021). We manually entered paper responses into a Filemaker Pro Advanced 17 database (Claris International Inc., Cupertino, CA, USA) as soon as possible after receipt and we reviewed summary statistics after each data entry session to minimize data entry errors.

Independent variables

To determine loss and income related to wild pigs, respondents were asked 4 questions: 3 related to revenue derived from wild pigs, and one related to loss due to wild pigs (Figure 1). We removed all records where responses related to income created through wild pigs (via guiding, trapping or leased hunting) and loss attributed to wild pigs were non-numeric and could not be formatted to a numeric answer (e.g., Zero to $0). We removed all responses where respondents indicated that they had received income via guiding, trapping, or leased hunting, but did not provide a value (either left blank or reported as $0). We created a composite measure of wild pig-derived income (Income) by summing income reported via guiding, trapping, and leased hunting. To control for respondent overreporting and reporting errors, we removed responses that exceeded the 99% percentile for income and loss. Data were then partitioned into landowner (LO) and nonlandowner (NLO) responses. We further partitioned our landowner data into 4 participant groups: those who experienced only loss (LO-Loss), those who received only income (LO-Income), those who experienced both loss and income (LO-Loss and Income), and those who experienced neither loss nor income (LO-Neither). We partitioned our nonlandowner data into 2 groups: those who received income (NLO-Income), and those who did not receive income (NLO-No Income). There was no NLO-Loss group, as no nonlandowners reported loss due to wild pigs.

To examine if land use influenced our dependent variables, we created a binary variable to indicate whether a landowner's land was used for agriculture (Ag, 0 = No, 1 = Yes). We considered land used for crop and/or domestic livestock production as agricultural land. We deleted any records for landowners that did not indicate how their land was used. For all data, we removed all records where respondents were less than 18 years of age.

Dependent variables

We calculated a mean measure of general attitudes (Attitude) towards wild pigs by averaging responses to 7 belief statements (Table 1). Respondents indicated their answer on a 5-point Likert scale from Completely agree to Completely disagree. Responses were coded such that 0 = Completely disagree to 4 = Completely agree. The statements "The harm caused by wild pigs outweighs any benefits of having them in Texas," "Wild pigs do not

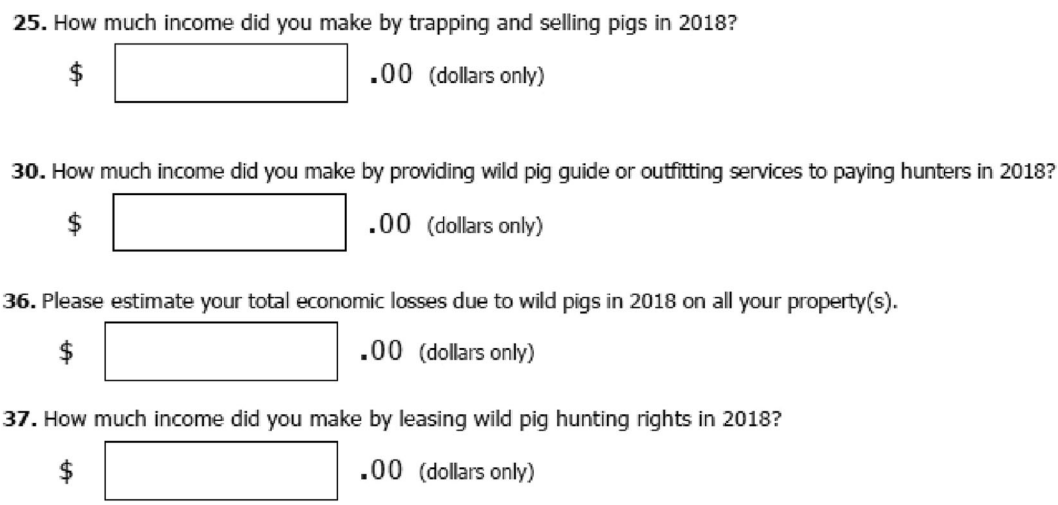

FIGURE 1 Questions regarding income and loss due to wild pigs on the Texas A&M Human Dimensions of Wild Pigs survey conducted 4 June and 13 August 2019.

TABLE 1 Seven belief statements used to calculate general attitudes (Attitude) of hunters towards wild pigs in Texas. Respondents were asked to indicate on a 5-point Likert scale ranging from Completely disagree (scored as 0) to Completely agree (scored as 4) how much they agreed with each statement such that higher scores indicated more positive attitudes towards wild pigs.

Statements
Wild pigs increase my overall quality of life.
The harm caused by wild pigs outweighs any benefits of having them in Texas.[a]
Wild pigs are a valuable resource for recreation, meat, or income in Texas.
Wild pigs do not belong in Texas.[a]
Overall, my feelings about wild pigs in Texas are generally positive.
Wild pigs are a nuisance.[a]
Wild pigs have the right to exist wherever they may occur.

[a]Responses were reverse coded for analysis.

belong in Texas," and "Wild pigs are a nuisance" were reverse coded such that lower values of this measure indicated a negative attitude towards wild pigs, while a higher value indicated a more positive attitude towards wild pigs. Respondents that did not answer all 7 statements were excluded from analysis. We used Cronbach's alpha to measure the internal reliability of the multi-item scale used to evaluate Attitude.

To measure personal acceptability of Trap and Sell, Leased Hunting, and Government/Agency Hunting as wild pig control methods (Acceptability), respondents were asked "Which of the following types of wild pig control methods are, or would be, personally acceptable to you?" They indicated their answer on a 5-point Likert scale from Completely unacceptable = 0 to Completely acceptable = 4. To measure perceived effectiveness of Trap and Sell, Leased Hunting, and Government/Agency Hunting as wild pig control methods (Effectiveness), respondents were asked "Which of the following types of wild pig control methods do you think are, or would be, effective?" and were asked to indicate their answer on the same Likert scale as used for Acceptability. Responses were coded the same way as for Acceptability and respondents that did not respond to all questions for Acceptability and Effectiveness were excluded from analysis.

We compared Attitude, Acceptability (of Trap and Sell, Leased Hunting, and Government/Agency Hunting) and Effectiveness (of Trap and Sell, Leased Hunting, and Government/Agency Hunting) among all 4 landowner groups (LO-Loss, LO-Income, LO-Loss and Income, and LO-Neither) using Kruskal-Wallis tests (adjusted for ties) and Dunn's tests with Bonferroni corrections to examine pairwise comparisons. We compared Attitude, Acceptability and Effectiveness between both non-landowner groups (NLO-Income, NLO-No income) using Mann Whitney U tests. Results for Mann Whitney U tests and Kruskal-Wallis tests are reported as mean ranks due to unequal distributions among groups (Hart 2001, McDonald 2014).

To investigate if the magnitude of loss or income influenced attitudes, we created a series of regression analyses for the following 4 participant groups that reported loss, income, or both: LO-Loss (IVs: Loss, Ag), LO-Income (IVs: Income, Ag), LO-Loss and Income (IVs: Loss, Income, Ag), and NLO-Income (IV: Income). Loss and Income were both continuous variables and Ag was binary. For each of these 4 groups, we created a multiple linear regression model (to investigate the influence of predictors on Attitude) and 6 ordinal logistic regression models. We created one model for each control type: Trap and Sell, Leased Hunt, and Government/Agency Hunting, for both Acceptability and Effectiveness for a total of 7 regression models per participant group. Interactions between independent variables were included in each model. To more accurately interpret regression models that included the variable Ag, we scaled regression inputs by dividing by 2 standard deviations (Gelman 2007). For multiple linear regressions, we visually assessed goodness-of-fit and reported robust standard errors to account for potential heteroscedasticity in large data sets (Long and Ervin 2000). Outliers with a Cooks Distance greater than

4 were removed from final analyses. For ordinal logistic regressions, we considered models significant if likelihood ratio chi-squared tests indicated our models fit the data better than the null model. We used Brant's test (Brant 1990) to check that proportional odds assumptions had been met and visually assessed goodness of fit using surrogate residuals (Greenwell et al. 2017), and the Lipsitz test (Lipsitz et al. 1996). Where proportional odds assumptions were not met, we ran partial proportional odds (PPO) models. For all regression models that included both Income and Loss, the variables were standardized prior to being entered into the model. We report beta coefficients for significant predictors for both linear and ordinal logistic regressions.

We calculated descriptive statistics for the participant groups that reported neither loss nor income (LO-Neither and NLO-No income). To examine the influence of Ag on Attitude, Acceptability and Effectiveness in the LO-Neither group, we ran Mann-Whitney U tests with Ag as the binary grouping variable.

We conducted analyses in RStudio version 4.0.3 (R Core Team 2018) and SPSS version 24 (IBM SPSS Statistics for Windows 2016, Armonk, NY, USA). We used the following packages in RStudio: arm (Gelman and Su 2020), brant (Schlegel and Steenbergen 2020), car (Fox and Weisberg 2019), DescTools (Signorell et al. 2021), DHARMa (Hartig 2021), effects (Fox and Hong 2009), generalhoslem (Jay 2019), ggplot2 (Wickham 2016), interactions (Long 2019), ltm (Rizopoulos 2006), MASS (Venables and Ripley 2002), ordinal (Christensen 2019), sure (Greenwell et al. 2017), and VGAM (Yee 2015). We set an alpha of 0.05 and only significant results are reported. Effect sizes for Kruskal-Wallis tests and Mann Whitney U tests are reported as eta-squared (η^2) and we considered $\eta^2 < 0.06$ small, $0.06 < \eta^2 < 0.13$ medium, and $\eta^2 > 0.13$ large (Cohen 1988). Effect sizes for linear regression are reported as Adj. R^2, and effect sizes for ordinal logistic regressions are reported as McFadden's R^2. For McFadden's R^2, we interpreted values great than 0.2 as a large effect (Louviere et al. 2000).

RESULTS

We successfully contacted 159,420 licensed hunters through email and 2,494 through conventional mail methods ($n = 161{,}914$). To be consistent across collection methods, we considered contact to be successful if email addresses did not send back an undeliverable notification and if letters were not returned to sender. Nevertheless, we cannot determine whether our email was delivered to the respondent's inbox, or to a junk folder, or whether letters were disposed of without being opened. There were thus a total of 37,225 completed surveys for a combined response rate of 23% (23.20% to email questionnaire and 7.10% to mail questionnaire). After removing responses from our sample according to procedures outlined above, we analyzed data from a total of 22,176 respondents comprised of 8,707 (39.26%) landowners and 13,469 (60.74%) nonlandowners. Thirty-eight (0.17%) responses were from paper questionnaires, and 22,138 (99.83%) responses were collected via the online questionnaire. Of the 22,176 respondents, 416 (1.88%) reported receiving income due to wild pigs; 341 (81.97%) of these respondents were landowners, and 75 (18.03%) were nonlandowners. In addition, 5,624 (25.36%) of the 22,176 respondents reported losses due to wild pigs, all of which were landowners (Table 2).

We regressed several key questions in our questionnaire (questions 31, 36, 37, 53 and 60) on the number of days to response as an indicator for potential nonresponse bias. For 2 of our 5 items (36 and 60), responses differed by the number of days taken to respond ($P < 0.05$). However, effect sizes were small ($R^2 < 0.001$), suggesting that there was no evidence of meaningful nonresponse bias (Linder et al. 2001). The items for Attitude had a Cronbach's $\alpha = 0.86$, which indicates good internal consistency.

Landowners

There was a difference in Attitude among landowner groups ($H = 402.66$, $P < 0.01$, $\eta^2 = 0.05$), with LO-Neither, LO-Loss and Income, and LO-Income all showing more positive attitudes towards wild pigs than LO-Loss.

TABLE 2 Demographic and summary information for 22,176 respondents to the Texas A&M Human Dimensions of Wild Pigs Survey. All respondents were Texas, USA hunting license holders for 2018 and above the age of 18 (contact information provided by the Texas Parks and Wildlife Department). Respondents received an invitation to participate in the survey through email or paper mail and were sent up to 2 reminder messages. Data were collected between June and August 2019.

		N	
Landowners	All	8,707	Loss: $\bar{x}$ = $1,696.00 (SD = $3,470.04, min. = $0, max. = $25,000)
			Income: $\bar{x}$ = $23.36 (SD = $162.30, min. = $0, max. = $2,000)
			Age: $\bar{x}$ = 52.15 years (SD = 13.33, min. = 18, max. = 117)
			Gender: Female = 420, male = 8,126, missing = 161
			Ethnicity: White = 7,853, Black/African American = 40, American Indian/Alaskan Native = 60, Spanish/Hispanic/Latino = 334, Asian = 18, Native Hawaiian/Pacific Islander = 3, Other = 159, Missing = 240
			Ecoregion: Blackland Prairies = 867, Cross Timbers = 1,144, Edward's Plateau = 1,538, Gulf Prairies = 892, High Plains = 245, Pineywoods = 1439, Post Oak Savannah = 1,382, Rolling Plains = 275, South Texas Plains = 529, Trans-Pecos = 43, Missing = 353
	Loss only	5,352	Loss: $\bar{x}$ = $2,606.00 (SD = $4018.34, min. = $1, max. = $25,000)
			Age: $\bar{x}$ = 51.72 (SD = 13.20, min. = 18, max. = 90)
			Gender: Female = 240, Male = 5,018, Missing = 91
			Ethnicity: White = 4,859, Black/African American = 28, American Indian/Alaskan Native = 42, Spanish/Hispanic/Latino = 200, Asian = 8, Native Hawaiian/Pacific Islander = 1, Other = 79, Missing = 103
			Ecoregion: Blackland Prairies = 516, Cross Timbers = 662, Edward's Plateau = 908, Gulf Prairies = 559, High Plains = 148, Pineywoods = 909, Post Oak Savannah = 911, Rolling Plains = 176, South Texas Plains = 343, Trans-Pecos = 18, Missing = 202.
	Income only	69	Income: $\bar{x}$ = $563.40 (SD = $581.16, min. = $1, max. = $2,000)
			Age: $\bar{x}$ = 51.53 years (SD = 13.57, min. = 21, max. = 78)
			Gender: Female = 3, Male = 65, Missing = 1
			Ethnicity: White = 62, American Indian/Alaskan Native = 1, Spanish/Hispanic/Latino = 4, Other = 1, Missing = 1
			Ecoregion: Blackland Prairies = 8, Cross Timbers = 11, Edward's Plateau = 15, Gulf Prairies = 8, Pineywoods = 3, Post Oak Savannah = 11, Rolling Plains = 4, South Texas Plains = 6, Missing = 3
	Loss and income	272	Loss: $\bar{x}$ = $3,002.00 (SD = $4,148.32, min. = $1, max. = $25,000)
			Income: $\bar{x}$ = $604.80 (SD = $575.41, min. = $1, max. = $2,000)
			Age: $\bar{x}$ = 50.94 years (SD = 14.95, min. = 18, max. = 89)
			Gender: Female = 13, Male = 251, Missing = 8
			Ethnicity: White = 244, Spanish/Hispanic/Latino = 14, Other = 8, Missing = 6
			Ecoregion: Blackland Prairies = 24, Cross Timbers = 41, Edward's Plateau = 45, Gulf Prairies = 22, High Plains = 3, Pineywoods = 37, Post Oak Savannah = 46, Rolling Plains = 15, South Texas Plains = 27, Missing = 12.

(Continues)

TABLE 2 (Continued)

		N	
	Neither	3,014	Age: $\bar{x}$ = 53.04 years (SD = 13.37, min. = 18, max. = 117)
			Gender: Female = 161, Male = 2,792, Missing = 61
			Ethnicity: White = 2,688, Black/African American = 12, American Indian/Alaskan Native = 17, Spanish/Hispanic/Latino = 116, Asian = 10, Native Hawaiian/Pacific Islander = 2, Other = 71, Missing = 98
			Ecoregion: Blackland Prairies = 319, Cross Timbers = 430, Edward's Plateau = 570, Gulf Prairies = 303, High Plains = 94, Pineywoods = 490, Post Oak Savannah = 414, Rolling Plains = 80, South Texas Plains = 153, Trans-Pecos = 25, Missing = 136.
Nonland-owners	All	13,469	Income: $\bar{x}$ = $3.15 (SD = $58.45, min. = $0, max. = $2,000)
			Age: $\bar{x}$ = 50.00 years (SD = 13.83, min. = 18, max. = 117)
			Gender: Female = 476, Male = 12,671, Missing = 322
			Ethnicity: White = 11,664, Black/African American = 90, American Indian/Alaskan Native = 88, Spanish/Hispanic/Latino = 860, Asian = 74, Native Hawaiian/Pacific Islander = 23, Other = 241, Missing = 429
			Ecoregion: Blackland Prairies = 1,527, Cross Timbers = 1,686, Edward's Plateau = 1,779, Gulf Prairies = 1,582, High Plains = 438, Pineywoods = 2138, Post Oak Savannah = 848, Rolling Plains = 225, South Texas Plains = 434, Trans-Pecos = 64, Missing = 2,748.
	Income	75	Income: $\bar{x}$ = $566.50 (SD = $563.82, min. = $10, max. = $2,000)
			Age: $\bar{x}$ = 45.72 years (SD = 13.11, min. = 19, max. = 71)
			Gender: Female = 3, Male = 71, Missing = 1
			Ethnicity: White = 60, Black/African American = 2, American Indian/Alaskan Native = 1, Spanish/Hispanic/Latino = 7, Asian = 1, Native Hawaiian/Pacific Islander = 1, Other = 2, Missing = 1
			Ecoregion: Blackland Prairies = 10, Cross Timbers = 10, Edward's Plateau = 12, Gulf Prairies = 5, High Plains = 1, Pineywoods = 11, Post Oak Savannah = 5, Rolling Plains = 3, South Texas Plains = 7, Missing = 11
	No income	13,394	Age: $\bar{x}$ = 50.02 years (SD = 13.83, min. = 18, max. = 117)
			Gender: Female = 473, Male = 12,600, Missing = 321
			Ethnicity: White = 11,604, Black/African American = 88, American Indian/Alaskan Native = 87, Spanish/Hispanic/Latino = 853, Asian = 73, Native Hawaiian/Pacific Islander = 22, Other = 239, Missing = 428.
			Ecoregion: Blackland Prairies = 1,517, Cross Timbers = 1,676, Edward's Plateau = 1,767, Gulf Prairies = 1,577, High Plains = 437, Pineywoods = 2,127, Post Oak Savannah = 8,743 Rolling Plains = 222, South Texas Plains = 427, Trans-Pecos = 64, Missing = 2,737.

LO-Income and LO-Neither had more positive attitudes towards wild pigs than LO-Loss and Income (Figure 2). There was a difference in Effectiveness of Trap and Sell ($H = 23.14$, $P < 0.01$, $\eta^2 < 0.01$), Effectiveness of Leased Hunting ($H = 62.88$, $P < 0.01$, $\eta^2 < 0.01$) and Effectiveness of Government/Agency Hunting between landowner groups ($H = 21.08$, $P < 0.01$, $\eta^2 < 0.01$; Table 3). There was also a difference in Acceptability of Leased Hunting ($H = 36.74$, $P < 0.01$, $\eta^2 = 0.01$) and Acceptability of Government/Agency Hunting between groups ($H = 11.06$, $P < 0.05$, $\eta^2 < 0.01$). There was an interaction between Income and Ag on Attitude in the LO-Income group, such that attitudes towards wild pigs became more positive as Income increased for those who used their land for agriculture but became more negative as income increased for landowners who did not use their land for agriculture ($F_{3,65} = 3.32$, $P = 0.03$, Adj. $R^2 = 0.09$; Table 4). There was also an effect of Ag on the acceptability of Trap and Sell in this group ($LR\ X^2_{3,62} = 10.84$, $P < 0.05$, McFadden $R^2 = 0.07$), whereby those who used their land for agriculture were more likely to view Trap and Sell as an acceptable control method. However, the sample size for this group was too small to effectively run Brant's and Lipsitz tests, and diagnostic plots of model residuals suggested potential heteroscedasticity, thus we interpret this result with caution.

Attitudes towards wild pigs became more negative as loss increased, and were more negative in those who use their land for agriculture in the LO-Loss group ($F_{3,5348} = 73.03$, $P < 0.01$, Adj. $R^2 = 0.04$; Table 4). A PPO model ($LR\ X^2_{3,5345} = 24.71$, $P < 0.01$, with parallel assumptions relaxed for Loss) for this group also showed an interaction between Ag and Loss on the acceptability of Trap and Sell, with those who used their land for agriculture considering Trap and Sell as a less acceptable control method as Loss increased, and those who did not use their land for agriculture viewing it as a more acceptable method as Loss increased. There was an effect of Ag on acceptability of Leased Hunting ($LR\ X^2_{3,5345} = 30.81$, $P < 0.01$, McFadden $R^2 < 0.01$) in this same group, with those who did not use their land for agriculture considering Leased Hunting a more acceptable method of control. Attitudes towards wild pigs became more positive as income increased in the LO-Loss and Income group ($F_{6,265} = 3.11$, $P < 0.01$, Adj. $R^2 = 0.04$; Table 4) and Leased Hunting was considered more effective as income increased ($LR\ X^2_{6,262} = 15.42$, $P = 0.02$; McFadden $R^2 = 0.02$, $\beta = 0.43$, SE = 0.20, $P < 0.05$).

For LO-Neither, there was an effect of Ag on Attitude with landowners who used their land for agricultural purposes having a more negative attitude towards wild pigs (Table 5). Respondents in this same

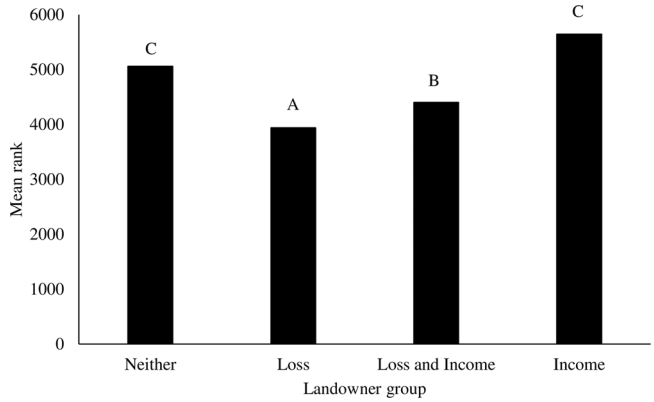

FIGURE 2 Mean ranks from Dunn's pairwise comparisons (with Bonferroni corrections) investigating differences in general attitudes (Attitude) towards wild pigs between 4 groups of Texas hunters who own land: Loss (had only financial loss due to wild pigs), Loss and Income (had financial loss but also received income due to wild pigs), Income (received income due to wild pigs and no financial loss), and Neither (had neither financial loss nor income due to wild pigs). Significant differences between landowner groups are denoted by letters A, B and C, such that landowner groups that do not share a letter show significant differences in attitudes ($P \leq 0.05$), with higher mean rank scores indicating more positive attitudes towards wild pigs.

TABLE 3 Mean ranks, *H* statistics and *P* values from 6 Kruskal-Wallis tests investigating the difference in personal acceptability (Acceptability) and perceived effectiveness (Effectiveness) of 3 wild pig management efforts (Trap and Sell, Leased Hunting, and Government/Agency Hunting) between 4 different groups of Texas hunters who own land: Loss experienced only financial loss due to wild pigs, Loss and Income experienced financial loss but also received income due to wild pigs, Income received income due to wild pigs and no financial loss, and Neither had neither financial loss nor income due to wild pigs. Higher mean rank scores indicate higher Acceptability or Effectiveness ratings. Significant differences ($P \leq 0.05$) between landowner groups for each dependent variable as determined by Dunn's pairwise comparison tests with Bonferroni corrections are denoted by letters a, b and c (such that groups that do not share a letter are significantly different). Effects sizes for all significant tests were small ($\eta^2 < 0.01$).

Dependent variable	*H*	*P*	Loss	Loss and Income	Income	Neither
Effectiveness: Trap and sell	23.14	<0.01	4265.18^{a}	4720.72^{b}	4819.09^{ab}	4467.98^{b}
Acceptability: Trap and sell	6.52	0.09	4330.01	4672.44	4354.12	4367.85
Effectiveness: Leased hunting	62.88	<0.01	4211.36^{a}	4144.86^{a}	4204.57^{ab}	4629.57^{b}
Acceptability: Leased hunting	36.74	<0.01	4248.82^{a}	4361.99^{ab}	4354.20^{ab}	4546.91^{b}
Effectiveness: Govt/agency hunting	21.08	<0.01	4305.21^{a}	3903.88^{b}	4112.71^{abc}	4486.78^{c}
Acceptability: Govt/agency hunting	11.06	0.01	4373.21^{a}	4664.47^{ab}	3590.93^{b}	4363.49^{ab}

group that used their land for agriculture considered Government/Agency Hunting and Leased Hunting to be less acceptable and less effective methods of control than those who did not use their land for agriculture. However, they considered Trap and Sell a more acceptable control method if they used their land for agriculture.

Nonlandowners

There was a difference in Acceptability of Trap and Sell between groups, ($U = 575{,}424.00$, $P < 0.05$, $\eta^2 < 0.01$), whereby NLO-Income (mean rank = 7,710.32) considered Trap and Sell a more acceptable control method than NLO-No income (mean rank = 6,729.54).

DISCUSSION

Our study found that all participant groups showed negative attitudes towards wild pigs, considered leased hunting and trapping and selling to be at least somewhat acceptable or effective forms of wild pig control, and government or agency hunting as less acceptable or effective. However, we note that the effect sizes for our analyses were small, indicating that income and loss derived from wild pigs and land use (in those who own land) have little real world influence on the attitudes of Texas hunters towards wild pigs and their management.

Overall, our results indicate that Texas hunters have negative attitudes towards wild pigs, regardless of landownership. As hypothesized, landowners who received income from wild pigs had a more positive attitude towards wild pigs than landowners who experienced loss, and attitudes towards wild pigs became more negative as loss increased, and more positive as income increased. Contrary to our prediction, both nonlandowners who received income and those that did not receive income from wild pigs had similar negative attitudes. We note that landowners and nonlandowners that garner income from wild pigs represent a small proportion of the sample population.

TABLE 4 Significant linear regression analyses investigating the influence of wild pig derived income, losses due to wild pigs, and land use (whether land is used for agriculture or not) on attitudes towards wild pigs and their management in 3 different groups of Texas hunters who own land: Income received income due to wild pigs, Loss experienced only financial loss due to wild pigs, and Loss and Income had financial loss but also received income due to wild pigs. Respondents completed the Texas A&M Human Dimensions of Wild Pigs Survey from June to August 2019. We calculated a mean measure of attitudes (Attitude) such that high values represented positive attitudes towards wild pigs. Similarly, higher values indicated that the management type (Trap and Sell, Leased Hunting, and Government/Agency Hunting) was considered more effective/acceptable. We conducted linear regression models to investigate Attitude, and ordinal logistic regression models to investigate Acceptability and Effectiveness of management efforts. Predictors were considered significant if $P \leq 0.05$.

Participant group	Dependent variable	Model predictors	β	SE	P
Income	Attitude	Income	−0.23	0.35	0.51
		Ag	−0.41	0.24	0.09
		Income*Ag	1.09	0.48	0.02
	Acceptability: Trap and sell	Income	<0.01	<0.01	0.97
		Ag	2.27	0.88	<0.01
		Income*Ag	<−0.01	<0.01	0.23
Loss	Attitude	Loss	−0.29	0.05	<0.01
		Ag	−0.17	0.02	<0.01
		Loss*Ag	0.02	0.05	0.78
	Acceptability: Trap and sell[a]	Loss	0.12	0.07	0.07
		Ag	0.05	0.06	0.42
		Loss*Ag	−0.21	0.07	<0.01
	Acceptability: Leased hunting	Loss	<−0.01	<0.01	0.22
		Ag	−0.19	0.01	<0.01
		Loss*Ag	<0.01	<0.01	0.86
Loss and Income	Attitude	Income	0.30	0.12	0.01
		Loss	−0.41	0.06	<0.01
		Ag	−0.02	0.12	0.88
		Income*Loss	−0.11	0.19	0.55
		Income*Ag	−0.29	0.25	0.91
		Loss*Ag	−0.15	0.29	0.60
	Effectiveness: Leased hunting	Income	0.43	0.20	0.03
		Loss	−0.09	0.26	0.74
		Ag	−0.40	0.24	0.09
		Income*Loss	0.06	0.09	0.54
		Income*Ag	−0.16	0.24	0.50
		Loss*Ag	−0.24	0.29	0.41

[a]Partial-proportional odds model, with assumptions relaxed for Loss.

TABLE 5 Results for 7 Mann-Whitney U tests investigating the influence of land use (Ag = land used for agriculture, No Ag = not used for agriculture) on attitudes towards wild pigs, and personal acceptability (Acceptability) and perceived effectiveness (Effectiveness) for 3 methods of wild pig control (Trap and Sell, Leased Hunting, and Government/Agency Hunting) in Texas hunters who had neither loss nor income due to wild pigs. Respondents completed the Texas A&M Human Dimensions of Wild Pigs Survey between June and August 2019. Higher mean rank scores indicate a more positive attitude towards wild pigs, or higher Acceptability or Effectiveness ratings of wild pig management efforts. Effects sizes for all significant tests ($P \leq 0.05$) were small ($\eta^2 < 0.01$).

Dependent variable	*U*	*P*	Ag: Mean rank	No Ag: Mean rank
Attitude	1079925.50	0.04	1472.20	1537.88
Effectiveness: Trap and sell	1140505.00	0.61	1515.65	1500.48
Acceptability: Trap and sell	1180375.00	0.02	1544.25	1475.87
Effectiveness: Leased hunting	1079849.50	0.03	1472.14	1537.93
Acceptability: Leased hunting	1057404.50	<0.01	1456.04	1551.78
Effectiveness: Govt/agency hunting	1059843.50	<0.01	1457.79	1550.28
Acceptability: Govt/agency hunting	1048018.50	<0.01	1449.31	1557.58

We found variation in the acceptability and perceived effectiveness of different management techniques among the different landowner groups. As hypothesized, we found evidence that landowners who generated income due to wild pigs considered government or agency hunting to be a less acceptable and less effective method of control than those who did not generate income. One could speculate that individuals who derive income from wild pigs may consider such control efforts as unacceptable or ineffective due to the perception that such activities could hinder earning potential by removing pigs from the landscape. However, this is speculation and hunters who generated income from wild pigs but did not own land showed no such attitudes toward government or agency hunting, but, those hunters who generated income due to wild pigs have more positive attitudes towards control methods that can generate income (i.e., leased hunting, and trapping and selling wild pigs).

Among landowner groups, attitudes towards wild pigs were influenced by whether the land was used for agriculture. Landowners who received no income from wild pigs had more negative attitudes towards wild pigs if they used their land for agriculture. As wild pigs can cause considerable damage to crops and pose a threat to livestock (Bevins et al. 2014, Miller et al. 2017, Anderson et al. 2019, McKee et al. 2020), this negative attitude seems logical, as no income is generated from wild pigs to offset the losses associated with the species' presence on their land. Landowners who used their land for agriculture considered trapping and selling wild pigs a more acceptable or effective form of control than landowners who did not use their land for agriculture. Trapping allows wild pig control efforts to be confined to particular areas of land, which may reduce the potential damage to crops or disturbance to livestock that other control methods may create (e.g., leased hunting). Landowners that experienced neither income nor loss and used their land for agriculture considered government and agency control both less acceptable and less effective than those who did not use their land for agriculture. For those who do not experience losses due to wild pig damage, the presence of state or federal government agencies on their land may be seen as an infringement of their privacy with no potential benefit (Caplenor et al. 2017).

The primary finding from our study is that only a small minority of hunters appear to generate income from wild pigs in Texas. Less than 1% of nonlandowning hunters received direct financial benefit from wild pigs, and only 3.91% of land-owning hunters did so. The majority of surveyed landowners experienced only losses due to wild pigs, and losses were approximately fourfold larger than reported income. Our findings only

explain a fraction of the variance in hunter attitudes towards wild pigs and their management in Texas. While the economic benefits of wild pigs may be of considerable value to some stakeholder groups, most hunters receive no monetary gain from wild pigs. Thus, basing management decisions around those few who receive financial gains from wild pigs through guiding, selling, and leased hunting is reductionist, and likely fails to grasp the true nature of value conflicts between different stakeholder groups that result in disagreements regarding wild pig tolerance and management (Degner et al. 1983, Pfeiffer and Voeks 2008, Caplenor et al. 2017, von Essen 2020).

MANAGEMENT IMPLICATIONS

Our work suggests that wild pig eradication provides a far greater economic benefit in the form of damage abatement than the income from wild pig hunting for the landowners in Texas. Although our survey captured income generated by wild pigs via trapping and selling, guiding, and leased hunting, it did not capture the value of goods or services exchanged for such practices (e.g., trading hunting rights with other landowners). Nevertheless, we did not account for much of the attitude variance around wild pigs, indicating that there are other, human-based factors not included in this study that one should consider. Revenue derived from wild pigs should not be considered a driving factor in explaining hunters' attitudes towards wild pigs, regardless of landownership. Those tasked with and interested in the management of wild pigs, as well as hunting, must consider the needs and desires of a diverse hunting public in setting policy.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

Our study was reviewed by Texas A&M University Institutional Review Board and determined to meet the criteria for exemption (IRB ID No. IRB2018-1219M).

DATA AVAILABILITY STATEMENT

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

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REFERENCES

Adams, C. E., B. J. Higginbotham, D. Rollins, R. B. Taylor, R. Skiles, M. Mapston, and S. Turman. 1973. Regional perspectives and opportunities for feral hog management in Texas. Wildlife Society Bulletin 33:1312–1320.

Anderson, A., C. Slootmaker, E. Harper, J. Holderieath, and S. A. Shwiff. 2016. Economic estimates of feral swine damage and control in 11 US states. Crop Protection 89:89–94.

Anderson, A., C. Slootmaker, E. Harper, and S. A. Shwiff. 2019. Predation and disease-related economic impacts of wild pigs on livestock producers in 13 states. Crop Protection 121:121–126.

Barrios-Garcia, M. N., and S. A. Ballari. 2012. Impact of wild boar (*Sus scrofa*) in its introduced and native range: a review. Biological Invasions 14:2283–2300.

Beasley, J. C., S. S. Ditchkoff, J. J. Mayer, M. D. Smith, and K. C. Vercauteren. 2018. Research priorities for managing invasive wild pigs in North America. Journal of Wildlife Management 82:674–681.

Bevins, S. N., K. Pedersen, M. W. Lutman, T. Gidlewski, and T. J. Deliberto. 2014. Consequences associated with the recent range expansion of nonnative feral swine. BioScience 64:291–299.

Brant, R. 1990. Assessing proportionality in the proportional odds model for ordinal logistic regression. Biometrics 46: 1171–1178.

Brooks, J. P., R. K. Smith, C. A. Aldridge, B. Chaney, A. Omer, J. Dentinger, G. M. Street, and B. H. Baker. 2020. A preliminary investigation of wild pig (*Sus scrofa*) impacts in water quality. Journal of Environmental Quality 49:27–37.

Campbell, T. A., and D. B. Long. 2009. Feral swine damage and damage management in forested ecosystems. Forest Ecology and Management 257:2319–2326.

Caplenor, C. A., N. C. Poudyal, L. I. Muller, and C. Yoest. 2017. Assessing landowners' attitudes toward wild hogs and support for control options. Journal of Environmental Management 201:45–51.

Caudell, J., E. Dowell, and K. Welch. 2016. Economic utility for the anthropogenic spread of wild hogs. Human–Wildlife Interactions 10:230–239.

Christensen, R. H. B. 2019. ordinal–regression models for ordinal data. R package version 2019.12-10. https://CRAN.R-project.org/package=ordinal. Accessed 5 Feb 2021.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences. Second edition. Erlbaum Associates, Hillsdale, New Jersey, USA.

Connally, R. L., M. G. Frank, G. E. Briers, N. J. Silvy, K. M. Carlisle, and J. M. Tomeček. 2021. A profile of wild pig hunters in Texas, USA. Human-Wildlife Interactions 15:6–21.

Degner, R. L., L. W. Rodan, W. K. Mathis, and E. P. J. Gibbs. 1983. The recreational and commercial importance of feral swine in Florida: Relevance to the possible introduction of African swine fever into the U.S.A. Preventive Veterinary Medicine 1:371–381.

Dillman, D. A., J. D. Smyth, and L. M. Christian. 2008. Internet, mail, and mixed-mode surveys: the tailored design method. Third edition. Wiley, Hoboken, New Jersey, USA.

Ditchkoff, S. S., and M. J. Bodenchuk. 2020. Management of wild pigs. Pages 175–198 *in* K. C. VerCauteren, J. C. Beasley, S. S. Ditchkoff, J. J. Mayer, G. J. Roloff, and B. K. Strickland, editors. Invasive wild pigs in North America: ecology, impacts and management. CRC Press, Boca Raton, Florida, USA.

von Essen, E. 2020. How wild boar hunting is becoming a battleground. Leisure Sciences 42:552–569.

Fox, J., and J. Hong. 2009. Effect displays in R for multinomial and proportional-odds logit models: extensions to the effect package. Journal of Statistical Software 32:1–24.

Fox, J., and S. Weisberg. 2019. An R companion to applied regression. Third edition. Sage Publications, Thousand Oaks California, USA.

Gelman, A. 2007. Scaling regression inputs by dividing by 2 standard deviations. Statistics in Medicine 27:2865–2873.

Gelman, A., and Y.-S. Su. 2020. arm: data analysis using regression and multilevel/hierarchical models. R package version 1.11-2. https://CRAN.R-project.org/package=arm. Accessed 5 Feb 2021.

Grady, M. J., E. E. Harper, K. M. Carlisle, K. H. Ernst, and S. A. Shwiff. 2019. Assessing public support for restrictions on transport of invasive wild pigs (*Sus scrofa*) in the United States. Journal of Environmental Management 237: 488–494.

Greenwell, B. M., A. J. McCarthy, B. C. Boehmke, and D. Liu. 2017. sure: surrogate residuals for ordinal and general regression models. R package version 0.2.0. https://CRAN.R-project.org/package=sure. Accessed 5 Feb 2021.

Hart, A. 2001. Mann-Whitney test is not just a test of medians: differences in spread can be important. BMJ 323: 391–393.

Hartig, F. 2021. DHARMa: residual diagnostics for hierarchical (multi-level/mixed) regression models. R package version 0.4.1. https://CRAN.R-project.org/package=DHARMa. Accessed 5 Feb 2021.

Higginbotham, B. 2013. Wild pig damage abatement education and applied research activities. Texas A&M AgriLife Research and Extension Center-Overton. https://overton.tamu.edu/files/2013/06/Wild-Pig-Damage-Abatement-Education-Applied-Research-Activites.pdf. Accessed 12 Oct 2022.

IBM SPSS Statistics for Windows. Version 24.0. 2016. Armonk, New York, USA.

Jay, M. 2019. generalhoslem: goodness of fit tests for logistic regression models. R package version 1.3.4. https://CRAN.R-project.org/package=generalhoslem. Accessed 5 Feb 2021.

Kirch, P. V., and S. J. O'Day. 2003. New archaeological insights into food and status: a case study from pre-contact Hawaii. World Archaeology 34:484–497.

Lewis, J. A., J. L. Corn, J. J., Mayer, T. R. Jordan, M. L. Farnsworth, C. L. Burdett, K. C. VerCauteren, S. J. Sweeney, and R. S. Miller. 2019. Historical, current, and potential population size estimates of invasive wild pigs (*Sus scrofa*) in the United States. Biological Invasions 21:2373–2384.

Linder, J., T. Murphy, and G. Briers. 2001. Handling nonresponse in social science research. Journal of Agricultural Education 42:43–53.

Lipsitz, S. R., G. M. Fitzmaurice, and G. Molenbergh. 1996. Goodness-of-fit tests for ordinal response regression models. Journal of the Royal Statistical Society 45:175–190.

Long, J. A. 2019. interactions: comprehensive, user-friendly toolkit for probing interactions. R package version 1.1.0. https://cran.r-project.org/package=interactions. Accessed 10 Feb 2021.

Long, J. S., and L. H. Ervin. 2000. Using heteroscedasticity consistent standard errors in the linear regression model. The American Statistician 54:217–224.

Louviere, J. J., D. A. Hensher, and J. Swait. 2000. Stated choice methods: analysis and applications. Cambridge University Press, New York, New York, USA.

Mapston, M. E. 2004. Feral hogs in Texas. Texas Cooperative Extension. https://tfsweb.tamu.edu/uploadedFiles/TFSMain/Manage_Forest__Land/Wildlife_Management/Non-Game/Feral_hogs_TCE.pdf. Accessed 12 Oct 2022.

Mayer, J. J., and I. L. Brisbin, Jr. 1991. Wild pigs in the United States: their history, comparative morphology, and current status. University of Georgia Press, Athens, USA.

Mayer, J. J., and I. L. Brisbin, Jr. 2009. Wild pigs: biology, damage, control techniques and management. https://www.wildpiginfo.msstate.edu/pdfs/SRNL-Mayer-Biology%20Damage%20Control.pdf. Accessed 2 Dec 2021.

McClean, H. 2020. Understanding hunting-wild pig (*Sus scrofa*) interactions in the United States: a mixed-methods research approach to inform invasive species management. Thesis, Colorado State University, Fort Collins, USA.

McDonald, J. H. 2014. Handbook of Biological Statistics. Third edition. Sparky House Publishing, Baltimore, Maryland, USA.

McKee, S., A. Anderson, K. Carlisle, and S. A. Shwiff. 2020. Economic estimates of invasive wild pig damage to crops in 12 US states. Crop Protection 132:105105.

McKee, A. M., P. M. Bradley, D. Shelley, S. McCarthy, and M. Molina. 2021. Feral swine as sources of fecal contamination in recreational waters. Scientific Reports 11:4212.

Mellish, J. M., A. Sumrall, T. A. Campbell, B. A. Collier, W. H. Neill, B. Higginbotham, and R. R. Lopez. 2014. Simulating potential population growth of wild pig, Sus scrofa, in Texas. Southeastern Naturalist 13:367–376.

Miller, R. S., S. J. Sweeney, C. Slootmaker, D. A. Grear, P. A. di Salvo, D. Kiser, and S. A. Shwiff. 2017. Cross-species transmission potential between wild pigs, livestock, poultry, wildlife, and humans: implications for disease risk management in North America. Scientific Reports 7:7821.

Pfeiffer, J. M., and R. A. Voeks. 2008. Biological invasions and biocultural diversity: Linking ecological and cultural systems. Environmental Conservation 35:281–293.

Pimental, D. 2007. Environmental and economic costs of vertebrate species invasions into the United States. Managing Vertebrate Invasive Species: Proceedings of an International Symposium. G. W. Witmer, W. C. Pitt, and K. A. Fagerstone, editors. USDA/APHIS/WS, National Wildlife Research Center, Fort Collins, Colorado, USA.

R Core Team. 2018. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rizopoulos, D. 2006. ltm: an R package for latent variable modelling and item response theory analyses. Journal of Statistical Software 17:1–25.

Schlegel, B., and M. Steenbergen. 2020. brant: test for parallel regression assumption. R package version 0.3-0. https://cran.r-project.org/package=brant. Accessed 8 Feb 2021.

Signorell, A. 2021. DescTools: tools for descriptive statistics. R package version 0.99.40. https://cran.r-project.org/package=DescTools. Accessed 5 Feb 2021.

Tabak, M. A., A. J. Piaggio, R. S. Miller, R. A. Sweitzer, and H. B. Ernest. 2017. Anthropogenic factors predict movement of an invasive species. Ecosphere 8(6):e01844.

Texas Senate Bill 317. 2019. Relating to the taking of feral hog without a hunting license. https://legiscan.com/TX/text/SB317/id/2018952. Accessed 21 Nov 2021.

Venables, W. N., and B. D. Ripley. 2002. Modern applied statistics with S. Fourth edition. Springer, New York, New York, USA.

Weeks, P., and J. Packard. 2009. Feral hogs: invasive species or nature's bounty? Human Organization 68:280–292.

Wickham, H. 2016. Ggplot2: elegant graphics for data analysis. Springer-Verlag, New York, New York, USA.

Yee, T. W. 2015. Vector generalized linear and additive models: with an implementation in R. Springer, New York, New York, USA.

Zivin, J., B. M. Hueth, and D. Zilberman. 2000. Managing a multiple-use resource: the case of feral pig management in California rangeland. Journal of Environmental Economics and Management 39:189–204.

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