Texas hunters' perceptions regarding the acceptability of toxicants to control wild pig populations

Keith M. Carlisle,[1] Department of Human Dimensions of Natural Resources, Warner College of Natural Resources, Colorado State University, 1480 Campus Delivery, Fort Collins, CO 80523, USA *keith.m.carlisle@usda.gov*

Sophie McKee, Department of Economics, College of Liberal Arts, Colorado State University, C138 Clark Building, Fort Collins, CO, 80523, USA

Hailey E. Ellis, Department of Human Dimensions of Natural Resources, Warner College of Natural Resources, Colorado State University, 1480 Campus Delivery, Fort Collins, CO 80523, USA

Lauren M. Jaebker, Department of Human Dimensions of Natural Resources, Warner College of Natural Resources, Colorado State University, 1480 Campus Delivery, Fort Collins, CO 80523, USA

John M. Tomeček, Department of Rangeland, Wildlife, and Fisheries Management, Texas A&M University, 495 Horticulture Rd., College Station, TX 77843, USA

Alan D. Bright, Department of Human Dimensions of Natural Resources, Warner College of Natural Resources, Colorado State University, 1480 Campus Delivery, Fort Collins, CO 80523, USA

Rachael L. Connally, Department of Rangeland, Wildlife, and Fisheries Management, Texas A&M University, 495 Horticulture Rd., College Station, TX 77843, USA

Maureen G. Frank, Department of Rangeland, Wildlife, and Fisheries Management, Texas A&M University, 495 Horticulture Rd., College Station, TX 77843, USA

Stephanie A. Shwiff, National Wildlife Research Center, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Fort Collins, CO 80521, USA

Abstract: Wild pigs (*Sus scrofa*) are an invasive species in the United States. They damage agriculture, degrade water quality and ecological communities, and host a number of viruses, parasites, and bacteria transmissible to humans and animals. In states such as Texas, USA, where wild pigs cause extensive damage to agriculture and property, officials have considered allowing for the use of toxicants to control wild pig populations. To provide decision-makers with information regarding stakeholders' perceptions of the use of toxicants to control wild pigs, we surveyed Texas hunters in 2019 to assess the level of acceptance of a hypothetical wild pig toxicant, the sociodemographic and other factors most closely associated with acceptability of such a toxicant, and the specific concerns that underlie hunters' positions on the use of such a toxicant. We received 37,317 completed responses to an online, self-administered survey. Respondents were divided over the use of a toxicant, with 43% finding a toxicant acceptable, 18% neutral, and 39% finding a toxicant unacceptable. The factor most closely associated with acceptance of a wild pig toxicant was respondents' desired wild pig population size in Texas (χ^2 = 3,657.7, P < 0.001, V = 0.26), with 70% of respondents who preferred that wild pigs be completely removed from Texas finding the use of a toxicant to be acceptable, compared to 14% of respondents who preferred that wild pig populations increase or stay the same. The most commonly raised concerns in connection with toxicant usage were potential negative impacts to nontarget animals (33%) and negative impacts to human health (24%). Our research suggests that while achieving a consensus among Texas hunters on toxicant usage is unrealistic, building majority support may be possible if the identified concerns are sufficiently addressed in product development and outreach.

Key words: feral pigs, human dimensions, hunters, invasive species, management, perceptions, *Sus scrofa,* Texas, toxicant

Wild pigs (*Sus scrofa*), also known as feral swine, feral hogs, wild hogs, and wild boar (Keiter et al. 2016), are an invasive species in the United States that include introduced Eurasian wild boar, descendants of escaped domestic pigs, and hybrids of the two (Corn and Jordan 2017). They cause significant damage to agriculture, degrade water quality and ecologi-

[1]Present address: National Wildlife Research Center, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Fort Collins, CO 80521, USA

cal communities, and host a number of viruses, parasites, and bacteria transmissible to humans and animals (Lewis et al. 2019, Brooks et al. 2020, McKee et al. 2020).

Over the last several decades, wild pig populations have expanded across the southern United States into western and midwestern states, with at least 35 states now hosting wild pig populations (Corn and Jordan 2017). With this range expansion, the U.S. wild pig population has grown from an estimated 2.4 million in 1982 to an estimated 6.9 million in 2016 (Lewis et al. 2019). This relatively dramatic growth has been attributed to multiple factors, including the species' high fecundity and adaptability as well as human translocation, primarily for the purpose of sport hunting (Caplenor et al. 2017, Grady et al. 2019).

To curb population growth and mitigate damages, private and government actors have used a variety of control methods, including aerial shooting, trapping, snaring, and hunting (Davis et al. 2018). While these efforts have not generally kept pace with the growth of wild pig populations in the most heavily affected states, they have almost certainly helped to avoid greater economic losses, as wild pigs may be capable of tripling their population every 5 years in the absence of control (Sanders et al. 2020).

Mounting losses for agricultural producers in Texas, USA, have put additional pressure on state officials to adopt new measures to control the growing wild pig population. To that end, in 2017, the Texas Agriculture Commissioner issued an emergency rule approving limited use of a warfarin-based wild pig toxicant marketed as Kaput® Feral Hog Bait (Kaput; Scimetrics Ltd. Corp, Wellington, Colorado, USA), the only federally registered wild pig toxicant (Poché et al. 2018; 42 Tex. Reg. at 735). This action was quickly met with a backlash from various environmental, hunting, and industry groups. Amid the controversy, the manufacturer of Kaput withdrew the toxicant's registration in Texas in 2017.

No wild pig toxicants are presently used in Texas or any other U.S. state, though efforts are underway to develop a sodium nitrite-based wild pig toxicant for use in the United States (Snow et al. 2018). In addition, Kaput remains federally registered, leaving open the possibility for re-registration in Texas. A successful introduction of either of these toxicants may hinge, in part, on understanding and satisfactorily addressing the concerns of stakeholders in advance.

The objectives of this study were to measure Texas hunters' level of acceptance of a wild pig toxicant, to determine the factors most closely associated with hunters' acceptance of a wild pig toxicant, and to identify the most common concerns that inform hunters' acceptance, or lack of acceptance, of a wild pig toxicant. For purposes of our research, we considered a "Texas hunter" to be anyone who hunted wild pigs or other species in the state of Texas, regardless of their state of residence. With respect to the first objective, we also examined acceptability of 4 other commonly used wild pig lethal control methods (trapping and lethal removal, lease hunting, use of snares, and aerial shooting) for comparative purposes, and we evaluated the potential for conflict associated with toxicant usage relative to the other control methods. With respect to the second objective, additional factors we examined in relation to toxicant acceptance included the extent to which hunters prefer to hunt wild pigs, their level of concern about several types of damages associated with wild pigs, their preferred wild pig population size, ownership or management of any land in Texas and the uses of such land, income from wild pig-related activities, economic losses from wild pigs, and several sociodemographic characteristics (age, gender, and state residency).

We focused on Texas hunters because they are a key stakeholder group in the context of wild pig control and the use of toxicants. In this regard, hunters proved to be among the most effective and organized critics of the state's 2017 decision to allow limited use of Kaput. Immediately following the announcement of the decision, a wild pig hunting organization generated an online petition that quickly garnered thousands of signatures, and hunting interests joined with other groups to lobby the state for legislation to restrict toxicant usage (Zielinski 2017). In response, the Texas House of Representatives passed a bill requiring further scientific study of any lethal toxicant intended for use on wild pigs in Texas (Crum 2017).

While hunters made headlines in 2017 for opposing toxicants in Texas, no studies have investigated the specific concerns and beliefs that inform hunters' attitudes toward toxicants.

Jaebker et al. (2021) engaged with social identity theory in examining whether Texas hunters' acceptability levels for several wild pig control methods varied by membership in conservation, agriculture, and hunting organizations (the authors found no meaningful differences). This study takes a different approach by not only examining acceptability levels toward a toxicant, but by also analyzing the specific preferences and concerns of hunters when it comes to toxicant usage in Texas. Further, it examines a range of variables (e.g., profit or loss associated with wild pigs) to explain or predict toxicant acceptability, and it measures the level of polarization among hunters on the issue of toxicant usage. This in-depth examination of hunters' beliefs and attitudes concerning a wild pig toxicant provides useful information to Texas decision-makers, natural resource managers, and toxicant developers in relation to any potential or planned introduction of a toxicant in Texas. Our study may also be of interest to decision-makers in other locations who are considering approval of a wild pig toxicant, as the concerns expressed by hunters in this study provide a window into the types of issues that may arise elsewhere.

Study area

The state of Texas, located in the south-central region of the United States, comprises 673,397 km^2 of land and a variety of geographical regions with distinct landscape attributes and climates (Carlisle et al. 2021). It has one of the largest agriculture industries in the nation, ranking third among states in 2014 in agricultural cash receipts behind California and Iowa, USA (Gleaton and Robinson 2016). In addition, of all U.S. states confronted with wild pig challenges, none has been more affected than Texas. With an estimated wild pig population of 2.5 million in 2016 (Lewis et al. 2019), Texas has more wild pigs than any other state. Moreover, with wild pigs present in nearly every county of the state (Froehly et al. 2020), damage management is a statewide issue. The ubiquity of wild pigs in Texas has resulted in considerable agricultural losses. Anderson et al. (2016) estimated that Texas producers suffered nearly $90 million USD in losses in 2014 attributed to wild pig damage to 6 high-value crops. McKee et al. (2020) found that Texas producers of 4 additional crops lost almost $116 million USD in 2018 to wild pigs. Both studies found that crop losses in Texas to wild pigs exceeded those in other states with significant wild pig populations, reflecting both the large number of wild pigs in Texas as well as the size of the state's crop industry.

Methods

The Texas A&M University Institutional Review Board reviewed this study and determined that it met the criteria for exemption (IRB ID: IRB2018-1219M). We primarily collected data for this study using an online questionnaire hosted on Qualtrics, an online survey platform, under the auspice of the Texas A&M AgriLife Extension Service. Two of the individuals who developed the questionnaire were licensed Texas hunters with subject matter expertise. In addition, the questionnaire was pretested by 51 individuals, 9 of whom worked for the Texas Parks and Wildlife Department (TPWD) and 42 of whom worked for Texas A&M AgriLife Extension Service as extension agents.

The sample population was provided by TPWD and included all holders of a Texas hunting license (in-state and out-of-state) above the age of 18 for the 2018–2019 hunting year who had an email address on record with TPWD (n = 169,619 out of 1,106,625 licensed non-youth Texas hunters). To evaluate coverage error, we also included in our sample a randomly selected subset of 2,615 licensed Texas hunters who did not have an email address on record with TPWD (total n = 172,234).

Although TPWD does not issue a wild pig hunting license, a general hunting license was required to hunt wild pigs in Texas at the time of survey administration, the only exception being the killing of a wild pig by a landowner while it was causing damage to the landowner's property. Thus, a large proportion of wild pig hunters in Texas, as well as hunters who target other species, were likely included in our sample.

On June 4, 2019, an email was sent to sample members inviting them to participate in the survey, and 5 days later, sample members were emailed a reminder about survey participation. An invitation letter to participate in the survey (online or through a paper survey) was mailed to the subset of sample members with no email address on record on June 5, 2019, and we followed the invitation letter with a reminder postcard to 1,000 randomly selected mail group

non-respondents 21 days later on June 26, 2019. The window for accepting completed surveys remained open through August 13, 2019. Data were exported from Qualtrics into a relational database created in FileMakerPro v14, where we collated data for analysis.

Variables assessed

Acceptability of a wild pig toxicant was measured through a questionnaire item that asked whether use of a "safe, humane toxicant" to control wild pigs is, or would be, personally acceptable. Our formulation of this item was informed by Carlisle et al. (2020), a survey study that examined the U.S. public's attitudes toward a wild pig toxicant that caused "minimal suffering and little harm to other wildlife." One-third of respondents in that study raised a concern about potential impacts to wildlife and other animals, though it is possible that the prevalence of the concern was the result of a priming effect (Vitale et al. 2008) stemming from the wording of the item. We included the modifiers "safe" and "humane" to provide a minimum amount of information that respondents may have needed to evaluate acceptability, but we did not specify what was meant by "safe" (e.g., safe for human consumption or safe for wildlife) or "humane" (e.g., fast acting or painless) so as to minimize any priming effect on responses to a subsequent open-ended item in which participants were asked "Please tell us more about your position on a safe, humane toxicant for wild pigs." Acceptability was rated on a 5-point scale from "completely unacceptable" (1) to "completely acceptable" (5). Acceptability of the use of snares, aerial shooting, lease hunting, and trapping and lethal removal were measured using the same 5-point scale. Responses from the open-ended question were analyzed to identify concerns that informed respondents' acceptance, or lack of acceptance, of a wild pig toxicant.

The independent variables used in our analysis were: (1) whether a participant hunted wild pigs; (2) a participant's preference for hunting wild pigs over other species (i.e., the extent to which a participant hunted wild pigs versus other animals on most hunting trips); (3) preferred wild pig population size; (4) income in 2018 from wild pig-related activities; (5) personal economic losses in 2018 due to wild pigs; (6) ownership or management of land in Texas; (7) growing crops, raising livestock, or engaging in personal recreation on any land owned or managed in Texas; (8) level of concern about crop losses, damage to pastures, or wildlife competition or predation by wild pigs; and (9) selected sociodemographic characteristics (e.g., age, gender, and state residency).

We categorized respondents as wild pig hunters based upon a questionnaire item that asked participants to indicate, and rank by importance, the species they hunted in Texas from a provided list. Responses were converted to a dichotomous variable whereby respondents who assigned any rank to wild pigs were categorized as wild pig hunters. Wild pig hunting preference was measured by an item that asked participants who previously indicated that they hunted wild pigs to select 1 of 5 statements that best describes the extent to which they target wild pigs and native game on most of their hunting trips. For purposes of analysis, we converted responses to 3 categories (primarily hunted wild pigs, hunted wild pigs and native game about equally, and primarily hunted native game). Preferred wild pig population size was measured through an item that asked participants to select the change they would like to see in wild pig population numbers in Texas from the following 4 options: completely removed, reduced, remain the same, and increase.

Income from wild pig-related activities was measured through items that asked participants to write in the amount of income they earned in 2018 from selling wild pigs, providing wild pig guide or outfitting services, and leasing wild pig hunting rights. Responses were converted to dichotomous variables whereby respondents who entered an amount greater than zero for 1 of these items were categorized as having earned income for that particular activity. Similarly, economic losses to wild pigs were measured through an item that asked participants to write in their estimated total economic losses to wild pigs in 2018.

We converted responses to a dichotomous variable whereby respondents who entered an amount greater than zero were categorized as having suffered an economic loss to wild pigs in 2018. Ownership or management of land in Texas was a dichotomous variable determined through an item that asked participants to indicate (yes/no) whether they own or manage land in Texas.

Those who answered yes were asked to rank by importance their uses of the land from a list of options. Dichotomous variables were created for the 3 land use types relevant to this study (farming/crops, livestock, and personal recreation) such that if a respondent assigned any rank to one of those land uses, the respondent was categorized as engaging in that land use.

We measured respondent level of concern about crop losses, damage to pastures, and wildlife competition or predation by wild pigs through an item that asked participants to rate their level of concern about these risks on a 5-point scale (1 = no concern, 5 = very high level of concern). We converted responses to 3 levels for analysis (no/low concern, moderate concern, high concern).

With respect to sociodemographic characteristics, Texas residency was a dichotomous variable determined according to information provided by TPWD concerning the type of hunting license (in-state or out-of-state) purchased by the sample member. Gender was a dichotomous variable determined according to an item that asked participants to identify their gender. Finally, age was measured by an item that asked participants to enter their birth year. We converted the responses to 5 levels for analysis: (1) <30, (2) 30–44, (3) 45–59, (4) 60–74, and (5) >74.

Data analysis

We calculated mean and percentage acceptance scores of toxicant usage and the other lethal control methods using R statistical software (R Development Core Team 2018). We then measured the potential for conflict for each control method in Microsoft Excel using the Potential for Conflict Index$_2$ (PCI_2), which provides a value ranging from 0 to 1, with 0 indicating consensus and 1 indicating the greatest potential for conflict (Vaske et al. 2010). A value of 0 is produced when all responses are distributed at a single point on the response scale, while a value of 1 is produced when responses are equally divided between the 2 most extreme points on the response scale (Harper et al. 2016). Statistical differences between PCI_2 values were tested in Microsoft Excel using pairwise *t* tests.

To examine relationships between toxicant acceptability and the independent variables, we conducted bivariate analyses in R statistical software. For this purpose, toxicant acceptability was converted to a 3-level variable (unacceptable, neutral, and acceptable), and we calculated the percentage of respondents who found the use of a wild pig toxicant to be unacceptable, neutral, and acceptable as a function of each independent variable. Pearson's chi-square tests were then conducted to assess statistical independence between the 3-level categorical variable on toxicant acceptance and all other variables. An alpha level of $P < .05$ was used to determine statistical significance, and Cramer's V was calculated as a measure of effect size to determine the practical significance of the findings. We used guidelines suggested by Vaske (2008) to interpret V scores, with V = 0.1 constituting a minimal effect size, V = 0.3 constituting a typical effect size, and V = 0.5 constituting a substantial effect size.

We analyzed and coded all qualitative data from the open-ended item seeking information about respondents' position on a wild pig toxicant in Microsoft Excel. We used an inductive coding process whereby codes (i.e., labels) were assigned to themes representing concerns that informed acceptance or lack of acceptance of a toxicant as they emerged during the process of data analysis. Once all responses were coded, the first 10,000 responses (representing a threshold beyond which no new themes had been identified during the first pass) were re-analyzed to ensure that all identified codes were applied consistently. Calculations were then made in Microsoft Excel to determine the number of occurrences of each theme across 3 respondent groups: those who found the use of a wild pig toxicant to be unacceptable, those who were neutral on the issue, and those who found the use of a wild pig toxicant to be acceptable.

Results

Respondent characteristics

Out of 169,619 emailed survey invitations, 10,199 emails (6%) were returned as undeliverable, and out of 2,615 mailed survey invitations, 121 (5%) were returned as undeliverable. Of the 161,914 survey invitations that reached sample members, 37,317 surveys were completed, providing an overall response rate of 23%.

Most respondents were male (96%) and white (91%), with a mean age of 51.6 and a median age of 53. Median household income was >$100,000,

Table 1. Acceptability levels ($\bar{x}$ and %) and potential for conflict (0 to 1) for wild pig (*Sus scrofa*) lethal control methods among hunters in Texas, USA, 2019. Overall mean: 5-point scale (1 = completely unacceptable, 5 = completely acceptable).

Control method	Overall mean	Completely unacceptable %	Somewhat unacceptable %	Neutral %	Somewhat acceptable %	Completely acceptable %	Potential for conflict index$_2$
Toxicant	3.08	27	12	18	11	32	0.58
Snares	3.57	13	12	19	17	39	0.45
Aerial shooting	4.20	7	5	11	17	60	0.30
Lease hunting	4.43	3	3	9	17	68	0.17
Trap and lethal removal	4.49	3	3	8	15	71	0.17

and 58% of respondents had completed a bachelor's degree or higher. In addition, 89% of respondents were Texas residents, and 73% of respondents indicated that they hunt wild pigs.

The survey response rate for the subset of hunters who received a survey invitation through regular mail (i.e., hunters with no email address on record with TPWD) was low (7%; n = 177), preventing meaningful comparisons between the 2 groups. We note, however, that we found no statistical difference on the question of toxicant acceptability between respondents with email addresses and those with no email addresses on record with TPWD (χ^2 = 8.794, P = 0.36).

In terms of representativeness of the study population, information provided by TPWD shows that the mean age of licensed Texas hunters for the 2018–2019 hunting year was 51.5, while 89% were male, and 94% were Texas residents. Thus, our completed sample had a somewhat higher proportion of males and out-of-state residents than the study population, but it was similar in terms of age. The TPWD provided no information on race/ethnicity, income, or education level of licensed hunters.

Following Lindner et al. (2001), we used an extrapolation method to test for nonresponse bias whereby respondents were divided into 2 equal groups of early and late responders. We then conducted Pearson's chi-square tests to assess statistical differences between the 2 groups on variables of interest, and we found either no statistical differences (α = 0.05) or effect sizes (V) that failed to reach the minimal threshold. The 5 variables were: (1) toxicant acceptability (χ^2 = 34.302, P <0.001, V = 0.035); (2) whether a participant hunted wild pigs (χ^2 = 88.012, P < 0.001, V = 0.05); (3) wild pig hunting preference (χ^2 = 12.625, P < 0.05, V = 0.013); (4) preferred wild pig population size (χ^2 = 49.45, P < 0.001, V = 0.041); and (5) ownership or management of land in Texas (χ^2 = 0.878, P = 0.349, V = 0.005). While we cannot conclude there was no nonresponse bias, we found negligible evidence of nonresponse bias using the extrapolation method.

Toxicant acceptability

Across all respondents, the mean acceptability score for the use of a safe, humane toxicant was 3.08 out of 5.0, with 27% completely unacceptable, 12% somewhat unacceptable, 18% neutral, 11% somewhat acceptable, and 32% completely acceptable (Table 1). By contrast, the mean acceptability scores for snares, aerial shooting, lease hunting, and trapping and lethally removing were 3.57, 4.20, 4.43, and 4.49, respectively. Among the 5 wild pig control methods, use of a safe, humane toxicant had the highest PCI_2 value (0.58), indicating a relatively higher degree of polarization and potential for conflict. The PCI_2 values for snares, aerial shooting, lease hunting, and trapping and lethally removing were 0.45, 0.3, 0.17, and 0.17, respectively. All PCI_2 values differed from one another (P < 0.05), with the exception of lease hunting and trapping and lethally removing.

Bivariate analyses

We were able to reject the null hypothesis of statistical independence in the Texas hunter population between the 3-level variable on toxicant

Table 2. Bivariate analysis of wild pig (*Sus scrofa*) toxicant acceptability (%) and independent variables among hunters in Texas, USA, 2019.

	Acceptability of safe, humane toxicant					
Independent variable	Unacceptable %	Neutral %	Acceptable %	χ^2	*P*	*V*
All respondents	39	18	43			
Preferred wild pig population size in Texas				3,657.70	<0.001	0.26
Completely removed	18	12	70			
Reduced	37	20	43			
Remain same	70	16	14			
Increased	75	11	14			
Concern about damage to pastures				973.38	<0.001	0.13
No/low concern	62	16	22			
Moderate concern	51	20	29			
High concern	35	18	47			
Concern about wildlife				733.66	<0.001	0.12
No/low concern	57	17	26			
Moderate concern	47	21	32			
High concern	36	17	47			
Economic loss to wild pigs in 2018				152.15	<0.001	0.12
Suffered economic loss to wild pigs	32	16	52			
No economic loss to wild pigs	42	18	40			
Concern about crop losses				675.37	<0.001	0.11
No/low concern	54	17	29			
Moderate concern	48	19	33			
High concern	35	18	47			
Whether or not hunt wild pigs				330.23	<0.001	0.11
Hunt wild pigs	42	17	41			
Do not hunt wild pigs	29	20	51			
Ownership/management of land in Texas				271.18	<0.001	0.10
Own/manage land	35	17	48			
Do not own/manage land	43	19	38			
Age				405.46	<0.001	0.09
0–29 years	46	16	38			
30–44 years	46	16	38			
45–59 years	40	19	41			
60–74 years	33	18	49			
75 years and over	27	19	54			
Wild pig hunting preference				330.96	<0.001	0.09
Primarily hunt wild pigs	51	16	33			
Hunt wild pigs and native game about equally	49	17	34			
Primarily hunt native game	38	18	44			

Table continued on next page...

Table continued from previous page.

Land use: livestock				232.98	<0.001	0.09
Use land for livestock	33	16	51			
Do not use land for livestock	41	19	40			
Land use: farming/crops				122.04	<0.001	0.07
Use land for farming/crops	33	15	52			
Do not use land for farming/crops	40	18	42			
Land use: personal recreation				95.83	<0.001	0.06
Use land for personal recreation	37	16	47			
Do not use land for personal recreation	41	18	41			
State residency				9.19	0.01	0.02
Texas residents	39	18	43			
Out-of-state residents	38	20	42			
2018 income from wild pig guide services				8.57	0.01	0.02
Income	46	19	35			
No income	39	18	43			
2018 income from wild pig hunting lease				3.99	0.14	0.02
Lease income	40	15	45			
No lease income	35	16	49			
Gender				5.41	0.07	0.01
Male	40	17	43			
Female	38	20	42			
2018 income from selling wild pigs				2.17	0.34	0.01
Income	37	16	47			
No income	37	17	46			

acceptance and all other variables except for gender ($\chi^2 = 5.41$, $P = 0.07$), income in 2018 from leasing wild pig hunting rights ($\chi^2 = 3.99$, $P = 0.14$), and income in 2018 from selling wild pigs ($\chi^2 = 2.17$, $P = 0.34$; Table 2). Preferred wild pig population size in Texas was the variable with the strongest relationship with respondents' level of acceptance of a wild pig toxicant ($\chi^2 = 3{,}657.70$, $P < 0.001$). The effect size for this variable ($V = 0.26$) was minimal, however, with 70% of respondents who preferred to see wild pigs completely removed from Texas finding the use of a toxicant to be acceptable and 14% of respondents who preferred wild pig populations to increase or stay the same finding the use of a toxicant to be acceptable. Eleven other variables had effect sizes that were minimal or near the minimal threshold, as follows (by order of effect size): (1) concern about damage to pastures by wild pigs ($\chi^2 = 973.38$, $P < 0.001$, $V = 0.13$); (2) concern about wild pigs' predation of or competition with wildlife ($\chi^2 = 733.66$, $P < 0.001$, $V = 0.12$); (3) economic losses to wild pigs in 2018 ($\chi^2 = 152.15$, $P < 0.001$, $V = 0.12$); (4) concern about crop losses ($\chi^2 = 675.37$, $P < 0.001$, $V = 0.11$); (5) whether or not the respondent hunted wild pigs ($\chi^2 = 330.23$, $P < 0.001$, $V = 0.11$); (6) ownership or management of land in Texas ($\chi^2 = 271.18$, $P < 0.001$, $V = 0.10$); (7) age ($\chi^2 = 405.46$, $P < 0.001$, $V = 0.09$); (8) wild pig hunting preference ($\chi^2 = 330.96$, $P < 0.001$, $V = 0.09$); (9) livestock production on land owned or managed in Texas ($\chi^2 = 232.98$, $P < 0.001$, $V = 0.09$); (10) farming or growing crops on land owned or managed in Texas ($\chi^2 = 122.04$, $P < 0.001$, $V = 0.07$); and (11) using land owned or managed in Texas for personal recreation ($\chi^2 = 95.83$, $P < 0.001$, $V = 0.06$).

Table 3. Explanation of themes occurring in responses by hunters in Texas, USA, when explaining their positions on wild pig (*Sus scrofa*) toxicant usage, 2019.

Theme	Explanation
Impacts on human health	Respondent expresses concern related to human health (e.g., ingestion of tainted wild pig meat)
Impacts on nontarget animals	Respondent expresses concern about unintended adverse impact on nontarget animals (pets, livestock, wildlife) from ingesting toxic bait or scavenging off a tainted carcass
Unknown unknowns	Respondent expresses concern about presently unknowable consequences of toxicants
Environmental impacts	Respondent expresses concern about potential adverse impacts to the environment (soil, water, plants, and/or habitat)
Pain and suffering	Respondent expresses concern about possible pain and suffering associated with toxicants
Waste of meat	Respondent expresses concern that toxicant usage could result in the waste of otherwise edible meat
Carcasses	Respondent expresses concern that the accumulation of pig carcasses could pose a nuisance, health hazard, or attract more predators
Toxicants most effective	Respondent believes that a toxicant would be the most effective method for controlling wild pigs
Last resort	Respondent prefers other control methods and approves of toxicants only as a last resort
Toxicants ineffective	Respondent believes toxicants would be ineffective at controlling wild pigs
Unethical/immoral	Respondent finds use of a toxicant to be unethical, immoral, or wrong
Damage caused by wild pigs	Respondent states that wild pigs are destructive or cause damage to property, agriculture, ecosystems, and/or wildlife
Invasive/pest/nuisance	Respondent uses the term "invasive," "pest," or "nuisance" to describe wild pigs
Cultural resource	Respondent states that wild pigs are a valuable resource for food or recreation in Texas
Economic resource	Respondent states that wild pigs bring economic benefits or income to Texans
Enjoy hunting wild pigs	Respondent states that he/she personally enjoys hunting wild pigs
No elimination of wild pigs	Respondent states that he/she does not want wild pigs eliminated from Texas
Wild pigs negatively impact hunting	Respondent states that wild pigs negatively impact hunting for other game
Allow/incentivize more wild pig hunting	Respondent prefers that wild pigs be controlled by placing fewer restrictions on wild pig hunting (e.g., on public lands) or by creating bounties for harvested wild pigs
Contraception/ sterilant	Respondent would prefer that wild pig contraception or a chemical sterilant be developed and used
Expand market/uses for meat	Respondent suggests easing restrictions on selling wild pig meat or creating more uses/markets for the meat in order to incentivize more hunting of wild pigs as a control method
Highly regulated/ controlled	Respondent states that if a toxicant is approved for use, it must be highly regulated or controlled (e.g., for use only on large land parcels, require license or training to administer)
Toxicant misuse	Respondent expresses concern that a toxicant will be misused by the public
Extensive research	Respondent states that extensive, long-term research should be required before any toxicant is approved
Hunting/trapping insufficient	Respondent states that hunting and trapping are insufficient to control growing wild pig populations

Table continued on next page...

Table continued from previous page.

Would hunt less	Respondent states that he/she or others would hunt less if a wild pig toxicant were used in Texas
Distrust government involvement	Respondent indicates that he/she distrusts the government in connection with the development, approval, or use of a toxicant
Landowners limit wild pig hunting	Respondent complains that toxicants would be unnecessary if landowners did not charge so much or restrict wild pig hunting on their property
Toxicant cost	Respondent expresses concern that toxicant or required toxic bait feeder could be cost prohibitive

Concerns informing toxicant acceptability

In total, 19,236 respondents (52%) provided responses to the open-ended item "Please tell us more about your position on a safe, humane toxicant for wild pigs." Of those respondents, 18,410 (96%) also responded to the item that asked participants to rate the acceptability of a safe, humane toxicant, with 44% finding a toxicant unacceptable, 16% neutral, and 40% finding a toxicant acceptable. As a group, the respondents who responded to the open-ended item were somewhat less accepting of a toxicant, with a mean toxicant acceptability score of 2.95 out of 5.0, compared to 3.08 for all respondents.

Analysis of the responses revealed 29 themes or concerns that informed respondents' acceptance or lack of acceptance of a wild pig toxicant (Table 3). The theme that occurred most frequently was concern about negative impacts to nontarget animals (33%; n = 6,075), with 48% of respondents who raised the concern finding toxicants unacceptable, 15% indicating they are neutral on the issue, and 37% finding toxicants acceptable (Table 4). Nontarget animals of concern included not only wildlife, but also pets and livestock. Perceived risks to nontarget animals included direct consumption of the toxicant as well as scavenging off the carcasses of poisoned wild pigs. Some respondents also raised concerns about long-term effects on other animals (e.g., "At this point there is no research available to confirm the long-term effects of toxicants on wildlife…control techniques such as this could cause long-term repercussions on other wildlife").

Concern about nontarget animals was followed in frequency of occurrence by concern about possible negative impacts on human health (24%; n = 4,331), with toxicant acceptability percentages mirroring those associated with concern about negative impacts to nontarget animals. Most of the concerns relating to human health explicitly referred to the possibility that someone could unknowingly eat meat from a wild pig that had consumed the toxicant (e.g., "People consuming the meat that could have been tainted makes me nervous because a lot of people eat what they shoot," and "As primarily a subsistence hunter, I would be quite upset, as I would discontinue to hunt and eat the meat of hogs if a poison were in use, even if supposedly safe…I only want natural meat, and this is my reason for hunting").

The 3 themes rounding out the 5 most frequently occurring themes were concern about negative environmental impacts (e.g., to soil, water, and habitat; 6%; n = 1,041), concern about "unknown unknowns" (i.e., negative consequences that are presently unknowable; 6%; n = 1,041), and concern about damage caused by wild pigs, including damage to property, agriculture, and ecosystems (5%; n = 849). The theme associated with the highest percentage of acceptance of a toxicant was belief that a toxicant would be the most effective method for controlling wild pigs (93% toxicant acceptability), followed by belief that hunting and trapping are insufficient for controlling wild pigs in Texas (90% toxicant acceptability). The theme associated with the lowest percentage of acceptance for toxicant usage was belief that toxicants are immoral, unethical, or wrong (2% toxicant acceptability), followed by the assertion that the respondent and/or others would hunt less in Texas if a toxicant were in use (8% toxicant acceptability).

Discussion

Although Texas hunters, and wild pig hunters in particular, may have appeared fairly united in their opposition to a warfarin toxicant in 2017, our findings show that Texas hunters—regardless of whether they hunt wild pigs—are far

Table 4. Frequency of themes (% and *n*) occurring in responses by hunters in Texas, USA, when explaining their positions on wild pig (*Sus scrofa*) toxicant usage and correlation of themes with responses on the acceptability of a wild pig toxicant (%), 2019.

		Acceptability of safe, humane toxicant		
Theme	% and # of responses	Unacceptable %	Neutral %	Acceptable %
Impacts on nontarget animals	33 (*n* = 6,075)	48	15	37
Impacts on human health	24 (*n* = 4,331)	48	15	37
Environmental impacts	6 (*n* = 1,041)	58	12	30
Unknown unknowns	6 (*n* = 1,041)	71	14	15
Damage caused by wild pigs	5 (*n* = 849)	17	12	71
Allow/incentivize more wild pig hunting	3 (*n* = 574)	77	11	12
Pain and suffering	3 (*n* = 469)	54	12	35
Extensive research	2 (*n* = 424)	41	21	38
Toxicants most effective	2 (*n* = 394)	4	3	93
Cultural resource	2 (*n* = 374)	77	11	12
Contraception/sterilant	2 (*n* = 341)	22	13	65
Hunting/trapping insufficient	2 (*n* = 338)	6	4	90
Last resort	2 (*n* = 320)	43	25	32
Highly regulated/controlled	2 (*n* = 302)	23	16	61
Invasive/pest/nuisance	2 (*n* = 280)	27	9	64
Enjoy hunting wild pigs	1 (*n* = 272)	50	16	34
Waste of meat	1 (*n* = 234)	77	13	10
Carcasses	1 (*n* = 221)	56	18	26
Expand market/uses for meat	1 (*n* = 199)	78	11	11
Toxicants ineffective	1 (*n* = 162)	53	19	28
Economic resource	1 (*n* = 148)	77	8	15
Distrust government involvement	1 (*n* = 130)	61	16	23
Would hunt less	1 (*n* = 130)	83	9	8
No elimination of wild pigs	1 (*n* = 120)	41	19	40
Landowners limit wild pig hunting	1 (*n* = 115)	75	16	9
Wild pigs negatively impact hunting	1 (*n* = 106)	10	11	79
Toxicant misuse	1 (*n* = 103)	59	16	25
Unethical/immoral	1 (*n* = 96)	94	4	2
Toxicant cost	1 (*n* = 93)	16	20	64

from homogenous in their level of acceptance of a hypothetical safe and humane wild pig toxicant. Among the 5 lethal control methods that we examined, the degree of polarization or potential for conflict was highest for toxicant usage, with 39% of respondents finding a safe, humane toxicant unacceptable, 18% neutral, and 43% acceptable. While there was a statistical difference in toxicant acceptability between wild pig hunters and non-wild pig hunters, the effect size was minimal, with 42% of wild pig hunters finding a toxicant unacceptable, 17% neutral, and 41% acceptable. Overall, use of a safe, humane toxicant was the least acceptable wild pig control method we examined. For comparison, the second-least-acceptable method was snares, and the most acceptable method was trapping and lethal removal. This finding is generally consistent with

Carlisle et al. (2020), who found that toxicants had the lowest level of approval among 6 different wild pig lethal control methods, with a slim majority (51%) of respondents finding the use of a wild pig toxicant to be unethical.

Our findings also show that successfully predicting a Texas hunter's acceptance of a wild pig toxicant based upon the factors we considered is difficult. In general, toxicant acceptance tends to increase with age and with level of concern over wild pig damage to crops, pastures, and wildlife. In addition, hunters who own or manage land in Texas and hunters who use their land for farming, raising livestock, or personal recreation are all somewhat more likely to be accepting of a toxicant. The same is true of hunters who have suffered economic losses to wild pigs. In addition, acceptance of a toxicant tends to decrease the more a hunter focuses on or specializes in hunting wild pigs. However, we found that the effect sizes for all these variables were minimal, suggesting that the practical significance of these factors in helping to predict toxicant acceptance among Texas hunters is small. In fact, the only variable with an effect size approaching medium or typical was the preferred wild pig population size in Texas, with 70% of respondents who preferred that wild pigs be completely removed from Texas finding a toxicant acceptable, compared to 14% of those respondents who preferred that wild pig populations in Texas either remain the same or increase.

Additionally, although one may reasonably hypothesize that individuals who profit from wild pigs are less likely to be accepting of a toxicant, we found no statistical differences in toxicant acceptability for individuals who earned income in 2018 from leasing wild pig hunting rights or selling wild pigs. While we did find a statistical difference in toxicant acceptability for individuals who earned income in 2018 for providing wild pig guide or outfitting services, the effect size was well below the minimal threshold. Taken together, these findings suggest that considerations beyond a hunter's own self-interest factor into many individuals' calculations of toxicant acceptability.

In terms of management implications, the relatively high level of polarization we found among Texas hunters in regard to toxicant acceptance underlines the importance of engaging in public outreach well before any wild pig toxicant is made available for use in Texas. The controversy in 2017 over the state's approval of a wild pig toxicant is testament to how quickly such decisions can backfire if public officials fail to engage with interested and/or affected stakeholder groups in advance (Frey 2017). Our findings suggest that no stakeholder group's support for a toxicant should be taken for granted. We found that even among respondents who were more likely to be negatively impacted by wild pigs, opinions were divided about the acceptability of a wild pig toxicant. For example, 33% of respondents who reported growing crops and 32% of respondents who reported having suffered an economic loss to wild pigs in 2018 found the use of a toxicant to be unacceptable. At the other end of the spectrum, opinions were also divided among hunters with the greatest interest in hunting wild pigs. We found that 33% of hunters who primarily hunt wild pigs found a toxicant to be acceptable, while 16% were neutral on the issue. These findings speak to the importance of broadly focused outreach and engagement efforts that reach a wide swath of the public. Such efforts can aid in building the public's trust and in demonstrating credibility (Genovesi 2008), both of which are essential for potentially controversial initiatives like the introduction of a wild pig toxicant.

In addition, the themes and specific concerns about toxicants that we identified in our qualitative analysis can inform the content of public outreach campaigns associated with any potential toxicant introduction. It is noteworthy that, as with Carlisle et al. (2020), approximately 1 in 3 respondents raised concerns about possible negative impacts to nontarget animals—by far the most common concern in both studies—notwithstanding differences in the studied populations and wording of the relevant questionnaire items. This suggests that regardless of the U.S. geographical context, failure to address risks to nontarget species in product development and public outreach could trigger a backlash across diverse stakeholder groups.

The importance or prevalence of other concerns surrounding a wild pig toxicant are likely more context dependent. For example, Carlisle et al. (2020) found that only 7% of respondents in their study of the U.S. general public raised concerns about possible harm to human health, as compared to 24% of Texas hunters in the pres-

ent study. This likely reflects the relative popularity of eating wild pig meat in Texas, particularly among hunters. Other themes revealed by our analysis, such as belief that toxicant usage is immoral and concern about presently unknowable risks ("unknown unknowns"), demonstrate that no amount of research on the safety of a toxicant and no amount of public outreach will satisfy all Texas hunters.

Finally, we note that while most of the 29 concerns we identified were shared by only 1–2% of respondents, this should not be interpreted as suggesting that only 1–2% of Texas hunters care about these particular issues. Rather, a more appropriate way to interpret them is that these concerns were top-of-mind, and likely very salient, for 1% or 2% of respondents when they were asked to provide information about their position on a safe, humane toxicant. Any of the identified themes could become relatively more important and/or contentious when amplified through media reports and public debates surrounding the merits of using a wild pig toxicant. Taken together, these themes and concerns suggest that achieving anything close to a consensus on toxicant usage in Texas is unrealistic. However, the 18% of respondents who were neutral on toxicant usage, together with the 43% who found it acceptable, suggest that building majority support among hunters is possible.

One caveat of this study concerns its representativeness of the study population and the generalizability of the findings. Given that the sample largely excluded hunting licensees with no email addresses on record with TPWD and given that we were unable to meaningfully assess any resulting coverage error, the generalizability of the findings is limited. As previously noted, our completed sample had a somewhat higher proportion of males and out-of-state residents than the study population, but it was similar in terms of age. However, while some studies have found that males generally perceive environmental risks as smaller and more acceptable than do females (Flynn et al. 1994, Norgaard 2007), we found no difference between male and female respondents on the acceptability of a wild pig toxicant. In addition, while there were statistical differences between in-state and out-of-state residents with respect to toxicant acceptability, the effect size was well below the minimal threshold.

It is possible, however, that coverage error or nonresponse bias at least partly explains why a much higher percentage of respondents in our study (73%) reported that they hunt wild pigs, as compared to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Fish and Wildlife Service 2011). In that study, 38% of individuals who hunted in Texas reported that they hunted "other animals," a category that included wild pigs. We note, however, that in our study, "hunting" was defined in the questionnaire to include not only recreational hunting, but also hunting for management purposes (e.g., trapping and removing). In addition, the figure we reported included respondents who do not regularly hunt wild pigs. Among the respondents who indicated that they hunt wild pigs, 15% reported that they exclusively or primarily hunt wild pigs on most hunting trips, while 20% reported that they hunt wild pigs and other game roughly equally, and 65% reported that they hunt wild pigs only occasionally or rarely. As this relates to the question of toxicant acceptability, we note that although there was a statistical difference between respondents who hunt wild pigs and those who do not, the effect size was minimal.

Future research concerning the acceptability of wild pig toxicants should examine the salience of wild pig toxicant issues to Texas hunters and other stakeholder groups. While we found a high level of polarization on the issue of acceptability, we did not include measures of issue salience in our study. It is conceivable that while fewer than half of respondents found a safe, humane toxicant to be unacceptable, the issue may be of greater importance to those respondents, and as a result, they may be more easily activated to participate in public debates over a toxicant. It is also critical that future research focus on other stakeholder groups, including agricultural producers. While such studies in Texas can provide insights into possible issues and outcomes in other states, attitudes toward toxicants will likely vary from state to state, depending on contextual factors such as the cultural and economic importance of wild pig hunting. Indeed, a recent survey study in Alabama, USA, found that a majority of respondents from 3 stakeholder groups—hunters, agricultural producers, and forestland owners—generally supported the use of a wild

pig toxicant in Alabama (Williams et al. 2021). It is therefore advisable that similar studies be conducted in other states or regions when planning for the introduction of a wild pig toxicant.

Management implications

Divided hunter attitudes toward a wild pig toxicant and concerns over potential negative impacts to nontarget species and human health suggest the importance of engaging in broad stakeholder outreach prior to the reintroduction of a toxicant in Texas.

Acknowledgments

We are grateful to the Texas A&M AgriLife Extension Service for funding this research and to the Texas Parks and Wildlife Department for providing access to contact information of licensed hunters. We wish to thank all the Texas hunters who generously gave of their time to participate in this research and make this study possible. Mention of commercial products does not represent an endorsement by the U.S. Government. The findings and conclusions in this publication are those of the authors and should not be construed to represent any official U.S. Department of Agriculture or U.S. Government determination or policy. Comments provided by G. Massei, HWI associate editor, and 2 anonymous reviewers greatly improved an earlier version of our manuscript.

Literature cited

Anderson, A., C. Slootmaker, E. 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.

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.

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.

Carlisle, K. M., N. Didero, S. McKee, J. Elser, and S. A. Shwiff. 2021. Towards a more comprehensive understanding of wild pig (*Sus scrofa*) impacts on agricultural producers: insights from a Texas case study. Crop Protection 150:105793.

Carlisle, K. M., E. E. Harper, and S. A. Shwiff. 2020. An examination of ethical attitudes towards wild pig (*Sus scrofa*) toxicants in the United States. International Journal of Pest Management 68:35–42.

Corn, J. L., and T. R. Jordan. 2017. Development of the national feral swine map, 1982–2016. Wildlife Society Bulletin 41:758–763.

Crum, B. 2017. Special report: is poison the answer to feral hog problem? Abilene Reporter-News. March 4, 2017. USA Today Network, McLean, Virginia, USA, <https://www.reporternews.com/story/news/local/2017/03/04/poison-answer-feral-hog-problem/98705028/.> Accessed July 12, 2021.

Davis, A. J., B. Leland, M. Bodenchuk, K. C. VerCauteren, and K. M. Pepin. 2018. Costs and effectiveness of damage management of an overabundant species (*Sus scrofa*) using aerial gunning. Wildlife Research 45:696–705.

Flynn, J., P. Slovic, and C. K. Mertz. 1994. Gender, race, and perception of environmental health risks. Risk Analysis 14:1101–1108.

Frey, D. 2017. Is Kaput kaput? The Wildlife Professional. September/October:38–40.

Froehly, J. L., N. R. Beane, D. E. Evans, K. E. Cagle, and D. S. Jachowsk. 2020. Using multiscale behavioral investigations to inform wild pig (*Sus scrofa*) population management. PLOS ONE 15(2): e0228705.

Genovesi, P. 2008. Limits and potentialities of eradication as a tool for addressing biological invasions. Pages 385–402 *in* M. M. Caldwell, G. Heldmaier, R. B. Jackson, O. L. Lange, H. A. Mooney, E. D. Schulze, and U. Sommer, editors. Ecological studies. Volume 193. Springer, New York, New York, USA.

Gleaton, C., and J. Robinson. 2016. Facts about Texas and U.S. agriculture. Texas A&M Agrilife Extension Service, College Station, Texas, USA, <https://agecoext.tamu.edu/wp-content/uploads/2016/06/FullReport.pdf>. Accessed July 12, 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.

Harper, E. E., C. A. Miller, J. J. Vaske, M. T. Mengak, and S. Bruno. 2016. Stakeholder attitudes and beliefs toward wild pigs in Georgia and Illinois. Wildlife Society Bulletin 40:269–273.

Jaebker, L. M., T. L. Teel, A. D. Bright, H. E. McLean,

J. M. Tomeček, M. G. Frank, R. L. Connally, S. A. Shwiff, and K. M. Carlisle. 2021. Social identity and acceptability of wild pig (*Sus scrofa*) control actions: a case study of Texas hunters. Human Dimensions of Wildlife 27:507–521.

Keiter, D. A., J. J. Mayer, and J. C. Beasley. 2016. What is in a "common" name? A call for consistent terminology for nonnative *Sus scrofa*. Wildlife Society Bulletin 40:384–387.

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.

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

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.

Norgaard, K. M. 2007. The politics of invasive weed management: gender, race, and risk perception in rural California. Rural Sociology 72:450–477.

Poché, R. M., D. Poché, G. Franckowiak, D. J. Somers, L. N. Briley, B. Tseveenjav, and L. Polyakova. 2018. Field evaluation of low-dose warfarin baits to control feral hogs (*Sus scrofa*) in north Texas. PLOS ONE 13(11): e0206070.

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

Sanders, H. N., D. G. Hewitt, H. L. Perotto-Baldivieso, K. C. VerCauteren, and N. P. Snow. 2020. Invasive wild pigs as primary nest predators for wild turkeys. Nature Research 10:2625.

Snow, N. P., J. A. Foster, E. H. VanNatta, K. E. Horak, S. T. Humphrys, L. D. Staples, D. G. Hewitt, and K. C. Vercauteren. 2018. Potential secondary poisoning risks to non-targets from a sodium nitrite toxic bait for invasive wild pigs. Pest Management Science 74:181–188.

U.S. Fish and Wildlife Service. 2011. National survey of fishing, hunting, and wildlife-associated recreation. U.S. Fish and Wildlife Service, Washington, D.C., USA, <https://www.census.gov/library/publications/2014/demo/fhw-11-nat.html>. Accessed July 12, 2021.

Vaske, J. J. 2008. Survey research and analysis: applications in parks, recreation and human dimensions. Venture Publishing, State College, Pennsylvania, USA.

Vaske, J. J., J. Beaman, H. Barreto, and L. B. Shelby. 2010. An extension and further validation of the potential for conflict index. Leisure Sciences 32:240–254.

Vitale, D. C., A. A. Armenakis, and H. S. Field. 2008. Integrating qualitative and quantitative methods for organizational diagnosis: possible priming effects? Journal of Mixed Methods Research 2:87–105.

Williams, E. T., C. A. Lepczyk, W. Morse, and M. Smith. 2021. Stakeholder perspectives towards the use of toxicants for managing wild pigs. PLOS ONE 16(2): e0246457.

Zielinski, A. 2017. Sid Miller wants to unleash a "hog apocalypse." San Antonio Current. February 22, 2017. Euclid Media Group, LLC, Cleveland, Ohio, USA, <https://www.sacurrent.com/news/sid-miller-wants-to-unleash-a-hog-apocalypse-2748192>. Accessed July 12, 2021.

Associate Editor: Giovanna Massei

Keith M. Carlisle is a supervisory social scientist and Human Dimensions Unit Leader at the USDA's National Wildlife Research Center in Fort Collins, Colorado. He has a professional background in law and policy and has earned degrees in law, economics, environmental management, and human dimensions of natural resources. Broadly, his research is focused on understanding human–wildlife conflict and coexistence through an interdisciplinary lens that includes social psychology, economics, and political science.

Sophie McKee is a research associate in the Department of Economics at Colorado State University and a contracted research economist at the USDA-APHIS National Wildlife Research Center in Fort Collins, Colorado. Her main research interests and publications involve the estimation of the economic impacts of feral swine damage and wildlife transmitted diseases and the valuation of wildlife damage management actions on agriculture and natural resources. She teaches a graduate class in data visualization at the University of Colorado Boulder. She received her Ph.D. degree in economics from Colorado State University and her M.S. degree in computer science from Supélec.

Authors continued on next page...

Hailey E. Ellis is a research associate at Colorado State University and is contracted at the National Wildlife Research Center in Fort Collins, Colorado, where she is a human dimensions specialist. She received a B.S. degree in fish, wildlife, and conservation biology and a M.S. degree in human dimensions of natural resources from Colorado State University. Her research centers on using interdisciplinary social science frameworks to understand and explain human–wildlife interactions. The goal of her research is to aid in informing wildlife management in the United States.

Lauren M. Jaebker is a research associate in the Department of Human Dimensions of Natural Resources at Colorado State University (CSU) and contracted human dimensions specialist at the USDA-APHIS National Wildlife Research Center in Fort Collins, Colorado. She received a B.S. degree in fish, wildlife, and conservation biology and an M.S. degree in human dimensions of natural resources from CSU. Much of her research focuses on mixed-method approaches to understand and explain human–wildlife interactions.

John M. Tomeček is an associate professor and extension wildlife specialist with the Texas A&M AgriLife Extension Service. He specializes in research and education on a variety of issues, especially wildlife damage and disease concerns, particularly with canines. He has worked extensively on the culture and habits of wildlife resources users, helping to tailor management solutions that are not only scientifically sound, but socially accepted.

Alan D. Bright is a professor in the Department of Human Dimensions of Natural Resources at Colorado State University. His research has focused on a variety of human dimensions of natural resources issues, including social psychological aspects of recreation and tourism behavior as well as public values and attitudes toward natural resource management strategies such as wildland fire management and the creation of defensible space in the wildland–urban interface.

Rachael L. Connally is a natural resource specialist with the Texas Parks and Wildlife Department in Presidio County, Texas. She earned her B.S. degree in wildlife biology from Texas State University in 2016 and her M.S. degree in wildlife and fisheries science at Texas A&M University in College Station in 2020. Her graduate thesis research involved developing and disseminating a questionnaire designed to better understand the human dimensions of exotic, invasive wild pigs. She enjoys working with people to help inform and improve wildlife management efforts that serve to meet both ecological and human needs.

Maureen G. Frank is an assistant professor and extension wildlife specialist with Texas A&M AgriLife Extension Service. Her programs focus on connecting people with wildlife, whether through hunting, birding, or reduction of human–wildlife conflicts, and she especially works on outreach to new and small-acreage landowners. She earned her B.S. degree in wildlife ecology from Texas A&M University and Ph.D. degree in wildlife biology from Utah State University.

Stephanie A. Shwiff is a supervisory research economist and project leader at USDA's National Wildlife Research Center and affiliate faculty at the University of Colorado–Boulder, where she teaches a class on benefit-cost analysis of food systems in the Masters of the Environment Program. At the National Wildlife Research Center, she leads the research project titled "Economics, operations research, and social dimensions of wildlife management." Her research is aimed at better understanding the economic impact of wildlife diseases and damage as well as developing, assessing, and improving wildlife management techniques.