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A Survey of Feral Swine Damage in a Selection of U.S. States

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ABSTRACT: We report the results of one of the most comprehensive surveys on feral swine damage and control in 11 U.S. states (Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, and Texas). The survey was distributed by the USDA National Agricultural Statistical Service in the summer of 2015 to a sample of producers of corn, soybeans, wheat, rice, peanuts, and sorghum in the 11 states listed above. A total of 4,377 responses were obtained. Findings indicate that damage caused by feral swine can be substantial. The highest yield loss estimates occur in peanut and corn production in the Southeast U.S. and Texas. We hope findings from this survey will help guide control efforts and research, as well as serve as a benchmark against which the effectiveness of future control efforts can be measured.

KEY WORDS: crop damage, economics, feral swine, invasive species, survey, *Sus scrofa*, wild pigs

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INTRODUCTION

Feral swine (*Sus scrofa*) have become widespread throughout much of the United States because of their reproductive potential and adaptable biology (Seward et al. 2004). Over the past 30 years, the range of feral swine has increased from 17 to 38 states (Bevins et al. 2014). The recent range expansion of feral swine has become a concern for agricultural producers in the United States. Feral swine can cause extensive damage by wallowing in the dirt and rooting with their snout for food below the soil surface. These activities increase soil erosion leading to excess runoff, decreased crop productivity, and levee failure, which lead to continued water quality degradation and agricultural crop damage. Additionally, feral swine eat 3-5% of their body weight per day (adult body weight range 150-220 lbs; 68-100 kg). The majority of their food is plant material, including agricultural crops (Taylor and Hellgren 1997).

There are few estimates of crop damage caused by feral swine in the U.S., and those that do exist are confined to a single field, a few counties, or part of a state. Thus, there is a need for a widespread estimate of crop damage by feral swine across crops and production regions. This would increase the efficiency of producer- and government-led control efforts by allowing resources to be allocated to the most severe problems. Furthermore, this type of information could serve as a baseline against which the effects of future control efforts could be measured.

METHODS

To gather information on the damage caused by feral swine across the United States, the National Agricultural Statistical Service (NASS) administered a survey instrument that was designed by researchers at the USDA APHIS WS National Wildlife Research Center. This study was funded by the National Feral Swine Damage Management Program.

Data Collection

The sample of producers was based on the Multivariate Probability Proportional to Size (MPPS) sampling design

(Bailey and Kott 1997) and NASS's list of known operations in the 11 states with the selected crops. A total of 9,720 surveys were mailed during summer of 2015 and, upon non-response, followed by up to ten phone calls for an interview.

Measurement

The survey was designed to simultaneously capture information related to feral swine presence, crop damage, livestock losses, control methods, live sales, and hunting, but the focus of the present analysis is on crop damage. The sampling frame focused on producers of corn (*Zea mays*), soybeans (*Glycine max*), wheat (*Triticum*), rice (*Oryza sativa*), peanuts (*Arachis hypogaea*), and sorghum (*Sorghum bicolor*) in Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, and Texas. Sorghum producers were only surveyed in Texas). States and crops were selected by a subjective evaluation of economic importance (United States Department of Agriculture 2014), vulnerability to feral swine, and political considerations. However, the instrument was designed to accommodate responses for any crop the respondents considered economically important on their operation.

Crop damage information was self-reported on the questionnaire by the producers. They could choose to respond for up to three of their highest-valued crops harvested on their operation in 2014. The questions were asked in a way that allowed us to gather information from producers that experienced no crop damage from feral swine so we could use the survey results to extrapolate to the state level. The questions also go beyond simply soliciting a percentage yield loss response. Instead, producers were asked how many of the acres of each crop were damaged by feral swine, as well as actual yield with the damage and expected yield without the damage on those acres. Self-reporting wildlife damages of crops is common and has been shown to be accurate (e.g. Wywiałowski 1994, Conover 2002, Tzilkowski 2002, Johnson-Nistler et al. 2005).

The survey allowed for each producer to report on up

to three crops they harvested in 2014. They were asked to provide total acres harvested and average yield per acre, giving total yield. For crop j on producer i 's operation, this is:

$$(1) \text{ Yield}_{ij} = (\text{acres harvested}_{ij})(\text{avg. yield per acre}_{ij})$$

If some acres were reported damaged by wild pigs, producers reported: (i) the number of acres damaged, (ii) average yield per acre on damaged acres, and (iii) expected yield per acre if these acres had not been damaged. Hypothetical yield losses for each producer's crops are then calculated as:

$$(2) \text{ Loss}_{ij} = (\text{acres damaged}_{ij}) \times \left(\text{avg. yield not damaged}_{ij} - \text{avg. yield} \frac{w}{\text{damage}_{ij}} \right)$$

Since actual yield on damaged acres was included in the original calculation of total yield in (1), hypothetical yield without feral swine damage is the sum of (1) and (2). Hypothetical yield loss due to feral swine damage as a percentage of total (hypothetical) yield is then:

$$(3) \text{ Percent Loss}_{ij} = 100 \times \frac{\text{Loss}_{ij}}{\text{Yield}_{ij} + \text{Loss}_{ij}}$$

Equation (3) gives the portion of yield lost to feral swine damage at the producer-crop level. To calculate the portion of yield lost for each crop within each state, we summed yield and hypothetical loss across all producers of each crop in each state and used these to calculate the portion of each crop's yield lost to feral swine across the state. Along with the producer level responses needed to calculate (3), each producer was given a calculated weight based on a non-response adjustment and Multivariate Probability Proportional to Size (MPPS) weight, as in Kott et al. (1998). These weights are used in the calculations that follow, specifically by weighting each producer's yields and losses in (1) and (2) by their unique weight in order to obtain a representative value at the state level.

Table 1. Questionnaire response, reports of feral swine on land, and crop damage by feral swine from a 2014 study of crop producers in 11 states across the U.S.

| | Response | Feral Swine on Land | Crop Damage by Feral Swine |
|----------------|----------|---------------------|----------------------------|
| Alabama | 337 | 45% | 29% |
| Arkansas | 202 | 32% | 21% |
| California | 485 | 9% | 4% |
| Florida | 159 | 65% | 45% |
| Georgia | 386 | 67% | 51% |
| Louisiana | 129 | 60% | 41% |
| Mississippi | 184 | 46% | 28% |
| Missouri | 674 | 5% | 2% |
| North Carolina | 494 | 16% | 10% |
| South Carolina | 373 | 47% | 28% |
| Texas | 954 | 66% | 49% |

RESULTS

NASS does not allow disclosure of any statistic if the maximum value of all values used to calculate the statistic divided by the sum of those same values is greater than 0.42 or if fewer than four producers who answer the

question answered the question the same way. For this reason, summary statistics at the state-crop level cannot be reported in some cases, since the low response rate results in some categories being dominated by a single producer. Thus, when zeroes are reported, they should be interpreted as such. Alternatively, reported NA's (represented with a "-" in the tables) could be zeroes or non-zeroes, but NASS would not allow the data to be disclosed.

A total of 9,720 surveys were mailed and 4,377 producers responded to the survey (45% response rate). Table 1 presents a summary of responses by state, including percentages of producers reporting: feral swine on their operation, and damage from feral swine on crops harvested during 2014 on their operations. Responses from Florida, Georgia, and Texas were most likely to indicate both the presence of feral swine on their land (65%, 67%, and 66% respectively) as well as crop damage by feral swine (45%, 51%, and 49%, respectively).

Of the responses summarized in Table 1, some observations of crop-level data were unusable (e.g., a producer reported feral swine damage to a crop but did not provide the number of acres damaged or a producer reported on crops other than those listed in Table 2). Table 2 reports the number of usable observations for calculating percentage yield loss at the state-crop level. Corn and soybeans provide the largest sample sizes, although we also had reasonable numbers of responses for wheat in some states. Given the pronounced regional nature of their production, sample sizes for the remaining crops were unsurprisingly small or non-existent in some states.

The results of the yield loss calculations for the crops of interest are presented in Table 3. Mean reported damage to corn was markedly higher in Georgia (4.73%) and Florida (4.41%) than in other states (next highest is Texas with 1.65% damage), while reported soybean damage was substantially higher in Florida (3.43%) than in other states (next highest is South Carolina with 1.52%). Reported wheat damage was most severe in Georgia (4.39%) and Texas (3.05%), and rice damage was most severe in Texas (2.46%) and Louisiana (1.26%). Of all the state and crop combinations, the highest mean reported damage occurred in peanut production in Texas (9.28%) and Alabama (6.17%). In fact, peanuts appear to incur the most damage among the reported crops, followed by corn. Most of these findings are expected given what we know about feral swine behavior, distribution, and the geographic distribution of the production of these crops.

DISCUSSION

Our findings suggest that of the states included in this study, feral swine impose the largest burden on agricultural producers in the Southeast and Texas. Reported damage was generally lower in California, Arkansas, and Missouri. However, in the case of California, this result may be affected by the diversity of agricultural production in the state. Fruit and vegetable production is common throughout many parts of California, and it is possible that by targeting grain and soybean producers, we were simply not sampling the relevant producers in California. In the case of Arkansas and Missouri, the relatively low damage is potentially related to the lesser distribution of feral swine. In much of Arkansas and all of Missouri, feral

Table 2. Usable observations for calculating percent of crops lost to feral swine damage in 11 states in the U.S. during 2014.

| state | corn | soybeans | wheat | rice | sorghum | peanuts |
|----------------|------|----------|-------|------|---------|---------|
| Alabama | 114 | 121 | 50 | - | - | 58 |
| Arkansas | 44 | 96 | 16 | 53 | - | - |
| California | - | - | - | 26 | - | - |
| Florida | 23 | 20 | - | - | - | 51 |
| Georgia | 123 | 63 | 23 | - | - | - |
| Louisiana | 32 | 58 | 13 | 16 | - | - |
| Mississippi | 69 | 103 | 11 | 15 | - | - |
| Missouri | 368 | 404 | 97 | 37 | - | - |
| North Carolina | 202 | 304 | 117 | - | - | 58 |
| South Carolina | 154 | 152 | 49 | - | - | - |
| Texas | 209 | 45 | 230 | 39 | 149 | 53 |

NASS does not allow disclosure of any statistic if the maximum value of all values used to calculate the statistic divided by the sum of those same values is greater than 0.42 or if fewer than 4 producers who answer the question answered the question the same way. For this reason, summary statistics at the state-crop level cannot be reported in some cases, since the low response rate results in some categories being dominated by a single producer. Thus, when zeroes are reported, they should be interpreted as such. Alternatively, reported NA's (represented with a "-") could be zeroes or non-zeroes, but NASS would not allow the data to be disclosed.

Table 3. Percent of crop lost to feral swine damage in 11 states in the U.S. during 2014.

| state | corn | soybeans | wheat | rice | sorghum | peanuts |
|----------------|-------|----------|-------|-------|---------|---------|
| Alabama | 0.93% | 1.38% | 0.62% | - | - | 6.17% |
| Arkansas | 1.09% | 0.27% | 0.75% | 0.27% | - | - |
| California | - | - | - | 0% | - | - |
| Florida | 4.41% | 3.43% | - | - | - | 1.84% |
| Georgia | 4.73% | 1.07% | 4.39% | - | - | - |
| Louisiana | 0.83% | 0.74% | 0.94% | 1.26% | - | - |
| Mississippi | 1.34% | 0.40% | 0.70% | 0.12% | - | - |
| Missouri | 0% | 0.02% | 0.01% | 0% | - | - |
| North Carolina | 0.38% | 0.09% | 0.15% | - | - | 0.49% |
| South Carolina | 1.59% | 1.52% | 1.71% | - | - | - |
| Texas | 1.65% | 1.10% | 3.05% | 2.46% | 2.87% | 9.28% |

NASS does not allow disclosure of any statistic if the maximum value of all values used to calculate the statistic divided by the sum of those same values is greater than 0.42 or if fewer than 4 producers who answer the question answered the question the same way. For this reason, summary statistics at the state-crop level cannot be reported in some cases, since the low response rate results in some categories being dominated by a single producer. Thus, when zeroes are reported, they should be interpreted as such. Alternatively, reported NA's (represented with a "-") could be zeroes or non-zeroes, but NASS would not allow the data to be disclosed.

swine are a relatively recent phenomenon. Thus, it may be the case that densities are lower than in the Southeastern states, or producers may simply be less aware of the damage because it has not occurred historically.

Furthermore, responses suggest that corn and peanuts suffer more damage than the other crops we focused on. This finding could have several causes. First, these crops may be inherently more attractive or vulnerable to damage than the other crops, or they may be relatively more common in areas with high swine densities. Alternatively (or additionally), producers of these crop may be more willing to incur damage or less able to invest in control effort. A final reason may be that damage is simply more observable in certain crops. This is perhaps a believable explanation for corn in particular, since trampled areas would be more apparent than for other crops. Nevertheless, responses suggest that feral swine damage to crops is widespread.

An understanding of which areas and crops experience the most damage will make any management more efficient. Producers and government agencies expend considerable time and effort managing feral swine damage, and knowing where the problem is most severe will help these

entities allocate their resources more appropriately. USDA APHIS Wildlife Services has recently initiated a widespread feral swine control campaign. In addition to guiding the implementation of this program, the findings we present can serve as a benchmark for evaluating this control program. Thus, our hope is that this survey can be repeated at regular intervals to ensure that the objectives of the control program are being met and progress is being made against the threat that feral swine represent to U.S. agricultural producers.

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