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Economic estimates of feral swine damage and control in 11 US states

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ABSTRACT

We report the results of one of the most comprehensive surveys on feral swine (*Sus scrofa*) damage and control in 11 US 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 (*Zea mays*), soybeans (*Glycine max*), wheat (*Triticum*), rice (*Oryza sativa*), peanuts (*Arachis hypogaea*), and sorghum (*Sorghum bicolor*) in the 11-state region. Producers that failed to respond to the initial mailing received multiple follow-up phone calls in an attempt to minimize non-response bias, and a total of 4377 responses were obtained. Findings indicate that damage can be substantial. The highest yield loss estimates occur in peanut and corn production in the Southeast and Texas. Control efforts are common, and producers incur considerable costs from shooting and trapping efforts. Extrapolating crop damage estimates to the state-level in 10 states with reportable damage yields an estimated crop loss of $190 million. Though large, this number likely represents only a small fraction of the total damage by feral swine in the 10 states because it only includes crop damage to six crops. 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.

1. 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) (Fig. 1). The recent range expansion of feral swine has inflicted substantial costs on agricultural producers in the United States. Though estimates of damage to agricultural production range widely and are largely context specific (Bevins et al., 2014), it is clear that feral swine have the ability to damage most crops, transmit diseases to both livestock and other wildlife, and effectively destroy ecosystems (Barrios-Garcia and Ballari, 2012; Crooks, 2002). At the same time, feral swine provide benefits to some in the form of subsistence and recreational benefits (e.g. hunting), the latter of which might benefit some agricultural producers (Zivin et al., 2000). These opposing negative impacts and positive use values associated with feral swine presence necessitate a better understanding of their impacts to agricultural producers.

While estimates of agricultural damage from feral swine exist, they are either largely individual (as summarized by Bevins et al. (2014)), or back-of-the-envelope style aggregations, as in the widely cited numbers reported by Pimentel et al. (2005). Thus, there is a need for both a precise and broad understanding of the how crop damage by feral swine varies across crops and production regions. This would enhance 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. To address this need, the National Agricultural Statistical Service (NASS) administered a survey instrument that was designed by researchers at the USDA/APHIS/WS National Wildlife Research Center.

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 and control efforts. Distribution targeted producers of corn (*Zea mays*), soybeans (*Glycine max*), wheat (*Triticum*), rice (*Oryza sativa*), peanuts (*Arachis hypogaea*),

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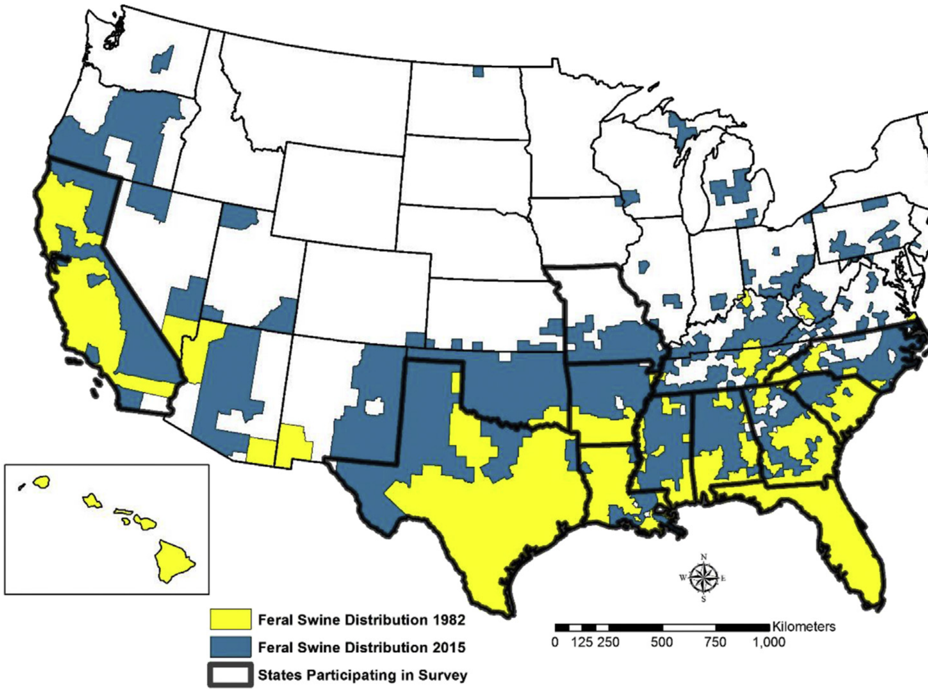

Fig. 1. Feral swine distribution in 1982 and 2015.

and sorghum (*Sorghum bicolor*) in Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi.

Missouri, North Carolina, South Carolina, and Texas.[1] States and crops were selected by a subjective evaluation of economic importance (United States Department of Agriculture (2014)), vulnerability to feral swine (see Fig. 1), and political considerations. However, the instrument was designed to accommodate responses for any crop the respondents considered economically important on their operation. We proceed with a discussion of the survey instrument, survey distribution, and NASS rules related to disclosure of information. Results are then presented, followed by a discussion of the implications of the findings.

1.1. Methods

Information on crop damage was solicited by the questions listed inFig. 2. Producers could choose to respond for up to three of their highest valued crops harvested on their operation in 2014. The structure of the questions enabled us to capture information from producers that experienced no crop damage from feral swine so that 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 the crops is common and has been shown to be accurate (Conover, 2002; Johnson-Nistler et al., 2005; Tzilkowski et al., 2002; Wywialowski, 1994).

To calculate feral swine damage to crops, we compared actual yield reported by each producer to the expected yield reported if no feral swine damage had occurred. Specifically, each producer reported total acres harvested for each of up to three crops, as well as average yield per acre, giving total yield. For crop j on producer i's operation, this is:

$$Yield_{ij} = (acres\ harvested_{ij})(avg.yield\ per\ acre_{ij}). \tag{1}$$

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:

$$Loss_{ij} = (acres\ damaged_{ij})(avg.yield\ not\ damaged_{ij} - avg.yield\ \ w/damage_{ij}). \tag{2}$$

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:

$$Percent\ Loss_{ij} = 100 \times \frac{Loss_{ij}}{Yield_{ij} + Loss_{ij}}. \tag{3}$$

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 as in (1) and (2), 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.

To estimate the dollar value of production lost to feral swine damage for the selected crops at the state level, we must assume

[1] Sorghum producers were only surveyed in Texas.