Classical Swine Fever Surveillance in Feral Swine

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ABSTRACT Diseases such as classical swine fever (CSF) and foot-and-mouth disease have been eradicated in the United States, but possible reintroductions merit the development of an enhanced surveillance system. Important foreign animal or transboundary diseases like these pose a significant risk to the health of wildlife and livestock in the United States. Wildlife Services (WS) performs surveillance in targeted feral swine (*Sus scrofa*) populations as part of a comprehensive United States Department of Agriculture, Animal and Plant Health Inspection Service effort to demonstrate disease-free status in our nation's livestock and wildlife. Surveillance is based on risk assessments which identify high risk states and the vicinity of feral swine to transitional or commercial swine production facilities. During 2007 and 2008, WS sampled and tested (n = 3661) feral swine. CSF was not detected in feral swine in the United States through this surveillance effort.

KEY WORDS classical swine fever, feral swine, disease surveillance

Feral swine (*Sus scrofa*) or wild hogs are not native to the United States and have been introduced throughout most of the country through translocation for hunting, abandonment by owners, escape from hunting preserves, and by dispersal of established feral populations (Seward et al. 2004). Additionally, feral swine can produce two litters per year with an average litter size of 4.2 to 7.5 piglets (Taylor et al. 1998), meaning that populations have the potential to increase rapidly. The nationwide population of feral swine has recently been estimated at 5 million individuals (Pimentel 2007) inhabiting 38 states (Wyckoff et al. 2009). Feral swine have also shown an ability to adapt to a wide range of habitats (Seward et al. 2004). The combination of humans influencing movements, prolific reproduction, and adaptability to various habitats has contributed to the expansion of feral swine across much of the United States.

Consequently, disease surveillance in feral swine has become increasingly more important to assure that disease introductions are detected early enough to limit or prevent spread into domestic swine populations. An introduction or outbreak of classical swine fever (CSF), or hog cholera, could have a severe impact on producers and the entire swine industry (USDA 2007). A single introduction could be potentially devastating to the United States economy with annual pork sales accounting for $11 billion (Witmer et al. 2004). The potential for transmission of diseases from feral swine to domestic swine is a concern because they can lead to production losses and decreased profits for domestic swine producers (USDA 1999).

To address the potential for disease transmission between feral and domestic swine and the potential impacts to the swine industry, the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) has implemented a feral swine disease surveillance project. While this comprehensive project includes testing feral swine for CSF, pseudorabies, swine brucellosis, trichinosis, and toxoplasmosis, the main objectives of CSF surveillance are to rapidly detect an introduction of CSF into the feral swine population in the United States as well as document disease freedom.

STUDY AREA

Twenty states with known populations of feral swine were identified as high risk based on a risk classification (USDA 2007) and subsequently targeted for foreign animal disease surveillance. These states include Arizona, Arkansas, California, Florida, Georgia, Hawaii, Iowa, Kansas, Kentucky, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Pennsylvania, Tennessee, Texas, and Wisconsin. Remaining states with feral swine populations were designated as low risk. Disease surveillance occurred at lower rates in Alabama, Colorado, Louisiana, Michigan, Mississippi, North Dakota, Oregon, South Carolina, Virginia, and West Virginia.

Feral swine populations in close proximity to domestic swine production facilities, landfills, high-risk (transitional) swine producers, international airports, and along the United States border with Mexico were targeted for disease surveillance purposes. Specific locations often included sites where feral swine damage management was already occurring.

METHODS

Samples sizes for CSF surveillance were set annually based on known feral swine populations, wildlife damage management projects, population size, and available resources. Between 1 October 2006 and 30 September 2007, feral swine (n = 1695) were targeted for sampling in 25 states. Between 1 October 2007 and 30 September 2008, feral swine sample size (n = 2155) was increased and included sampling in 32 states. In states with high populations of feral swine, local wildlife disease biologists determined the number of feral swine tested per trap night. This approach is acceptable as CSF is a highly contagious viral septicemia. Yearly post hoc analyses of disease freedom were based on actual nationwide sample sizes using FreeCalc v.2.0 (Cameron and Baldock 1998).

As CSF antibody detection was preferred over detecting CSF antigen and exposure to CSF was more important that detecting live virus, blood was selected as the best biological specimen. Whole blood was generally collected via cardiac puncture from dead feral swine and placed in sterile, 10 mL serum separating Vacutainer® test tubes. Whole blood remained in test tubes and either on ice or refrigerated until processing. Processing included centrifugation of whole blood to improve separation of serum from blood cells. One to two mL of serum was aliquoted from each test tube, placed in a Cyrovial®, and shipped to the diagnostic laboratory. Serum samples were shipped immediately or stored at 4°C and shipped no later than 3 days post collection. In rare occasions where field work made it difficult to ship samples on a regular basis, samples were frozen at -20°C and shipped no later than 2 weeks post collection. All serum samples were sent to the APHIS Foreign Animal Disease Diagnostic Laboratory at Plum Island

Animal Disease Center, New York for diagnostic testing.

At the diagnostic laboratory, serum was initially tested using the IDEXX Laboratories® enzyme-linked immunosorbent assay (ELISA). If serum tested negative for CSF antibodies, no additional testing was performed. If feral swine serum tested positive, an immunoperoxidase (IP) confirmatory test was conducted. If the IP confirmatory test was also positive, further testing was conducted to differentiate between bovine viral diarrhea (BVD) and CSF using the CSF/BVD differential IP-Virus Neutralization assay. Negative results were reported back to WS. Reporting positive and inconclusive results adhered to the proper communication protocol (USDA 2008).

RESULTS

WS collected biological specimens from feral swine in 30 states encompassing 269 counties (Fig. 1) to provide nationwide coverage for CSF surveillance in feral swine. During the first year of surveillance, feral swine (n = 1376) from 19 states (Table 1) were captured and tested using IDEXX Laboratories ELISA. During the second year of surveillance, feral swine (n = 2285) from 30 states (Table 1) were captured and tested using the same diagnostic procedures. None of the feral swine serum samples tested positive for CSF antibodies using IDEXX Laboratories ELISA test. Additional diagnostic testing using the IP confirmatory test was not performed. The results of the 2007 analysis (P = 0.048) suggested that the U.S. feral swine population was free from CSF at or above a prevalence above 0.15% at the 95% confidence level. The 2008 analysis (P = 0.041) suggested that the U.S. feral swine population was free from CSF at or above a prevalence above 0.05% at the 95% confidence level.

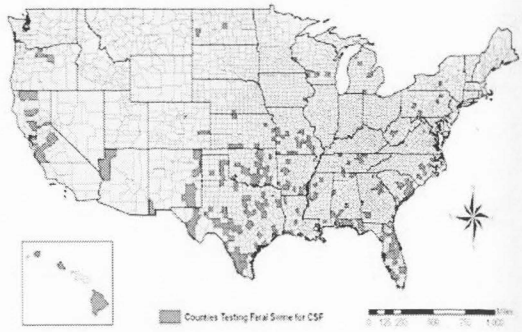

Figure 1. Counties testing feral swine serum for classical swine fever in 2007 and 2008.

DISCUSSION

The primary objectives of the CSF surveillance project were to document disease freedom as well as allow rapid detection of CSF exposure should the disease enter the U.S. feral swine population. Trading partners often require records and evidence that diseases do not exist in the United States or the commercial swine industry. The two-year surveillance period described herein included the testing of 3661 feral swine from 30 states. The remaining 8 states with known populations of feral swine are classified as low risk (USDA 2007), and sampling feral swine was not practical or possible. Three states classified as high risk for a CSF introduction do not currently have feral swine populations; therefore, sampling did not occur in Minnesota, South Dakota, and Washington. Overall, these broad surveillance efforts would have allowed a rapid detection of CSF should it have entered the feral swine population and provides the evidence to conclude that the United States feral swine population was free of CSF during the 2007–2008 surveillance period.

With a 25% increase in feral swine population size (Pimentel et al. 2005, Pimentel 2007) and distribution in recent years, wildlife managers must remain vigilant in assessing the overall health and

Table 1. Number of feral swine tested per state for classical swine fever.

State	2007	2008	Total
Alabama	7	38	45
Arizona	41	24	65
Arkansas	0	82	82
California	80	176	256
Colorado	0	19	19
Florida	270	237	507
Georgia	63	103	166
Hawaii	74	150	224
Iowa	6	0	6
Kansas	56	145	201
Kentucky	0	4	4
Louisiana	0	49	49
Michigan	0	36	36
Mississippi	0	55	55
Missouri	109	200	309
Nebraska	0	26	26
New Jersey	0	8	8
New Mexico	51	49	100
New York	0	13	13
North Carolina	78	102	180
North Dakota	10	21	31
Oklahoma	116	223	339
Oregon	22	7	29
Pennsylvania	3	13	16
South Carolina	74	107	181
Tennessee	27	20	47
Texas	284	313	597
Virginia	0	12	12
West Virginia	0	22	22
Wisconsin	5	31	36
Total	1376	2285	3661

risks presented by feral swine. Wildlife damage management affords such an opportunity to assess the overall health of feral swine and many other species of wildlife. Additionally, numerous pathogens have been identified in feral swine (Davis 1998, Williams and Barker 2001); therefore, comprehensive surveillance designs should be implemented to take advantage of lethally removed feral swine. Long-term endemic disease monitoring and rapid detection of foreign animal or transboundary diseases through wildlife damage management provides a practical and efficient approach at testing feral swine for viruses, bacteria, and parasites.

ACKNOWLEDGMENTS

WS National Wildlife Disease Program wildlife disease biologists performed the most crucial function in surveillance by collecting biological specimens from feral swine. Drs. David Pyburn and Samia Metwally were equally influential to the success of the surveillance project by providing diagnostic support. We thank numerous biologists, diagnosticians, and others involved in the surveillance project who contributed countless hours to make this project so successful.

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