

Feral Swine Hunting in the United States: An Analysis of Demographics, Expenditures, and Proximity to Range

*Addendum to the 2011 National
Survey of Fishing, Hunting, and
Wildlife-Associated Recreation*

Report 2011-11



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Report 2011-11



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Matthew Fuller
Wildlife and Sport Fish Restoration
U.S. Fish and Wildlife Service
Falls Church, VA

This report is intended to complement the National and State Reports for the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. The conclusions in this report are the author's and do not represent official positions of the U.S. Fish and Wildlife Service.

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Introduction

Feral swine are an invasive species. They are not native to the United States. Annually, they cause an estimated \$1.5 billion in agricultural and environmental damage.¹ A study by Anderson et al. (2016), revealed that \$89 million in damage is done to just six crops in Texas, alone.² Feral swine are also responsible for the spread of disease that can wreak havoc on the livestock industry. Miller et al. (2017), point out that humans are also susceptible to the range of diseases that feral swine carry.³

Because of this, an effort to formulate a national approach to feral swine management has been undertaken. The national approach includes many federal land management agencies including the U.S. Fish and Wildlife Service, as well as the Association of Fish and Wildlife Agencies and the National Invasive Species Council.

The national approach includes three components.⁴

1. Improved baseline operational capacity to respond to local needs for feral swine damage management, including improved infrastructure (e.g., personnel, equipment) and increased cost-share opportunities with partner agencies, tribes, and others.
2. National projects including strategic allocation of resources to reduce the range and size of the national feral swine population, increased research, modeling and risk analysis, national

¹ United States Department of Agriculture – Animal and Plant Health Inspection Service.

² Anderson et al. “Economic estimates of feral swine damage and control in 11 US states.” *Crop Protection*, 2016: 89-94.

³ Miller et al. “Cross-species transmission potential between wild pigs, livestock, poultry, wildlife, and humans: implications for disease risk management in North America.” *Scientific Reports*, August 2017.

⁴ USDA – APHIS. Record of Decision for Final Environment Impact Statement. *Feral Swine Damage Management: A National Approach*.



outreach and education program, and national coordination with Canada and Mexico.

3. Strategic projects at the local level to address specific vulnerable areas.

In high population areas, the short term goal is to stop the growth of the population with a long term goal of population reduction. In low population areas, there is a goal of immediate population eradication.

According to the **2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)**, there were only 718 thousand feral swine hunters in 2011, which is about five percent of hunters. Their total hunting-related trip and equipment expenditures while seeking feral swine totaled \$241 million.

This report provides information about feral swine hunter demographic characteristics, spending patterns, proximity to range, as well as a model for predicting the change in feral swine hunting participation based on a change in the range of feral swine. It is intended to be used as an informational tool by resource managers, academics, product manufacturers, and other interested parties.

The report is organized into four parts:

Part One: The “Participation and Demographics” section examines the size of the feral swine hunting population. Other species of game that were hunted by feral swine hunters are identified. Additionally, widely used demographic characteristics such as income, age, gender, education, marital status, and geographic location are included.

Part Two: The “Expenditures” section describes and analyzes the expenditures associated with feral swine hunting.

Part Three: The “Proximity to Range” section shows the distribution of feral swine range over time. Relative proximity of feral swine hunters to feral swine range is analyzed. Relative use of private property compared to land owned by the local, State, or Federal government is also presented.

Part Four: The “Feral Swine Hunting Participation Model” section models the likelihood of feral swine hunting based on household characteristics, respondent demographics, and proximity to feral swine range. Model parameters and odds ratios are reported. Probabilities based on demographics are graphed.

Part One – Participation and Demographics

Feral Swine Hunting Participation

Feral swine, while nowhere near as popular as deer or wild turkey, are hunted by approximately five percent of hunters in the United States. The FHWAR classifies feral swine as “other animal” hunting in the contiguous United States as well as Alaska. However, feral swine are considered “big game” in Hawaii.

Feral swine are culturally significant in Hawaii. Pigs are the centerpiece of a luau, a traditional celebration in Hawaii. Therefore any effort to eradicate the species in the contiguous United States may not be a viable option in Hawaii. Much of the analysis in this report differentiates between Hawaii and the rest of the United States.

Table 1 outlines the species that hunters sought in 2011. The bottom row consolidates the feral swine hunters in Hawaii with the rest of the feral swine hunters. Nineteen thousand hunters in Hawaii hunted feral swine. That is less than half of one percent of all hunters. However, 85 percent of the 23 thousand hunters in Hawaii hunted feral swine.⁵ Feral swine were hunted by 699 thousand hunters in the rest of the United States. As a proportion of all feral swine hunters, 97 percent hunted feral swine in the contiguous United States (Alaska does not have a population of feral swine).

⁵ U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau, 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation – Hawaii State Report.

Table 1. All Hunters and Feral Swine Hunters by Species Type: 2011

(Population 16 years old and older. Numbers in thousands.)

Type of Game	All Hunters	Percent of All Hunters	Hunters Who Hunt Feral Swine	Percent of Feral Swine Hunters
All hunters	13,674	100		
Big Game	11,570	85	641	89
Deer	10,851	79	628	87
Elk	867	6	...	...
Bear	526	4	...	...
Wild Turkey	3,115	23	211	29
Moose	106	1	...	...
Wild Sheep/Feral Goat	...	...	...	...
Feral Swine (Hawaii only)	19*	(Z)	19*	3*
Any unlisted big game	286	2	...	...
Small Game	4,506	33	278	39
Rabbit, hare	1,545	11	114*	16*
Quail	841	6	89*	12*
Grouse/Prairie Chicken	812	6	...	...
Squirrel	1,691	12	144*	20*
Pheasant	1,474	11	58*	8*
Ptarmigan	32*	(Z)	...	...
Any unlisted small game	299	2	...	...
Migratory Birds	2,583	19	251	35
Geese	781	6	58*	8*
Duck	1,371	10	130*	18*
Dove	1,271	9	166*	23*
Any unlisted migratory birds	227	2	...	...
Other Animals	2,168	16	699	97
Groundhog (Woodchuck)	195	1	...	...
Raccoon	325	2	...	...
Fox	174	1	...	...
Coyote	1,049	8	94*	13*
Wolf	...	...	...	...
Mongoose	...	...	...	...
Feral Swine	699	5	699	97
Any unlisted other animals	253	2	...	...
All feral swine	718	5	718	100

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

(Z) Less than 0.5 percent

Note: Detail does not add to total because of multiple responses.

The closest species in terms of total hunter participation is geese. The species that feral swine hunters sought the most in addition to feral swine is deer. Eighty-seven percent of feral swine hunters hunted deer. That is higher than the overall participation rate of 79 percent for all hunters seeking deer. In fact, most reportable species were sought at a higher rate by feral swine hunters when compared to the overall participation rate among all hunters. This speaks to the overall avidity of feral swine hunters.

About 26 thousand or four percent of feral swine hunters hunted feral swine and nothing else. Furthermore, 13.0 million hunters did not hunt feral swine at all. The remaining 692 thousand hunters sought feral swine and other species.

General Demographic Characteristics

Tables 2 through 9 address the distribution of all hunter and feral swine hunter populations among widely used demographic characteristics such as income, age, sex, education, marital status, and geographic location. All tables follow a similar format. The first two columns present the distribution of the U.S. population in 2011 among the demographic variables of interest. The first column “Number” indicates the distribution in quantity, and the second column “Percent” presents the proportion of total individuals that appear in each respective category of the demographic variable. Thus, in Table 2, the second column indicates that 11 percent of the U.S. population 16 years or older were 18 to 24 years old. The “Number” and “Percent” columns within the feral swine hunter category are handled in the same way. For example, row three of Table 2 reveals that 11 percent of feral swine hunters were 18 to 24 years old. Similarly, nine percent of all hunters were 18 to 24 years old.

Age

The age category with the greatest number of participants was 55 to 64 years old, 172 thousand, who make up 24 percent of feral swine hunters. The age group of 35 to 44 years follows closely with 164 thousand, or 23 percent of feral swine hunters. The age category with the least number of reportable participants was 18 to 24 years old, 80 thousand, or 11 percent of feral swine hunters. Other age groups make up a lower proportion of feral swine hunter than those 18 to 24 years old, but they are not reportable because they have a sample size of less than 10.

Comparing the percent of all hunters by age group to the percent of feral swine hunters by age group shows that there is a concentration of hunters from age 18 to 64 years. Eighty-six percent of all hunters were 18 to 64 years old, while 93 percent of all feral swine hunters fall into this age group. Fewer very young and very old individuals hunted feral swine than hunted overall.

Population Density of Residence

While nearly six in ten hunters live in a rural area, feral swine hunters are more likely to live in an urban area, 53 percent. This is most likely due to the fact that feral swine are indiscriminant to the property that they do damage to, so property owners would like to

eradicate the nuisance. In order to limit the potential damage to their property, either existing hunters or motivated non-hunters may take up feral swine hunting.

Population Size of Residence

Twenty percent of the U.S. population living outside an MSA⁶ went hunting in 2011 (Table 3). Feral swine hunters were equally as likely to reside outside of an MSA in 2011.

⁶ A Metropolitan Statistical Area (MSA) is a county or group of contiguous counties containing at least one city of 50,000 or more inhabitants or twin cities with a combined population of at least 50,000 (except in New England, which includes both towns and cities instead of counties).

Table 2. Age Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011
(Population 16 years old and older. Numbers in thousands.)

Age	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
16 to 17 years	7,652	3	419	3	...	...
18 to 24 years	26,517	11	1,288	9	80*	11*
25 to 34 years	41,613	17	2,079	15	136*	19*
35 to 44 years	40,779	17	2,416	18	164*	23*
45 to 54 years	46,167	19	3,143	23	116*	16*
55 to 64 years	38,469	16	2,842	21	172*	24*
65 years and older	38,117	16	1,487	11	...	...
65 to 74 years	22,655	9	1,221	9	...	...
75 and older	15,461	6	266	2	...	...

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

Table 3. Population Density and Size of Residence Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011
(Population 16 years old and older. Numbers in thousands.)

Characteristic	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
Population Density of Residence						
Urban	179,971	75	5,784	42	381	53
Rural	58,493	24	7,873	58	337	47
Population Size of Residence						
Inside Metropolitan Statistical Area (MSA)	212,650	89	10,915	80	576	80
Outside MSA	14,239	6	2,759	20	142*	20*

*Estimate based on sample size of 10–29

Census Geographic Division

Feral swine range is concentrated in the South and West of the United States. Additionally, Hawaii is part of the Pacific Census Geographic Division. With this understanding, it becomes obvious why feral swine hunters are located in the same area of the country. Sixty-five percent of feral swine hunters reside in the West South Central Division.

Race

The overall distribution of feral swine hunters are similar to that of all hunters. Whites make up more than nine in ten feral swine hunters. All other races includes Native Hawaiian or Other Pacific Islanders. The proportion of all other races in feral swine hunting is twice that of all hunters. However, that is still below the nine percent of the overall U.S. population that is made up of all other races.

Ethnicity

Hispanics made up 14 percent of the U.S. population 16 years old or older and 2 percent of them participated in hunting. An appreciably lower proportion of Non-Hispanics made up feral swine hunters when compared to all hunters, 89 percent compared to 98 percent. There were not enough Hispanic respondents to report an estimate for feral swine hunting.

Sex

Table 6 reveals that 89 percent of all hunters were male while 90 percent of feral swine hunters were male. The number of female hunters was not reportable because they had a sample size of less than 10.

Table 4. Census Geographic Division Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Census Geographic Division	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
New England	11,593	5	420	4	...	...
Middle Atlantic	32,392	14	1,558	11	...	...
East North Central	36,199	15	2,688	20	...	...
West North Central	15,860	7	1,661	12	...	...
South Atlantic	46,417	19	1,870	14	110*	15*
East South Central	14,206	6	1,531	11	41*	6*
West South Central	27,195	11	1,909	14	468	65
Mountain	17,013	7	1,043	8	...	...
Pacific	38,438	16	996	7	57	8

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

Table 5. Race and Ethnicity Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Characteristic	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
Race						
White	182,872	76	12,852	94	664	92
African American	23,305	10	413	3	...	...
Asian	11,647	5	27	(Z)	10*	1*
All others	21,387	9	382	3	42*	6*
Ethnicity						
Hispanic	32,557	14	271	2	...	...
Non-Hispanic	206,756	86	13,403	98	636	89

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

(Z) Less than 0.5 percent

Table 6. Sex Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Sex	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
Male	114,705	48	12,217	89	648	90
Female	124,608	52	1,457	11	...	...

... Sample size too small (less than 10) to report data reliably.

Education

Hunters, in general, have a very similar educational distribution when compared to the U.S. population. However, feral swine hunters have more participation at the extremes of the educational spectrum. Feral swine hunters with 11 years or less of education made up twice the overall distribution, 22 percent versus 11 percent, when compared to all hunters. Feral swine hunters with 5 years or more of college were 14 percent of the total, compared to 9 percent of all hunters. The percent of feral swine hunters that had 12 years of education to four years of college made up a smaller proportion of the total than all hunters.

Annual Household Income

All annual household income ranges below \$40,000 were not reportable for feral swine hunters. However, 65 percent of all hunters who reported their annual household income had an income of \$40,000 or more. For feral swine hunters, 66 percent had an income of \$40,000 or more. To compare that to the U.S. population, only 49 percent of the households had an annual income of \$40,000 or more. Feral swine hunters also had a proportion three times as high as all hunters that had an income of \$150,000 or more, 18 percent compared to six percent.

Marital Status

All hunters and feral swine hunters have very similar distributions of marital status. Both all hunters and feral swine hunters are more likely to be married than the U.S. population, 71 percent and 68 percent respectively compared to 55 percent. They are also less likely to have never been married than the U.S. population, 16 percent and 15 percent compared to 27 percent.

Table 7. Education Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Education	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
11 years or less	31,574	13	1,482	11	155*	22*
12 years	81,984	34	4,975	36	193	27
1 to 3 years of college	55,014	23	3,510	26	144*	20*
4 years of college	42,552	18	2,447	18	128*	18*
5 years or more of college	28,188	12	1,260	9	99*	14*

*Estimate based on sample size of 10–29.

Table 8. Annual Household Income Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Annual Household Income	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
Less than \$20,000	30,550	13	991	7	...	...
\$20,000 to \$24,999	12,713	5	533	4	...	...
\$25,000 to \$29,999	10,441	4	495	4	...	...
\$30,000 to \$34,999	11,504	5	556	4	...	...
\$35,000 to \$39,999	11,441	5	606	4	...	...
\$40,000 to \$49,999	17,091	7	1,129	8	91*	13*
\$50,000 to \$74,999	33,850	14	2,610	19	88*	12*
\$75,000 to \$99,999	25,236	11	2,371	17	70*	10*
\$100,000 to \$149,999	23,790	10	1,932	14	93*	13*
\$150,000 or more	17,151	7	861	6	132*	18*
Not Reported	45,545	19	1,591	12	124*	17*

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

Table 9. Marital Status Distribution of U.S. Population, All Hunters, and Feral Swine Hunters: 2011

(Population 16 years old and older. Numbers in thousands.)

Marital Status	U.S. Population		All Hunters		Feral Swine Hunters	
	Number	Percent	Number	Percent	Number	Percent
Total persons	239,313	100	13,674	100	718	100
Married	131,567	55	9,658	71	490	68
Divorced	24,418	10	1,348	10	106*	15*
Separated	4,590	2	317	2	...	...
Widowed	13,046	5	183	1	...	...
Never Married	65,691	27	2,168	16	111*	15*

*Estimate based on sample size of 10–29.

... Sample size too small (less than 10) to report data reliably.

Part Two – Expenditures

A basic summary of feral swine hunting expenditures is shown in Table 10. Trip expenditures were directly related to hunting trips. They included but were not limited to food, drink, lodging, and transportation fees. Equipment expenditures included both hunting equipment such as rifles, ammunition, hunting dogs, and auxiliary equipment used primarily for hunting (that is, camping equipment, clothing, and taxidermy costs). Special equipment primarily included purchases of big ticket items such as boats, campers, trucks, and cabins that were used primarily for hunting.

Expenditures

In 2011, hunters spent nearly \$306 million on trip-related, equipment, and other expenditures in pursuit of feral swine. That amounts to \$426 per feral swine hunter and \$512 per spender. For comparison, the average hunter spent \$2,465 in pursuit of any game or \$2,522 per spender. Only 83 percent of feral swine hunters spent money to go feral swine hunting in 2011. This compares to 98 percent of all hunters that spent money in pursuit of any game.

Feral swine hunters primarily chose to use private transportation to get to their hunting site. This is demonstrated by the fact that nearly all of those who spent money on transportation used private transportation. Interestingly, only 460 thousand of the 718 thousand feral swine hunters had transportation expenses. This would suggest that many feral swine hunters may be hunting on their own property.

The only reportable estimate for hunting equipment is ammunition, at \$61 per spender. Only 53 thousand of the 718 thousand feral swine hunters purchased ammunition. Therefore, 93 percent of feral swine hunters used ammunition that they had purchased in previous years.



USDA – APHIS

Of the 718 thousand feral swine hunters, 436 thousand, or 61 percent, purchased a license, tag, permit, or stamp to go feral swine hunting. This compares to 78 percent of all hunters that purchased a hunting license. There are many reasons that a hunter may be exempt from purchasing a license. However, in many States, feral swine are not considered game, and therefore can be hunted without a special tag, or even a hunting license. Feral swine also may not have a hunting season and therefore can be taken all year. Check your State's hunting laws and regulations for further guidance on the limitations of feral swine hunting.

Table 10. Feral Swine Hunting Expenditures by Category: 2011

(Population 16 years old and older)

<i>Expenditure Item</i>	<i>Expenditures</i>		<i>Spenders</i>		
	<i>Amount (thousands of dollars)</i>	<i>Average per hunter (dollars)</i>	<i>Number (thousands)</i>	<i>Percent of Hunters</i>	<i>Average per spender (dollars)</i>
Total, All Items	305,602	426	597	83	512
Trip-Related Expenditures					
Total trip-related	218,149	304	513	71	425
Food and lodging, total	90,412	126	467	65	194
Food	79,254	110	467	65	170
Lodging	11,159	16	85	12	131
Transportation, total	103,390	144	460	64	225
Public transportation	2,896*	4*	34*	5*	85*
Private transportation	100,494	140	457	64	220
Other trip costs, total	24,347*	34*	135*	19*	180*
Guide fees, pack trips, or package fees	13,529*	19*	41*	6*	330*
Public land use fees	...	...	...	...	...
Private land use fees	...	...	...	...	...
Equipment rental	...	...	...	...	...
Boating costs	...	...	...	...	...
Heating and cooking fuel	1,601*	2*	100*	14*	16*
Equipment Expenditures					
Hunting equipment, total	19,310*	27*	83*	12*	233*
Firearms	...	...	...	...	...
Rifles	...	...	...	...	...
Shotguns	...	...	...	...	...
Muzzleloaders, primitive firearms	...	...	...	...	...
Pistols, handguns	...	...	...	...	...
Bows, arrows, archery equipment	...	...	...	...	...
Telescopic sights	...	...	...	...	...
Decoys and game calls	...	...	...	...	...
Ammunition	3,228*	4*	53*	7*	61*
Hand loading equipment	...	...	...	...	...
Hunting dogs and associated costs	...	...	...	...	...
Other hunting equipment	...	...	...	...	...
Auxiliary equipment, total	...	...	...	...	...
Camping equipment	...	...	...	...	...
Binoculars, field glasses, telescopes, etc.	...	...	...	...	...
Special hunting clothing, rubber boots, waders, and foul weather gear	...	...	...	...	...
Processing and taxidermy costs	...	...	...	...	...
Other auxiliary equipment	...	...	...	...	...
Special equipment, total	...	...	...	...	...
Off-the-road vehicle	...	...	...	...	...
Travel or tent trailer, pickup, camper, van, motor home, recreational vehicle	...	...	...	...	...
Boats, boat accessories	...	...	...	...	...
Cabins and other	...	...	...	...	...
Other Expenditures					
Other Items, total	64,834	90	492	69	132
Magazines, books, DVDs	...	...	...	...	...
Membership dues and contributions	...	...	...	...	...
Land leasing and ownership	40,276*	56*	142*	20*	284*
Licenses, stamps, tags, and permits, total	12,145	17	436	61	28
Licenses	8,688	12	427	59	20
Federal duck stamps	N/A	N/A	N/A	N/A	N/A
Stamps, tags, and permits	3,457*	5*	117*	16*	30*
Plantings	12,183*	17*	44*	6*	277*

*Estimate based on sample size of 10–29. N/A Not Applicable.

... Sample size too small (less than 10) to report data reliably.

Part Three – Proximity to Range

Proximity Analysis

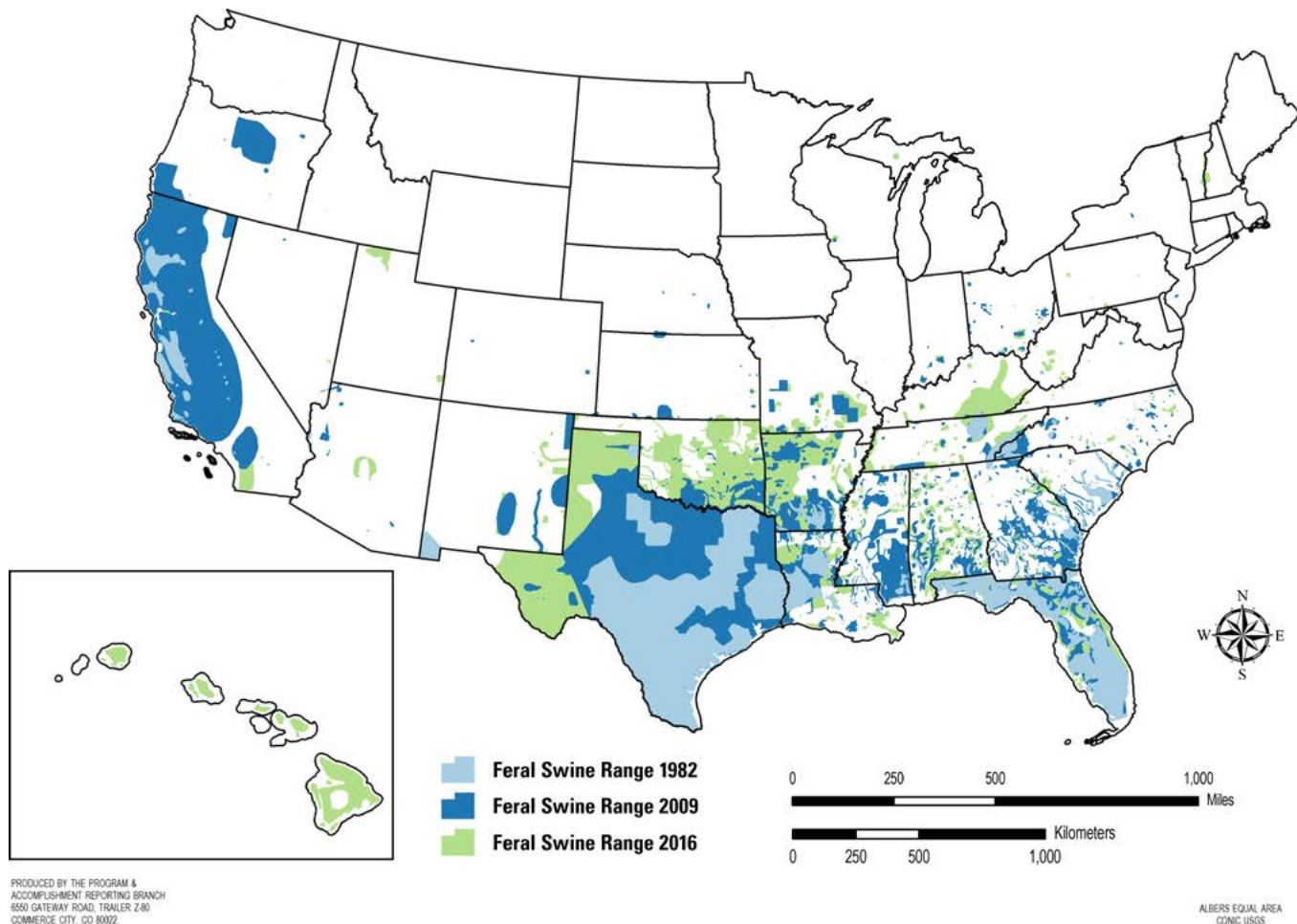
Feral swine range data are tracked by the United States Department of Agriculture – Animal and Plant Health Inspection Service. The following map show the spread of feral swine range over time. The light blue area is the range in 1982. The dark blue area is the range in 2009 that expanded from 1982. The green area is the range in 2016 that expanded from 2009 and 1982.

The 2009 data were used for the model estimated in Part Four of this report. Data were unavailable for range in Hawaii in 2009, therefore the 2016 data were used for Hawaii in the model. The respondents to the 2011 National Survey reported on their hunting activities during calendar year 2011. The households were selected for sample in July of 2010. Therefore, the range data and the response timeframes do not align perfectly. However, the best

available approach was used given the data limitations.

As can be seen on the map, range has persisted and expanded throughout the South and West. The range has expanded to at least 36 States. According to the plan developed to fight feral swine range expansion, eradicating small populations is a priority. Slowing and hopefully reducing the population of more established areas is also a priority.

Figure 1: Feral Swine Range in 1982, 2009, and 2016



An analysis was performed to estimate the proximity to the nearest feral swine range for each household. Based on this analysis, feral swine hunters were most likely to reside close to or within feral swine range. Among feral swine hunters, 92.3 percent lived within 25 miles of range (Figure 2). No feral swine hunter sampled lived farther away than 275 miles. Zooming into the distribution from 0 to 25 miles, 78.8 percent lived within 5 miles of range (Figure 3). Zooming farther into the distribution from 0 to 5 miles, 74.2 percent lived within a mile of range (Figure 4). This is evidence that nearly three-quarters of all feral swine hunters live in or bordering existing feral swine range.

Figure 2: Distribution of Distance to Nearest Feral Swine Range of Feral Swine Hunters (All Distances)

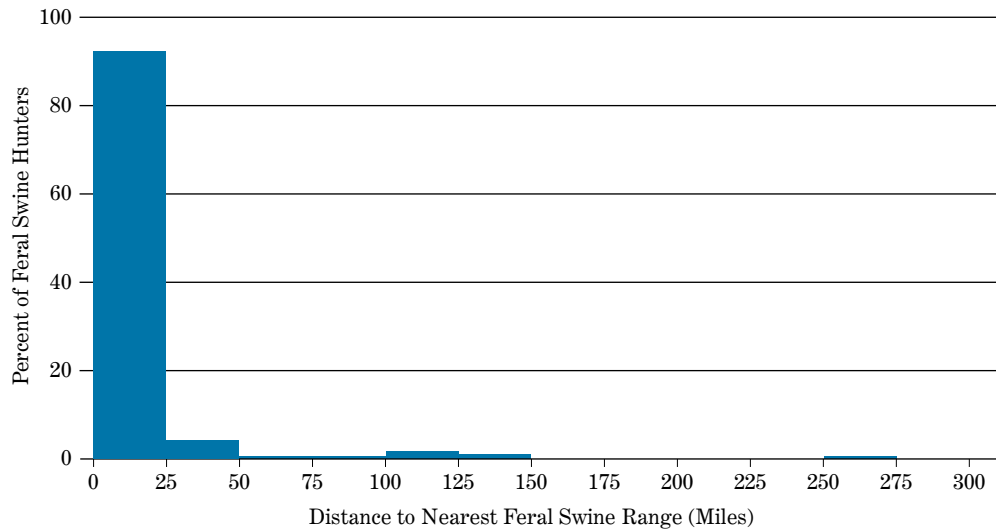


Figure 3: Distribution of Distance to Nearest Feral Swine Range of Feral Swine Hunters (25 Miles or Less)

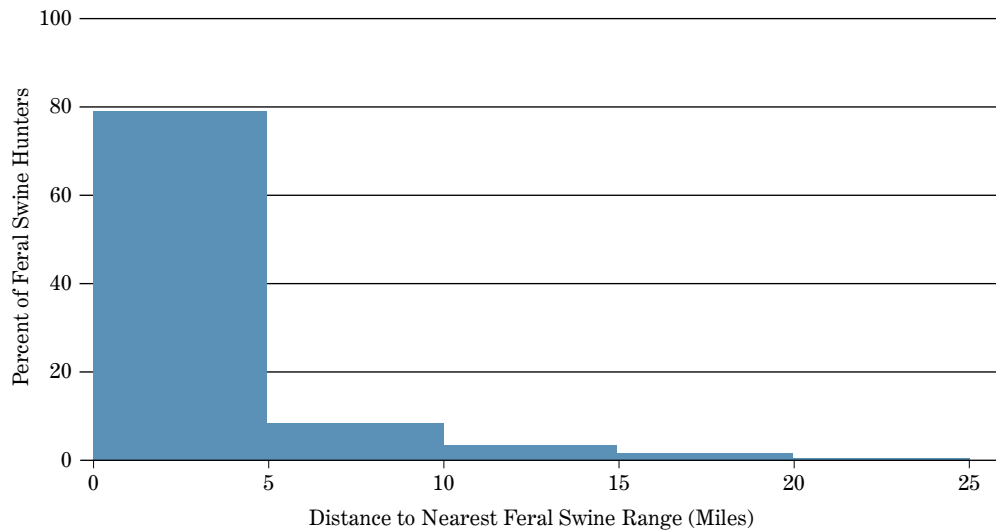
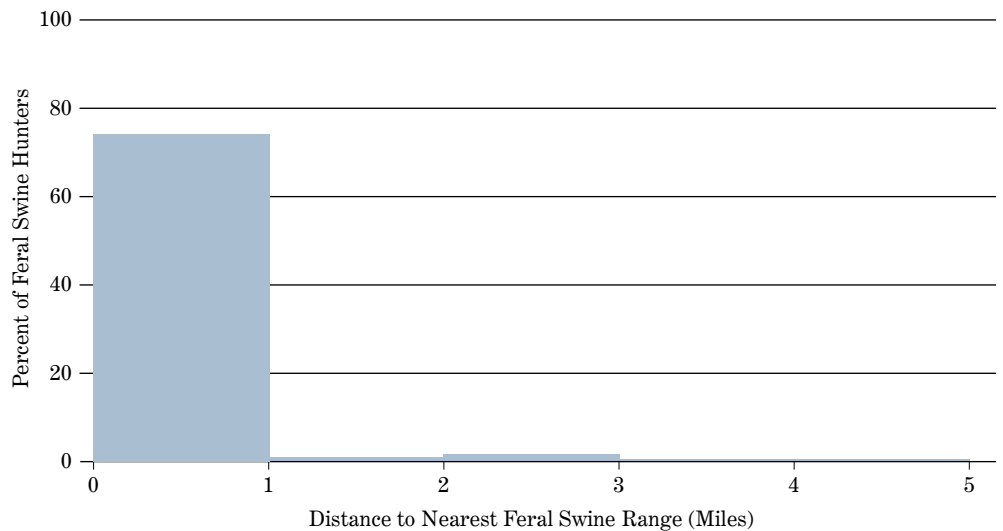


Figure 4: Distribution of Distance to Nearest Feral Swine Range of Feral Swine Hunters (5 Miles or Less)



Residency

Another way of determining the likelihood of an individual feral swine hunting is by analyzing the differences in residency among feral swine hunters. This analysis is limited to hunters that only hunted for one species in the State that they indicated they hunted for feral swine, due to data limitations.

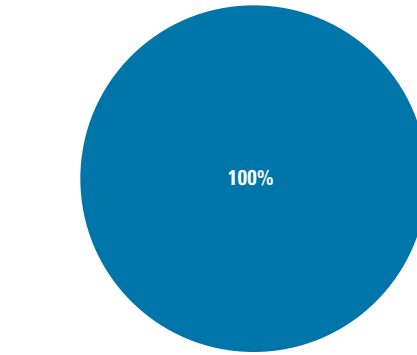
Figure 5 shows that in Hawaii, only State residents participated in feral swine hunting. Figure 6 shows that in the contiguous U.S., 94 percent of all feral swine hunters were State residents.

Many species are hunted by nonresidents throughout the United States. Some species only have range in limited areas. Hunters come from far and wide to hunt species like elk and moose. It is apparent that feral swine are not seen as this type of species.

Property Type

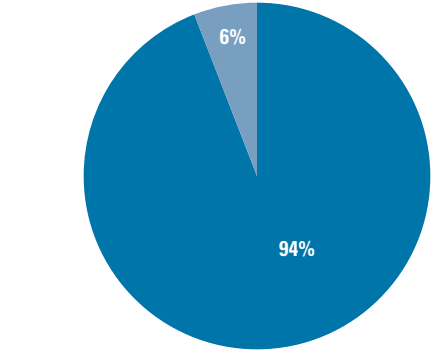
Additionally, analyzing the type of property that feral swine hunters hunted on gives a better idea of their preferred hunting location. Figure 7 indicates that 53 percent of the days spent feral swine hunting in Hawaii were on property owned by the local, State, or Federal government. Meanwhile, 47 percent of the hunting days were on private property. Figure 8 shows that 91 percent of all feral swine hunting days in the contiguous U.S. took place on private property. Conversely, nine percent took place on property owned by the local, State, or Federal government. This indicates the differences in both hunting opportunities and preferences in Hawaii compared to the rest of the U.S.

Figure 5: Feral Swine Hunting Days in Hawaii by State Residency Status



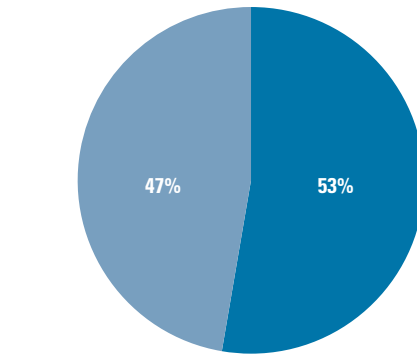
■ State residents
■ Nonresidents of State

Figure 6: Feral Swine Hunting Days in Contiguous U.S. by State Residency Status



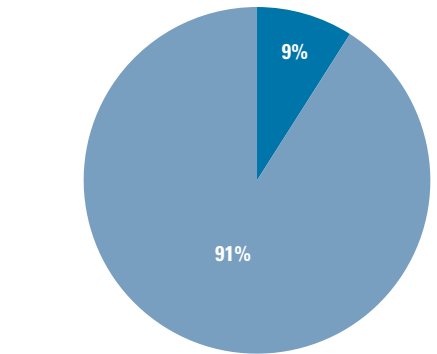
■ State residents
■ Nonresidents of State

Figure 7: Feral Swine Hunting Days in Hawaii by Property Type



■ Property owned by local, State, or Federal government
■ Private property

Figure 8: Feral Swine Hunting Days in Contiguous U.S. by Property Type



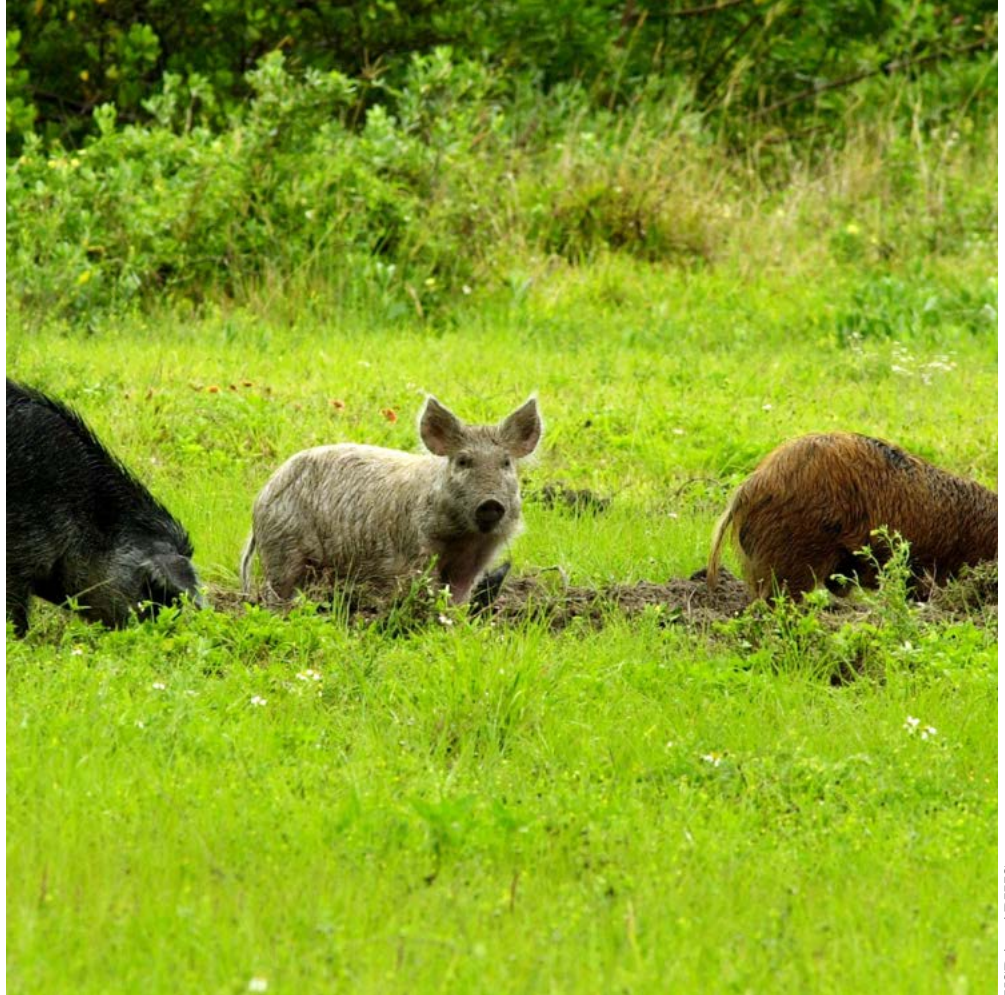
■ Property owned by local, State, or Federal government
■ Private property

Note: Analysis is limited to hunters that only hunted for one species in the State that they indicated they hunted for feral swine.

Part Four – Feral Swine Hunting Participation Model

Feral swine range continues to expand in the contiguous U.S., despite efforts to curb their population. In order to better understand how proximity to feral swine range affects the likelihood of a person to go feral swine hunting, a model was estimated. The preferred outcome of this effort would be to provide game management agencies with an additional tool to estimate how an expansion or contraction in feral swine range would affect the number of feral swine hunters. In the event of an expansion, this would give game management agencies a better idea of what kind of hunting response the increasing population might cause. In the event of a contraction, the model suggests there would be fewer recreational hunters seeking feral swine in the area.

A logistic model was used to estimate the likelihood of a person feral swine hunting. A logistic model has a binary dependent variable. In this instance, one means yes, the respondent did go feral swine hunting in 2011, and zero means no, the respondent did not go feral swine hunting in 2011. The resulting model is then manipulated to achieve odds ratios for each independent variable. An odds ratio can then be used to see the direction and size of the impact on the likelihood of a person participating in feral swine hunting.



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Variables

The variables considered for the model included household-level demographic statistics, person-level demographic statistics, and the measure of proximity to the nearest feral swine range for each household. Additionally, dummy variables for residence in Hawaii and Alaska were included. Hawaii is not in the contiguous U.S., and therefore wouldn't be subjected to an expansion of the existing feral swine populations. Additionally, as discussed earlier, Hawaiian hunters have a different perspective on feral swine. The dummy variable is an effort to capture this effect. Refer to Table 11 for a full breakdown of the independent variables and the subsequent levels considered.

Only households that had a response for all independent variables were considered for the regression. The final model was selected using backward selection criteria. Feral swine hunting is a rare event, as only 1.0 percent of unweighted respondents and 1.1 percent of weighted respondents indicated that they participated in feral swine hunting. When estimating a model where the outcome of interest is a rare event, logistic regression has a tendency to underestimate the likelihood of the total population. Therefore, to account for this bias, a Firth's bias correction was used as a likelihood penalty within the estimated model.

The logit regression is described by the following two equations:

$$P_i = \frac{e^{\beta_i X_i}}{1 + e^{\beta_i X_i}}$$

where:

$$\ln\left(\frac{P_i}{1 - P_i}\right) = \sum_{i=1} \beta_i X_i$$

P_i = Probability that the i th individual hunted feral swine in 2016.

X_i = Vector of independent variables

β_i = Vector of coefficients to be estimated

$\frac{P_i}{1 - P_i}$ = The odds ratio

Table 11. Potential Independent Variables for Feral Swine Hunting Participation Model

MSA	Indicator variable with two values to indicate size of residence
	Inside Metropolitan Statistical Area
	Outside Metropolitan Statistical Area
DENSITY	Indicator variable with two values to indicate density of residence
	Urban
	Rural
INCOME	Ordinal variable with two values to indicate annual household income
	Below \$50,000
	\$50,000 and above
HAWAII	Indicator variable with two values to indicate Hawaiian residency
	Resident
	Nonresident
ALASKA	Indicator variable with two values to indicate Alaskan residency
	Resident
	Nonresident
PROXIMITY	Proximity in miles to nearest feral swine range of residence. Residence within range given value of 0.

Respondent Demographic Characteristics

AGE	Age of resident in years for those 16 years old and older
SEX	Indicator variable with two values to indicate respondent sex
	Male
	Female
RACE	Nominal variable with four levels to indicate race
	White
	Black or African American
	American Indian of Alaska Naitive
	Asian
	Native Hawaiian of Other Pacific Islander
	Other
ETHNICITY	Indicator variable with two values to indicate Hispanic origin of respondent
	Hispanic
	Non-Hispanic
EDUCATION	Ordinal variable with five levels to indicate level of school completed by respondent
	11 years or less
	12 years
	1 to 3 years of college
	4 years of college
	5 or more years of college
JOB	Indicator variable with two values to indicate employment status
	Employed
	Unemployed
MARITAL	Nominal variable with five levels to indicate marital status
	Married
	Widowed
	Divorced
	Separated
	Never Married

The final model, as seen in Table 12, had an intercept, the sex of the respondent, the marital status of the respondent, whether or not the respondent lived inside or outside of a Metropolitan Statistical Area, a dummy variable to indicate whether or not the respondent was a resident of Hawaii, the age in years of the respondent, and the proximity in miles to the nearest feral swine range of the respondent's household.

In the final model, the reference case is represented by the intercept term. The reference case is as follows for each indicator, nominal, and ordinal variable:

- SEX: Male
- MARITAL: Divorced
- MSA: Outside MSA
- HAWAII: Nonresident

Table 12. FINAL MODEL: Penalized Maximum Likelihood Estimates of Logit Regression with Firth Penalty

<i>Variable</i>	<i>Value</i>	<i>Estimate</i>	<i>Standard Error</i>	<i>Wald Chi-Square</i>	<i>Pr > ChiSq</i>
Intercept		-0.708	0.479	2.179	0.140
SEX	Female	-1.488	0.297	25.079	<.0001
MARITAL	Married	-0.518	0.267	3.758	0.053
MARITAL	Never Married	-1.320	0.379	12.115	0.001
MARITAL	Separated	-0.924	0.714	1.675	0.196
MARITAL	Widowed	-1.506	1.359	1.228	0.268
MSA	Inside MSA	-0.888	0.233	14.505	0.000
HAWAII	Resident	1.694	0.579	8.560	0.003
AGE		-0.023	0.007	9.895	0.002
PROXIMITY		-0.055	0.008	50.661	<.0001

Results

The calculated odds ratios for each variable and subsequent level are presented in Tables 13 through 18. The estimate for the odds ratio for PROXIMITY is 0.947 to 1. That means that for every additional mile away from feral swine range, the odds of feral swine hunting decrease 5.3 percent. In order to see how this relationship decreases the likelihood of feral swine hunting, the probability was calculated for each distance to feral swine range and graphed in Figures 9 through 13.

The graphs are organized by marital status. Therefore, there are five graphs, one for each marital status level. Each graph has the probability of feral swine hunting on the y-axis and the proximity in miles on the x-axis. For demonstration purposes, the mean age of the sample, 44 years old, is used to calculate the probabilities. There are three additional variables for which to account. SEX, MSA, and HAWAII each have two levels that were used in the model. Therefore,

there are eight combinations of these three variables to take into account. Each graph has eight lines. Each line represents one of the eight combinations of SEX, MSA, and HAWAII. All of the graphs have the same y-axis so that they can be compared visually.

Figure 9 shows that the population's highest probability of feral swine hunting is a 44 year old divorced male who lives outside of an MSA, is a resident of Hawaii, and lives in feral swine range. An individual like this has an estimated probability of feral swine hunting of 50 percent.

Figure 13 shows that the lowest probability of feral swine hunting is a 44 year old widowed female who lives inside of an MSA, is a nonresident of Hawaii, and lives far from feral swine range. An individual like this has a less than one percent probability of feral swine hunting, even when they live in feral swine range, let alone far from the feral swine range.

Table 13. Odds Ratios by Sex

Sex	<i>Male</i>	<i>Female</i>
Male	–	4.425 (2.545 – 8.403)
Female	0.226 (0.119 – 0.393)	–

Table 14. Odds Ratios by Marital Status

Marital Status	<i>Married</i>	<i>Divorced</i>	<i>Separated</i>	<i>Widowed</i>	<i>Never Married</i>
Married	–	0.596 (0.359 – 1.037)	1.501 (0.485 – 7.930)	2.686 (0.396 – 223.935)	2.228 (1.257 – 4.109)
Divorced	1.678 (0.964 – 2.786)	–	2.519 (0.741 – 13.889)	4.505 (0.635 – 333.333)	3.745 (1.799 – 7.937)
Separated	0.666 (0.126 – 2.062)	0.397 (0.072 – 1.350)	–	1.789 (0.139 – 167.424)	1.486 (0.268 – 5.102)
Widowed	0.372 (0.004 – 2.525)	0.222 (0.003 – 1.575)	0.559 (0.006 – 7.194)	–	0.830 (0.010 – 6.452)
Never Married	0.449 (0.243 – 0.796)	0.267 (0.126 – 0.556)	0.673 (0.196 – 3.726)	1.205 (0.155 – 103.462)	–

Table 15: Odds Ratios by Population Size of Residence

Population Size of Residence	<i>Inside MSA</i>	<i>Outside MSA</i>
Inside MSA	–	0.412 (0.263 – 0.666)
Outside MSA	2.427 (1.502 – 3.802)	–

Table 16: Odds Ratios by Hawaii Residency

Hawaii Resident	<i>Yes</i>	<i>No</i>
Yes	–	5.441 (1.500 – 15.000)
No	0.184 (0.067 – 0.667)	–

Table 17: Odds Ratios by Age

Age	<i>Estimate</i>	<i>95% Confidence Interval</i>	<i>Units</i>
Years	0.978	(0.964 – 0.992)	1 Year

Table 18: Odds Ratios by Proximity to Feral Swine Range

Proximity	<i>Estimate</i>	<i>95% Confidence Interval</i>	<i>Units</i>
Distance to Feral Swine Range	0.947	(0.931 – 0.960)	1 Mile

Note: Indicates significantly different from compared category at 95 percent confidence level.

Figure 9: Probability of Feral Swine Hunting by Proximity to Feral Swine Range Based on Demographic Characteristics

(AGE=mean age of 44 years old, MARITAL=Divorced)

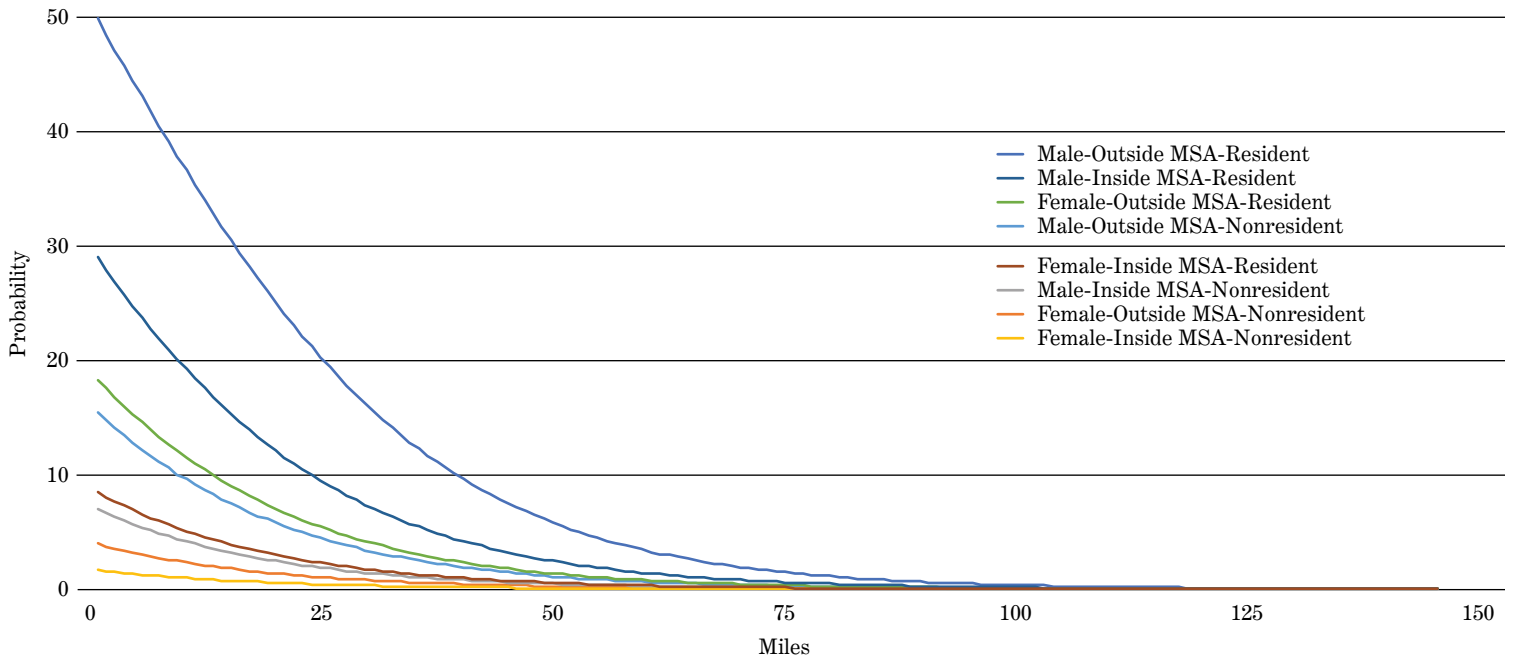


Figure 10: Probability of Feral Swine Hunting by Proximity to Feral Swine Range Based on Demographic Characteristics

(AGE=mean age of 44 years old, MARITAL=Married)

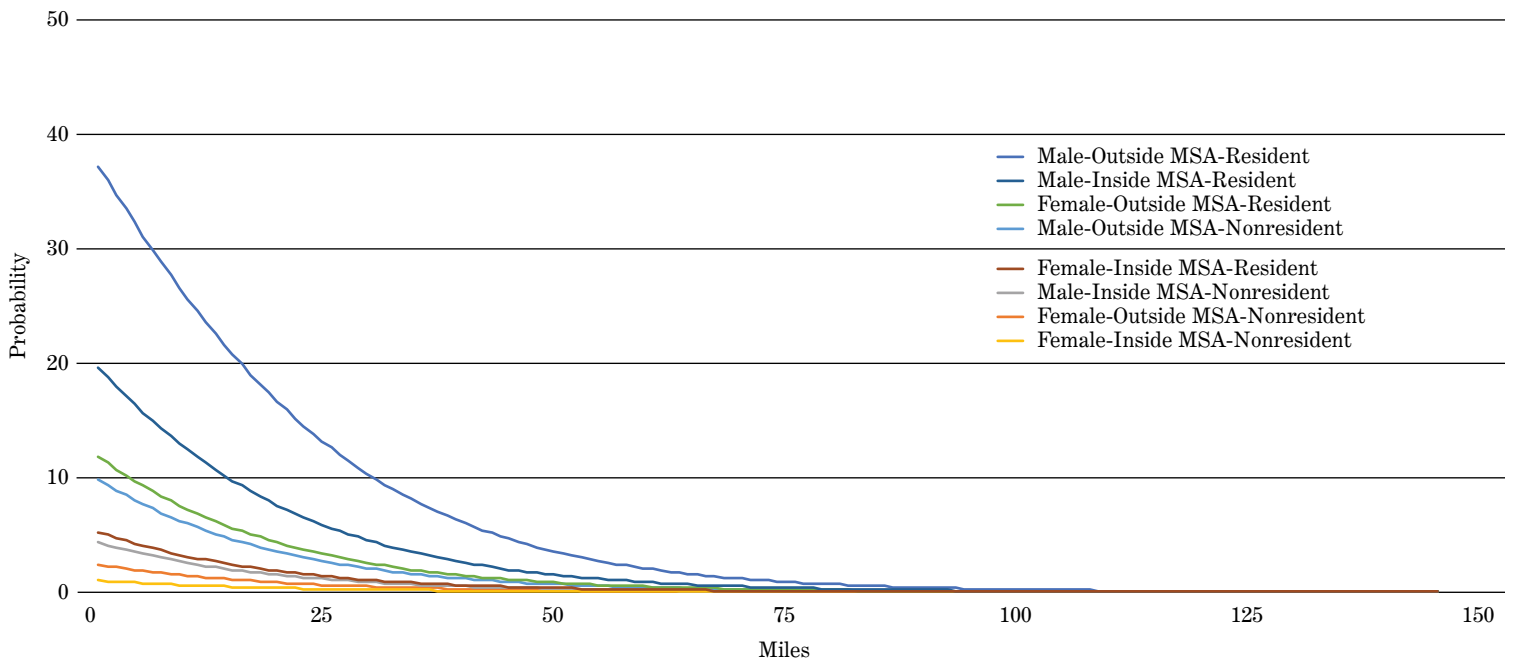


Figure 11: Probability of Feral Swine Hunting by Proximity to Feral Swine Range Based on Demographic Characteristics

(AGE=mean age of 44 years old, MARITAL=Never Married)

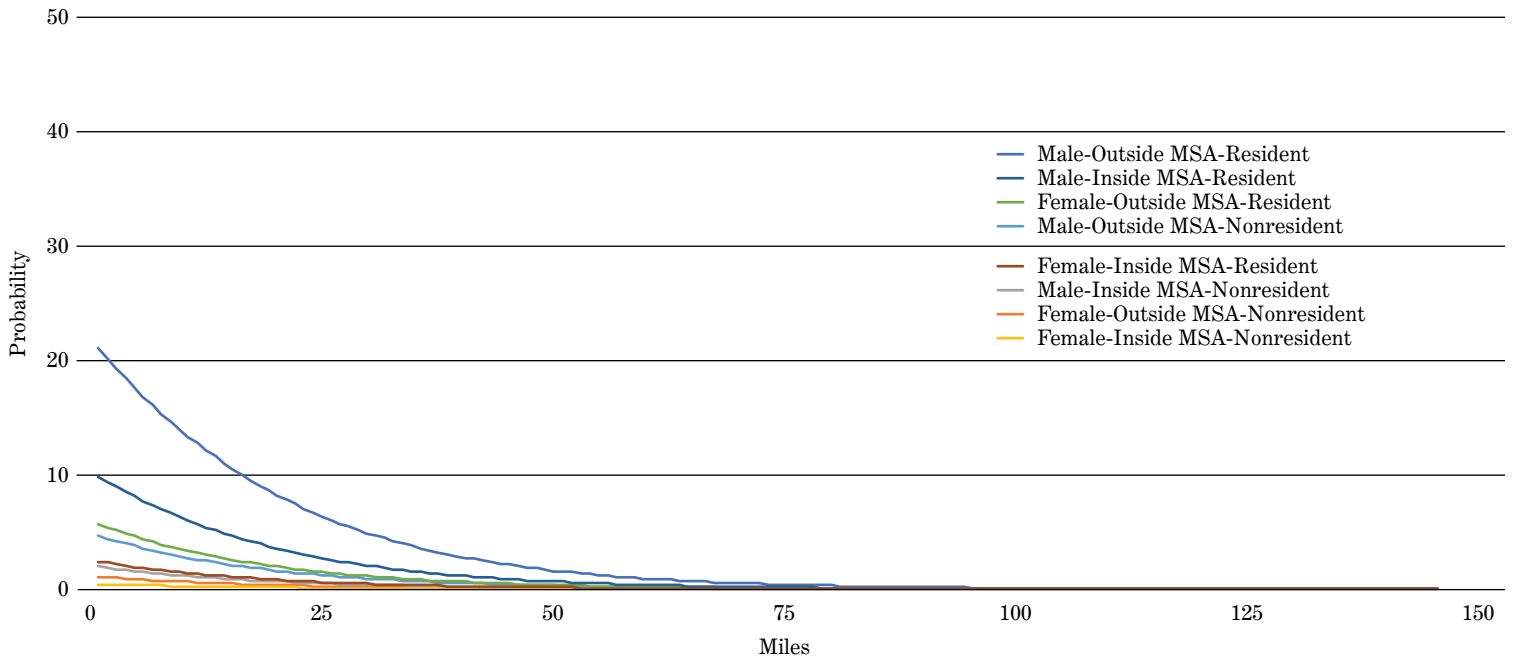


Figure 12: Probability of Feral Swine Hunting by Proximity to Feral Swine Range Based on Demographic Characteristics

(AGE=mean age of 44 years old, MARITAL=Separated)

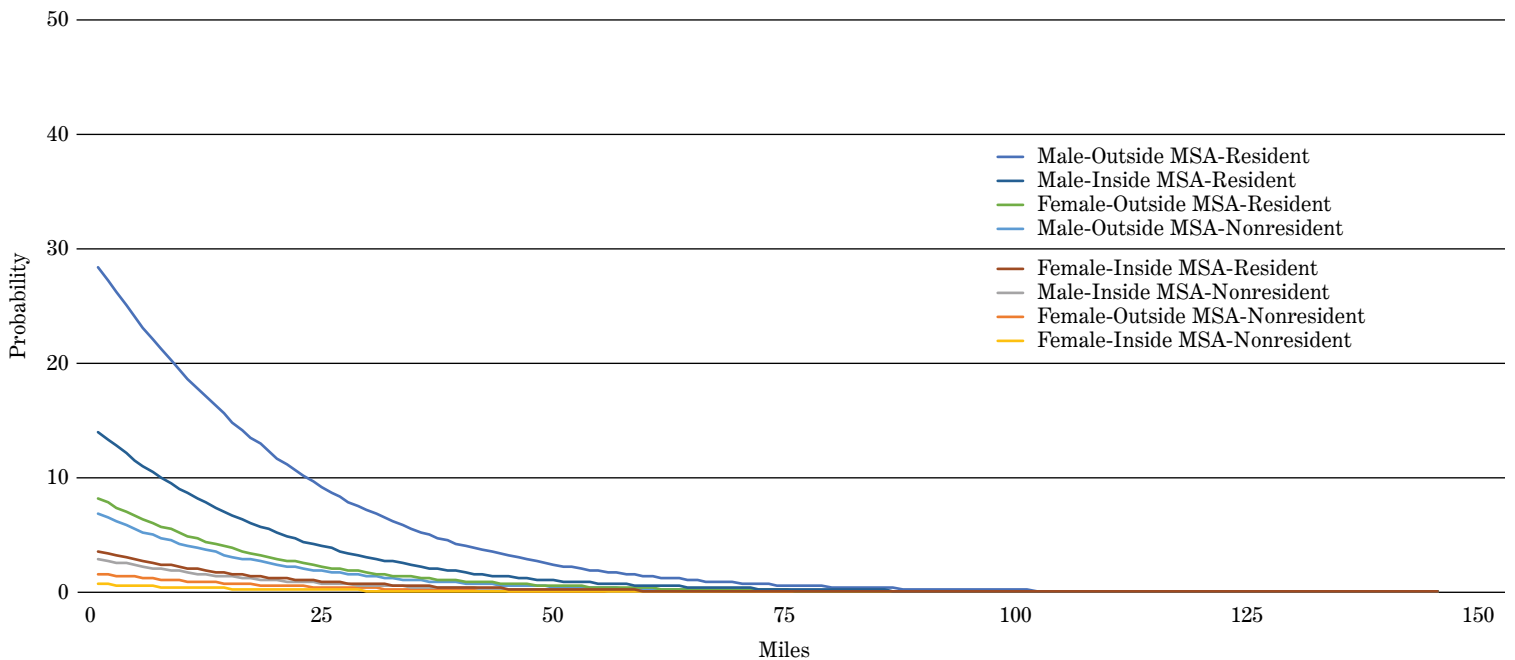
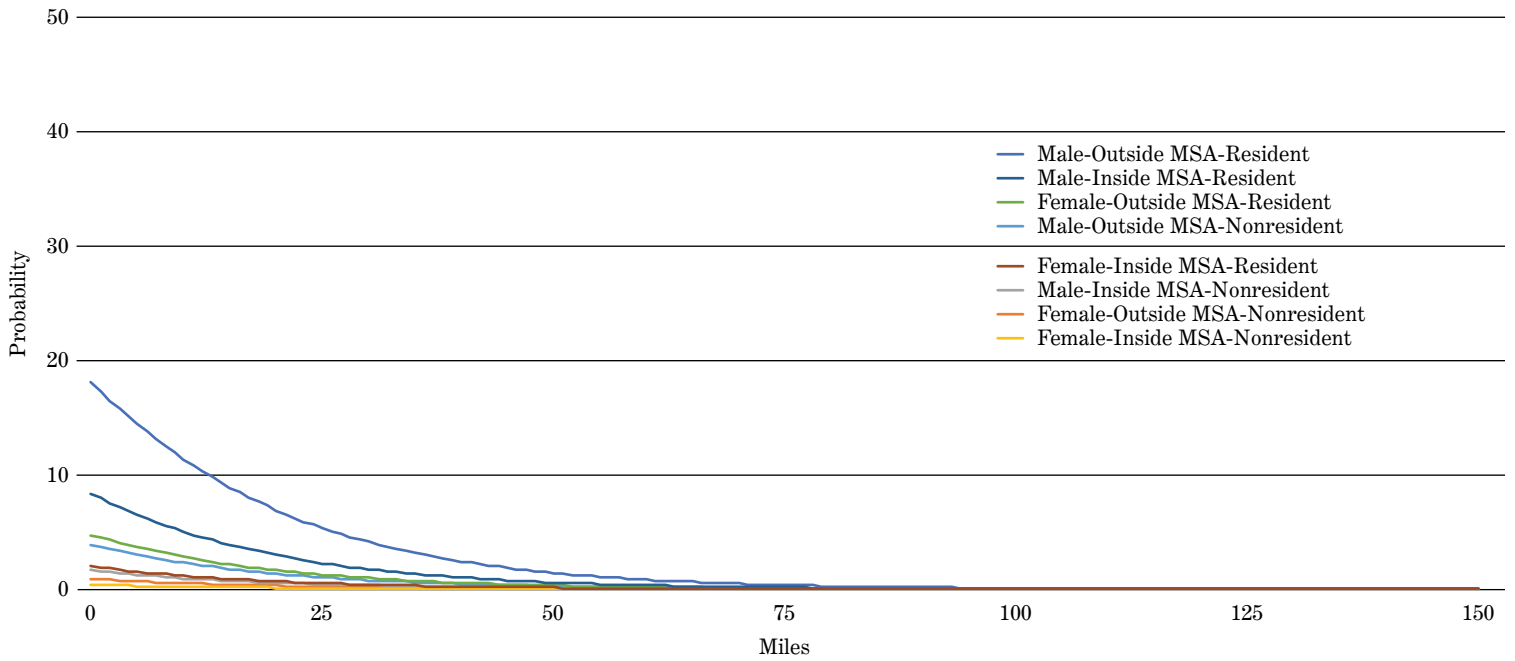


Figure 13: Probability of Feral Swine Hunting by Proximity to Feral Swine Range Based on Demographic Characteristics
 (AGE=mean age of 44 years old, MARITAL=Widowed)



Conclusion

The combination of 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation data and feral swine range data from USDA-APHIS provided a useful look into how demographics and proximity affect feral swine hunter behavior. The partnership between the U.S. Fish and Wildlife Service, USDA, and other land management agencies will benefit from the knowledge that proximity to range plays such a large role in an individual's choice to hunt feral swine.

Feral swine hunters are also hunters of many other species. They often participate at higher rates than other hunters. Their avidity is clear and represented by their choice to hunt feral swine in the first place. They also hail from urban areas more than all hunters. They are concentrated in the South and West, where the most established feral swine range exists. Their expenditures to hunt feral swine have a considerable impact on the economy.

The fact that feral swine hunters participate at a higher rate when hunting other species, on top of the feral swine hunting they are doing, goes to show that there is surplus demand, beyond hunting game species, among the highest-avidity hunters. Often hunting season limitations or the cost of travel to hunt affect hunters' marginal decisions to hunt. When feral swine are available to hunt all year and they are located in the hunters' back yard, in some instances, it allows for the excess demand to be met. Other explanations include hunters taking feral swine opportunistically while hunting other species or hunters hunting feral swine in order to protect the environment of the game species that they are more interested in seeking.



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Unfortunately, some feral swine hunters have taken it upon themselves to continue to supply this hunting opportunity by relocating sounders of swine. This causes the continued spread of an invasive species that causes incredible damage and is increasingly costly to eradicate.

Wildlife management agencies go to extreme lengths to control the spread of feral swine. If you are interested in helping eradicate feral swine, contact your State wildlife agency.

U.S. Department of the Interior
U.S. Fish & Wildlife Service



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