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Wild pigs are suspected as one possible source for the deadly September 2006 *E. coli* O157:H7 disease outbreak traced to consumption of California spinach grown in San Benito or Monterey counties. About the same time, to the north in Contra Costa County wild pigs were reported to be ruining golf course greens and suburban yards. Annually, the federal government spends roughly \$55,000 to maintain a pig exclusion fence to protect native species in Pinnacles National Monument. And, wild pigs are implicated in damages to livestock range and farm facilities in many places in California. On the other hand, wild pigs also provide opportunity for adventurous big game hunting. California Department of Fish and Game (CDFG) reports show that during the 2005/2006 season sport hunters reported taking 5,453 wild pigs from 44 of the 58 California counties, the vast majority (90%) taken on private lands.

The presence of wild pigs in California raises conflicting policy concerns. Even within the farming and ranching community, opinions differ on the degree to which wild pigs are an attractive source of revenue, sport hunting and food, or a destructive, non-native invasive pest with potential for transmitting disease and contaminating crops, and as competitor with cattle and deer for available forage. Current policies enable lethal removal of wild pigs by sport hunters and property owners threatened with property damage. In general, however, reproductive capacity soon restores the numbers. Increasingly, questions are being raised whether more aggressive attempts should be made to attempt to eradicate the non-native pig population from California or whether

additional strategies can provide adequate control over wild pigs and their negative impacts.

*Sus scrofa*, the pig species, is an introduced, non-native species from Eurasia. California, Florida, Hawaii and Texas all have major wild pig populations, and free-ranging populations exist also in at least 35 other states. Domestic pigs were first released in California by the Spanish in 1769 and by 1797 were raised at Mission San Juan Bautista in San Benito County. The larger, fiercer European wild boar was introduced to the neighboring Monterey County in the 1920s by George G. Moore for sport hunting on his private Carmel Valley property. Since then wild pigs have been deliberately and repeatedly illegally relocated elsewhere in the state to facilitate hunting opportunities, and they continue to be legally imported. Today's "wild pigs" in California are hybrids of wild boar and feral (i.e. escaped domestic) pigs. Wild pigs are now found in at least 44 California counties. In California, the wild pig is regulated as a big game mammal.

This *AIC Issues Brief* will tell the story of the wild pig in California, its economic and environmental impacts and evolving policy concerns. For a longer review of the underlying facts and issues please go to a draft online report at [www.aic.ucdavis.edu/](http://www.aic.ucdavis.edu/).

### Costs

Little data exists on the size of the total wild pig population in California or on direct (or indirect) costs to agriculture or the environment. Documentation of costs that does exist is sporadic and, frequently, anecdotal. Accordingly, we cannot

say whether costs of damage attributable to pigs have increased or decreased. Potential costs or actual costs of wild pig damage and damage prevention measures are certainly significant for some individuals and groups. An aggregation of reported costs suggests that current wild pig damage is small compared to the overall economic activity of agriculture in California (gross farm revenue of more than \$32 billion in 2006). Nevertheless the *potential* costs to agriculture are huge. In particular, the discovery of a foreign animal disease attributable to wild pigs would most likely lead to a trade embargo on affected species and products, with consequences on price and profit. Plant crops known to be contaminated with zoonotic diseases are unmarketable, even if not embargoed. Further, food safety fears often affect sales of uncontaminated produce.

Landowners, county agricultural commissioners, natural area managers, and University of California Cooperative Extension farm advisers and specialists are the sources for cited damage estimates. In requests to the USDA Wildlife Services (WS) to remove or destroy depredating pigs (i.e. pigs causing damage), complaining landowners estimated wild pigs caused \$1.8 million in damage over the most recent five years. The WS successfully trapped 470 pigs in 2006 for those who requested their services and had obtained depredation (i.e. relief) permits from CDFG—1,634 pigs over the 5 years.

Local impacts vary significantly. In recent years (FY2002-2006) landowners in Kern, San Luis Obispo, Monterey, Santa Barbara, San Benito, and Colusa reported to the WS the greatest total damage (Figure 1). The most significant damage reported in 2006 was in Monterey, Placer, Merced, San Luis Obispo and Mariposa counties.

Notably, in the 2005/06 hunting season recreational hunters reported taking the greatest number of pigs from Monterey, Kern, San Benito, Sonoma, and San Luis Obispo counties. Figure 2 shows the five-year total of pigs reported to CDFG as taken by landowners with CDFG depredation permits, the greatest numbers from San Benito and Monterey counties.

Another source of damage estimates is Frederick's survey of county agricultural commissioners who, for 1996 alone, estimated over \$1.7 million in damages to crops, fencing, roads and trails in 29 counties. Agricultural commissioners are not specifically charged with monitoring wild pigs, however, and the basis of their estimates is not reported. In 2007, Sweitzer sent a survey to agricultural commissioners asking for damage characterization and cost estimates, but results have not been published. Responding to another Sweitzer survey, natural area managers overwhelmingly identified rooting by pigs as a major problem, although without estimating dollar costs.

To conserve, protect and restore native plants and animals at Pinnacles National Monument in San Benito County, the National Park Service constructed a pig exclusion fence. Completed in 2003 after 18 years of construction, the 24-mile fence cost \$1.5 million to construct. Designed to prevent pigs from rooting underneath while allowing other animals to pass through or jump over it, the fence encloses 14,500 acres, much of the area in remote and rugged terrain. In addition, the federal government allocated \$844,000 to eradicate feral pigs at Pinnacles upon completion of the fence. In the last couple of years expenditures of approximately \$55,000 annually have been required to inspect for breaches and maintain the fence.

Not counting the significant costs of fencing and follow-up monitoring, The Nature Conservancy and the National Park Service spent roughly \$5 million (including a \$3.9 million contract to Prohunt NZ Ltd.) to implement total eradication of feral pigs from Santa Cruz Island, California to protect rare endemic species and cultural resources. The 62,000-acre island was declared pig free in June 2007, twenty-six months after initiating eradication and the lethal shooting of 5,036 pigs.

### **Disease infection and transmission.**

Wild pigs are susceptible to the same infections that affect domestic pigs and, depending on the disease, other mammals grown for human consumption. They could serve as reservoirs for viral, bacterial or parasitic disease agents that affect

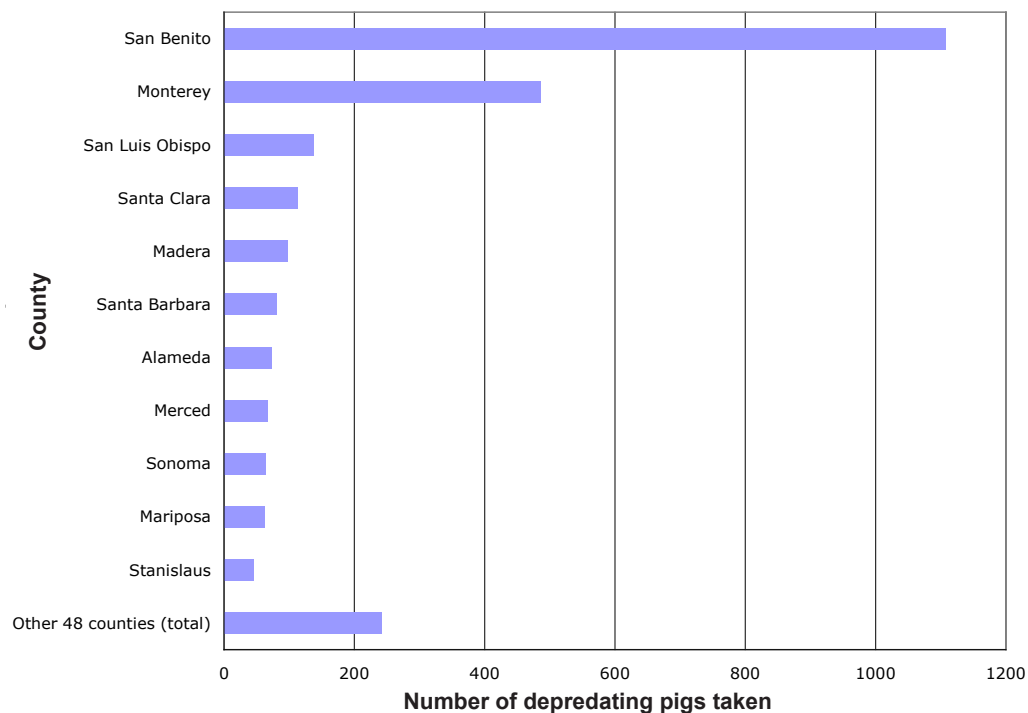
**Figure 1. Wild pig damage reported by landowners\* over five years to U.S. Wildlife Services (by county, FY2002-2006 totals)**



Source: USDA APHIS Wildlife Services, California State Office

\*Damage reports are from landowners who obtained California Department of Fish and Game depredation permits for wild pig removal.

**Figure 2. Total depredating pigs taken with depredation permits, as reported by landowners over five years to California Department of Fish and Game (by county, 2002-2006 totals)**



Source: California Department of Fish and Game

Note: It is not possible to determine whether some or all of the 1,634 pigs taken by the federal Wildlife Services at landowner request are included in the numbers reported to the CDFG by landowners.

(a) humans, (b) domestic mammals, (c) wildlife, and (d) hunters' health. Similarly, these same species could infect wild pigs, which subsequently could sustain disease reservoirs. Livestock, deer and other wildlife may pose risks of disease transmission comparable to that by wild pigs. All can pollute water supply or affect food safety.

Disease incidence and risk of infection from wild pigs in California has been much less than in Texas, Florida or Australia. The WS routinely collects diagnostic samples from pigs trapped pursuant to landowners' depredation (relief) permits issued by CDFG, and for the California Department of Health Services, California Department of Agriculture, the U.S. Fish and Wildlife Service and others. Over the past 20 years the California Animal Health and Food Safety Laboratory (CAHFS) at UC Davis has provided much of the diagnostic laboratory support for surveillance of diseases in California wildlife. In 2006 and 2007, all of the test results for classical swine fever and swine influenza were negative. The existence of either classical swine fever or swine influenza would result in trade embargoes on swine and swine products. Five of the 60 WS samples in 2006 that were tested for plague indicated those wild pigs had been exposed to plague but now had antibodies and could not infect others. While swine brucellosis and pseudorabies are not present in commercial California pigs, both have been found in wild pigs.

Because much of the nation's fresh-cut market vegetables are grown in the Salinas Valley, Atwill in the UC Davis School of Veterinary Medicine and Mandrell of the USDA Agricultural Research Service launched a major study this year to identify all sources of *E. coli* and all environmental factors and farming practices in the Salinas Valley that may increase risk of contamination to food crops. Cattle, deer and wild pigs all have tested positive for *E. coli* O157:H7, but other carriers or factors such as climate, landscape attributes, soil and water may be crucial, as may be the post-harvest processes.

### **Biology and ecology**

An omnivorous eater, cloven hoofed, with keen sense of smell and hearing, the wild pig is prolific,

smart and adaptable to a wide variety of climates and habitats. With pressures from hunters or when seasonal or environmental conditions become less favorable it is able to move or change its food habits. Once it has evaded control measures it is exceedingly wary. Schauss reports that with increased mortality, reproduction will increase, given sufficient feed and climate. Population models estimate that greater than 70 percent mortality would be required to affect the pig's ability to sustain replacement. Water, forage and cover for escape and shade are the limiting factors. On Santa Cruz Island they have recovered from even greater decimation due to drought. Predators include mountain lions, humans, and for smaller pigs, the golden eagle, coyote and black bear.

Not only does the pig graze like other hoofed animals, e.g. cattle, deer and sheep, but it uses its strong snout and neck muscles to root through the soil in search of plant or animal matter. Such "rototilling" damages crops, drip irrigation systems, native and other vegetation and often leads to erosion of soil and streambanks, and muddy runoff in the watershed. In addition, because pigs lack sweat glands they roll in seeps or streams to cool their skin by evaporation. Both rooting and wallowing result in degradation to the watershed and local water quality. Further, wild pigs' activities may damage livestock fences (letting cattle out and predators in), flood control levees, roads, and erosion control measures initiated by ranchers or natural resource managers.

Whether by direct trampling, rooting, digging or consumption, by competition for food and habitat, or effects on soil fertility, the reproductive potential of important native plant and animal species in California has been reduced by wild pigs. Moreover, wild pigs add to the challenges facing restoration or protection of endangered and threatened species.

Wild pigs are a focus of recent conflict between protecting and improving water quality, preserving wildlife habitat and assuring food safety by minimizing risk of contamination of crops. An October-December 2007 *California Agriculture* article provides evidence that natural wetlands

can filter out *E. coli*, and presumably other pathogens, in tailwater emerging from irrigated, grazed pastures. Nevertheless, with intent of removing habitat for animals that may carry food contaminants, such as *E-coli* O15:H7, and in response to pressures from processors and packers wanting minimal exposure to liability for risk, a few growers have removed filter strips, hedgerows and habitat planted with government incentives. Others are investing in fences near river bottoms. Some leafy vegetable growers are avoiding planting near vineyards, which are attractive to wild pigs, and have increased trapping and lethal removal. The guidelines recently issued by the lettuce and leafy green industry specify a 30-foot buffer from grazing lands.

### Regulation

Legally defined as big game in 1957, *wild pigs* are further defined as “free roaming pigs not distinguished by branding, ear marking or other permanent methods” and as such are subject to regulation for sustainability of hunting by the California Department of Fish and Game (CDFG). CDFG is also mandated under 1992 law to develop a wild pig management plan that may include pig management zones, live trapping and relocation of wild pigs, and encouraging sport hunting mitigation of pig depredation. Pigs that are not free roaming or distinguished by permanent markings are viewed as *domestic* pigs and their import, movement and health status is regulated by the California Department of Food and Agriculture (CDFA) and USDA Animal and Plant Inspection Service (APHIS). U.S. Department of Interior Fish and Wildlife Service is involved where there are impacts on endangered species, and it regulates hunting at federal wildlife refuges.

Relocation of California wild pigs is unlawful except under a permit issued by CDFG. However, CDFG has not issued any permits to relocate wild pigs. Currently, with a permit from USDA domestically-raised Eurasian wild boars from Canada may be imported to the United States provided they are certified as disease free and have official identification devices. CDFA will issue a permit to import these “transitional” swine into California

provided they test negative for brucellosis and pseudorabies virus (PRV). A total of 858 head legally entered over the four years 2003 through 2006.

Until recently wild pigs could be killed only by (1) licensed hunters possessing non-transferable CDFG pig license tags; or (2) property owners or tenants or their designated agents (often a federal, state or local government employee) who applied for and obtained a free depredation (i.e. relief) permit from the CDFG. Permits can specify constraints, such as the number of animals that may be taken, method and duration of the take, and may provide for trapping and relocation.

However, with passage of the 1997 McPherson Bill, the law changed significantly. Now under state law, “Notwithstanding Section 4652, any wild pig that is encountered while in the act of inflicting injury to, molesting, pursuing, worrying, or killing livestock or damaging or destroying, or threatening to immediately damage or destroy, land or other property, including, but not limited to, rare, threatened, or endangered native plants, wildlife, or aquatic species, may be taken immediately by the owner of the livestock, land, or property or the owner’s agent or employee, or by an agent or employee of any federal, state, county, or city entity when acting in his or her official capacity.”

### Recreational hunting

Humans are an important predator of California wild pigs. For some, the excitement and reward of hunting a wild pig ranks high. Pig hunting is popular in California. According to Sweitzer, wild pig tag revenues to CDFG totaled nearly \$3.2 million over the last 5 years. The revenue is available solely for wild pig management. For the 2007/08 season each pig tag costs \$17; in 2002/03 5-tag booklets cost \$15. While some ranchers do not want sport hunters or trespassers or added liability on their lands, others welcome the revenue from recreational tourism and managing a hunting preserve. For the latter, the wild pig is an economic asset. Still other landowners welcome hunter predation specifically to control undesired pig populations. Because pigs move away from areas of high

hunting and harassment pressure into more receptive areas, neighboring ranchers, farmers and natural preserve managers may find their crops and habitat under increasing vulnerability as a result.

In an attempt to alleviate depredation on private properties where hunters are not normally welcome, the CDFG recently initiated a program that arranges for controlled public hunts. There are no costs to the landowner and CDFG assumes the legal liability. One such controlled hunt occurred on The Nature Conservancy land on Santa Cruz Island as precursor to its major eradication project. Impact on depredation was insignificant.

Throughout the state, where hunting is allowed, the season is yearlong and there is no daily bag or possession limit. Recreational hunters must affix a pig tag to the carcass and return a portion of the tag to CDFG with information on the pig taken. In 2005/06 only 13.5 percent (5,453) of the 40,315 pig tags sold were returned, implying 13.5 percent success or lax reporting. The annual reported take with pig tags varied over the last 14 years, ranging from a high of almost 8 thousand in 1998/99 down to 4 thousand in 2004/05.

### Conclusion

Total statewide eradication of the wild pig is unlikely under current California law that defines the wild pig as a game animal, which is to be managed for sustainable hunting. Another challenge is the ongoing importation of healthy domestically-raised Eurasian wild boars. Moreover, despite CDFG's wild pig management plan with objective of minimizing depredation and the 1997 law that allows taking of potentially depredating pigs upon encounter, the range of the wild pig population has been expanding. This highlights the need for continued disease surveillance. Should the wild pig no longer be regulated as big game, the question could be who pays for eradication and is it feasible? On a statewide basis or regional? And finally, are there economically and environmentally feasible and effective alternatives to extermination?

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