REMOVING FERAL PIGS FROM SANTA CRUZ ISLAND, CALIFORNIA

J. DAVID STERNER, Department of Forestry and Resource Management, University of California, Berkeley, CA 94720

REGINALD H. BARRETT, Department of Forestry and Resource Management, University of California, Berkeley, CA 94720

1991 TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 27:47-53

Abstract: A project to study the feasibility of eradicating feral pigs (*Sus scrofa*) from a 2,250-ha exclosure was initiated June 1989 by The Nature Conservancy through cooperative agreements with the University of California and the California Department of Fish and Game. The cost and effectiveness of 3 methods were evaluated: (1) trapping, (2) hunting without dogs, and (3) hunting with dogs. As of October 1990, we had removed a total of 1,421 pigs from the pasture at a cost of $87,000. No pigs were known to remain. Trapping appeared to be the most efficient method at high to moderate densities but a small percentage of pigs was trap-shy. We recommend a multi-method, seasonal approach to feral pig eradication on Santa Cruz Island. We also evaluated an aerial census method for monitoring pig density. A pre-eradication aerial census produced an estimate (90% confidence limits) of 907 ± 284 pigs (39.4 ± 12.3 pigs/km^2). A post-trapping phase aerial census yielded an estimate of 158 ± 90 pigs (7.0 ± 4 pigs/km^2). Based on population reconstruction derived from age estimation of removed pigs, the actual pig numbers at the time of each census were 1,379 (60.9pigs/km^2) and 174 (7.7 pigs/km^2), respectively. The aerial estimates thus deviated from the population reconstruction estimates by 34% and 9% at the high and low densities, respectively.

Insular ecosystems may undergo reductions or extinctions of populations of endemic taxa when subjected to disturbances of introduced mammals (Carlquist 1974, Coblentz 1977). Santa Cruz Island, one of 8 California Channel Islands, has been subjected to the impacts of feral sheep and pigs since the 1850's. Rooting, trampling, consumption, accelerated erosion, and predation are among the documented impacts of pigs in the United States (Bratton 1974, Challies 1975, Wood and Barrett 1979, Stone 1985, Collins 1987, Barrett et al. 1988). The vegetation on Santa Cruz island has begun recovering since the removal of the sheep in the 1980's (Schuyler in press) but pigs continue to have a negative impact.

The Nature Conservancy (TNC) began a feral pig study in 1987 to develop an island wide eradication plan and to provide information for resource managers facing similar problems. One phase of this study, begun in June 1989, was an attempt to eradicate the pigs from a 2,250-ha exclosure. This project was completed under cooperative management agreements with the California Department of Fish and Game and the University of California. The objectives were the following: (1) eradicate feral pigs from a 2,250 ha exclosure, (2) compare the costs of different eradication methods, (3) reconstruct the eradicated population, and (4) evaluate a helicopter for censusing pigs.

Our study was funded by The Nature Conservancy under a cooperative management agreement with the California Department of Fish and Game and the University of California. We would like to thank Channel Islands Aviation and the University of California Field Station on Santa Cruz Island for their cooperation. We thank Cam Barrows, Diane Elfstrom-Devine, David Dewey, Bob Hansen, Steve Johnson, Lyndal Laughrin, Mike O'Neill, Peter Schuyler, Mark Severson, Jeff Souza and all other staff and volunteers for their assistance. In addition, we would like to thank Eric Loft for reviewing the manuscript.

METHODS

Study Area

Santa Cruz Island (249 km^2) is 38 km south of Santa Barbara, California. Two mountain ranges of distinct geology dominate the topography of the island. The northern range is volcanic with several peaks above 610 m and the southern range is largely metamorphic reaching a maximum elevation of 464 m. The 21-km Santa Cruz Island Fault separates these 2 ranges and manifests itself as the Central Valley. The topography of the island is rugged with steeply dissected ridges and slopes up to 30°.

The island has a Mediterranean-type climate characterized by hot dry summers and mild, wet winters. Rainfall averages 51 cm in the Central Valley and falls mainly between November and April. Mean monthly temperature in the Central Valley ranges from 12°C to 21°C (Brumbaugh 1980). Perennial streams and spring seeps distributed throughout island provide water year-round.

TNC has managed 90% (220 km^2) of the island, including the study area, since 1978. The study took place in the Willows pasture located on the south side of the island. The dominant vegetation types were oak woodland, chaparral, annual and perennial grassland and coastal scrub (Philbrick and Haller 1977).

Before the project began, a wire mesh fence that bounded the Willows pasture was repaired to prevent pigs from leaving or entering. We checked the fence every 2-3 weeks and repaired breaks. During the study,

only 3 breaks were known to occur. One boar, attracted by bait and pig carcasses in the study area, broke in and was caught in a nearby trap. Tracks at the other 2 holes indicated only solitary pigs had broken through.

Eradication

Selection of methods

Various methods, including trapping, aerial hunting, ground hunting, hunting with dogs, poison, snaring, and introduction of disease and predators have been used for feral pig eradication or control (Tisdell 1982, Hone 1983, Stone 1985, Coblentz and Baber 1987, Barrett et al. 1988, McIlroy et al. 1989). All methods except trapping and ground hunting with and without dogs were eliminated by TNC because of humanitarian, political, or ecological concerns. The option of trapping and transporting the pigs to the mainland was removed from consideration due to the existence of pseudorabies in the island pigs (Glosser 1988). Trapping was the first method implemented, followed by hunting and then hunting with dogs.

Trapping

The study area was divided into 3 7.5-km² sections after estimating that the 20 available traps would adequately cover each section. We used 20 1 x 3-m box traps with drop-doors. The trap design was a galvanized, welded pipe frame enclosed by large-gauge chain-link fencing. Drop-doors were triggered with a 10-mm polypropylene line stretched over bait from the lower rear of the trap and attached to a large steel pin inserted through the door.

From 15 June to 17 September 1989, the entire study area was trapped in 3 sweeps. One week before trapping, approximately 25 sites were pre-baited using commercial, pelleted, pig finishing feed in 50 lb. bags (Western Animal Supply, Santa Barbara, Calif. 93101). The large size of the traps required that bait sites be placed near roads. Bait sites were located near areas with pig sign or near springs and streams. Bait trails consisted of a continuous, thin line of pellets with small piles placed at intersections with pig trails. Bait trails were extended from 0.1 to 1.5 km from roads over the trapping period.

Initially, at least 23 kg of pig bait was left at each bait site, and sites were checked at least every other day. The amount of bait left each succeeding day was adjusted according to the amount being consumed. At some sites, up to 70 kg of bait per day was consumed. The 20 traps were placed in the bait sites in proportion to bait consumption. Two traps were placed at sites if consumption was over 40 kg per day. All traps were then set and checked in the morning for seven consecutive days. During the trapping period, bait sites were selected and baited in the adjacent section to maintain continuous trapping.

Pigs were dispatched while still inside the trap using a .357 magnum pistol with hollow-point bullets. Pigs observed feeding outside the trap were initially shot, but we discontinued this method because any pigs that escaped might be too frightened to return to the traps. We removed carcasses from the trap and placed them in nearby brush. Carcasses were typically consumed by other pigs within a few days.

Hunting

We divided the study area into 26 units averaging 0.9 km². Each unit consisted of at least 1 major canyon bordered by distinct ridges. Hunters were able to surround the more densely populated canyon bottoms and seal off escape across surrounding ridges. Teams of 7 to 10 hunters worked each unit. Each hunter was equipped with a .243 caliber rifle, a bright-orange safety vest, and a hand-held FM transceiver. We placed most of the hunters at the upper end of each canyon and on ridges on either side. One to 2 hunters were placed at the lower end of the canyon to intercept pigs attempting to escape through the canyon bottom. The hunters then swept the unit moving from the upper portion to the lower portion with at least 1 hunter covering the densely vegetated canyon bottom.

From 2 December 1989 to 7 March 1990, we conducted three hunting sweeps across the study area with the same number of hunter hours each sweep. Each unit was hunted once in each of the first 2 sweeps; during the third sweep however, some units were ignored if no pigs had been previously observed, while some units known to harbor pigs were hunted more than once.

Dogs

A dog trainer was contracted to acquire 5 trained hounds of the Catahoula Leopard Stockdog breed from pig hunters in Louisiana and Mississippi. In addition, two Plott hounds owned by the trainer were used. To protect the island fox population, appropriate tests, vaccines and preventive medications were administered to the dogs before they were transported to the island. The trainer was present during the entire project to maintain and complete the training of the dogs.

Teams of 4-6 hunters accompanied by 3-4 dogs systematically swept the entire Willows pasture. The dogs were concentrated in the main drainage of each subunit while hunters covered the ridges and side drainages. To prevent pigs from escaping, one hunter

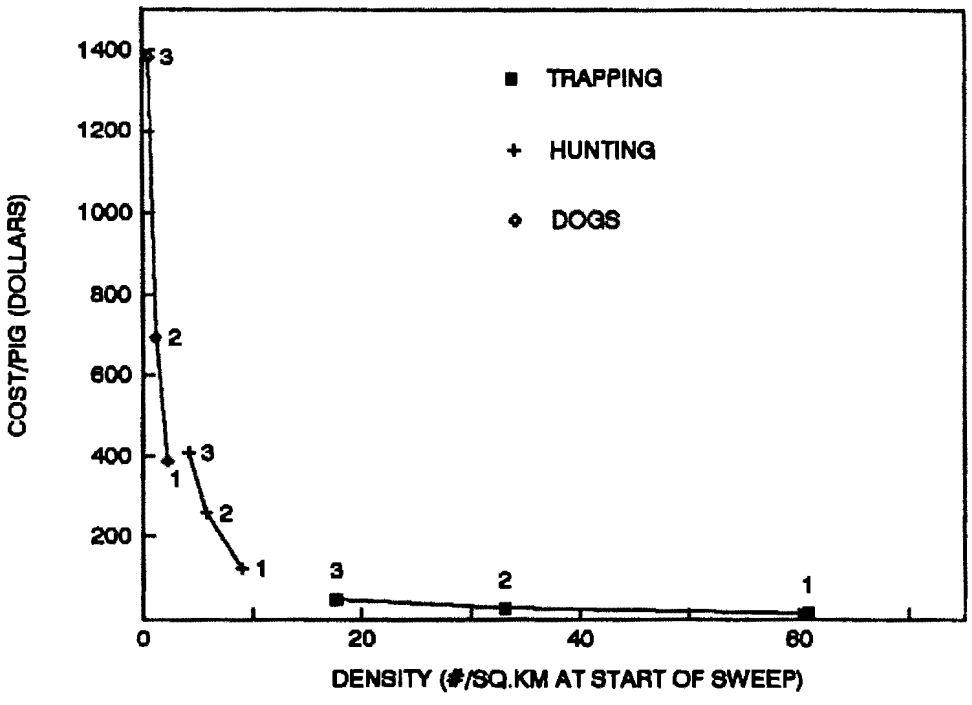

Figure 1. Catch per unit effort (dollars per pig) for 3 feral pig eradication methods on Santa Cruz Island, California, June 1989 -October 1990. Numbers indicate the 3 sweeps for each method.

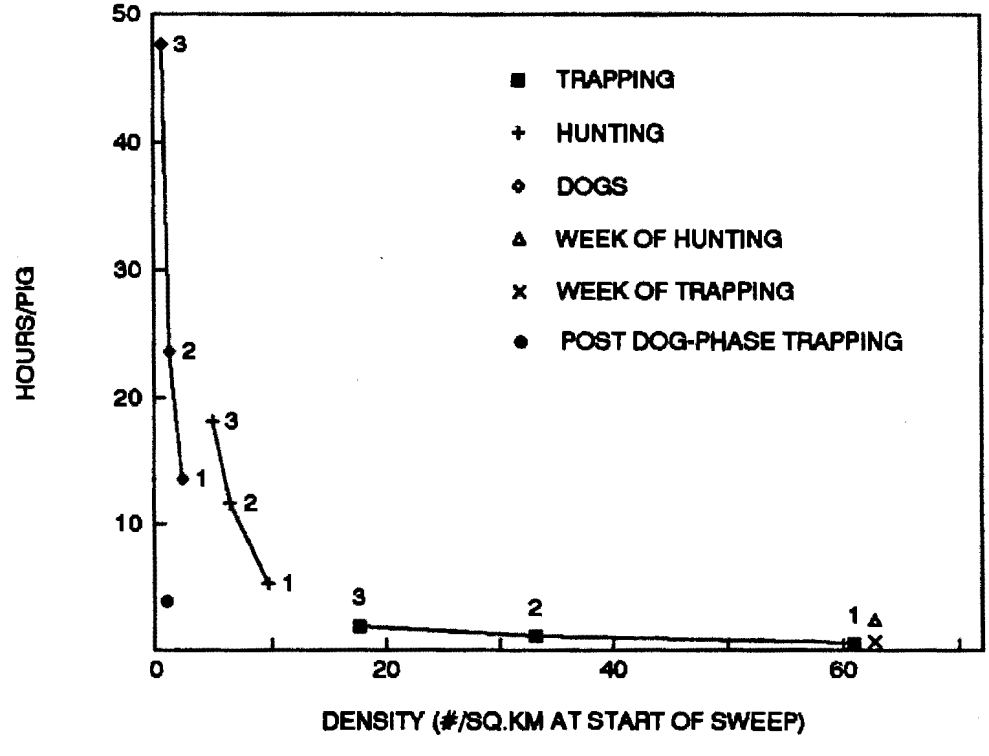

Figure 2. Catch per unit effort (hours per pig) of 3 feral pig eradication methods on Santa Cruz Island, California, June 1989 - October 1990. Numbers indicate the 3 sweeps for each method.

Table 1. Budgets of 3 feral pig eradication methods: (1) trapping, (2), hunting, and (3) dogs in the Willows pasture, Santa Cruz Island, California, June 1989 - October 1990.

TRAPPING:	
WAGES	$10,756
BAIT	6,156
TRANSPORTATION	2,500
HANDGUNS	560
MISC. EQUIP	1,011
TRAPS	6,000
VEHICLE USE	1,436
TOTAL:	$28,419
HUNTING:	
WAGES	$11,479
TRANSPORTATION	2,969
VEHICLE USE	877
MISC SUPPLIES	1,000
RIFLES	4,000
RADIOS	6,400
TOTAL:	$26,725
DOGS:	
WAGES	$9,283
TRANSPORTATION	2,969
VEHICLE USE	877
SUPPLIES	1,000
RIFLES	3,000
RADIOS	4,800
DOGS	6,300
BAIT	171
MISCELLANEOUS	559
HANDGUNS	560
TOTAL:	$28,959

reconstruction estimates by +34% and +9% at the high and low densities, respectively (Fig. 4).

DISCUSSION

Trapping was more efficient than hunting with or without dogs. Many pigs appeared to adjust their behavior when hunted with or without dogs making the efficiency of these methods decline more rapidly than trapping; they learned to lie still or flee immediately from the area, increasing their chances of escaping detection. During the first 3 weeks of trapping, 2 trappers averaged 32 pigs per day. The same effort applied to hunting with dogs would not result in the same number of pigs taken because dogs focus on one pig at a time and may spend several hours tracking each pig.

In spite of the greater efficiency of trapping, there was a small percentage of trap-shy pigs requiring some other removal method. In addition, hunting and use of dogs may be more efficient if there are no roads allowing easy access with traps. Costs increased substantially if traps had to be carried or flown in and trappers required to walk long distances to bait and check them. At least one eradication project has been implemented with the requirement to process the meat for human consumption (Barrett et al. 1988); under this constraint, trapping efficiency would likely increase relative to the other methods because it would be easier to process and transport the meat from roadside locations.

A seasonal approach to feral pig removal will increase the effectiveness of trapping and hunting with dogs. Although we had success with traps in all seasons, we recommend that trapping be implemented during the dry season when food sources are relatively scarce. The wet season is more suitable for hunting with dogs because pig scent will persist longer under moist conditions. In addition, dogs will have greater endurance under the cooler conditions.

For hunting, we found that 6-8 hunters per 100 ha worked well. For dogs, we found that 4-6 hunters and 3-4 dogs per 50 ha worked well. As the pig density decreases, the number of hunters could be decreased and the amount of area covered increased.

The aerial census underestimated actual density by 34% at high pig density but by only 9% at low density. The larger and more frequently encountered groups of pigs at high density were difficult to count, especially when moving through thick brush. Helicopter census appears to be particularly useful at low densities as a means of tracking success and determining where pigs remain.

The high population density that we found in the Willows pasture was probably a result of winter food abundance preceded by a large acorn crop the previous fall (Sterner 1990). The Willows pig population would likely have been reduced dramatically during the dry season that followed due to drought-induced food scarcity. Significant cost would be saved by initiating an island-wide eradication effort while the pig population is suffering from the effects of drought. The reconstructed population serves to illustrate the necessity of a very intensive eradication project; because of their high reproductive capacity, feral pigs can repopulate an area in a matter of months.

We recognize that capabilities of individual hunters and dogs may vary considerably and thus affect the cost of any eradication program. In addition, for any feral pig eradication project, there will be significant administrative and regulatory costs. We did not include these costs in this report as they will vary considerably among agencies. Planning logistics for such a project, particularly on a remote island can be complex and expensive. Complications because of negative public opinion along with environmental assessments and public hearings

may also prove costly. If meat processing is required, the cost of the project will increase substantially.

LITERATURE CITED

Barrett. R. H. 1978. The feral hog on the Dye Creek Ranch, California. Hilgardia 46:283-355.

_____, Goatcher, B. L., Gogan, P. J., and E. L. Fitzhugh, 1988. Removal of feral pigs from Annadel State Park. Trans. West. Sect. Wildl. Soc. 24:47-52.

Bratton, S. P. 1975. The effect of the European wild boar (*Sus scrofa*) on gray beech forest in the Great Smoky Mountains. Ecology 56:1356-66.

Brumbaugh, R. W. 1980. Recent geomorphic and vegetal dynamics on Santa Cruz Island. Pages 139-158 in D.M. Power, ed. The Calif. Islands: proceedings of a multidisciplinary symposium. Santa Barbara Mus. Nat. Hist., Santa Barbara, Calif.

Carlquist, S. 1974. Island Biology. Columbia Univ. Press, New York, N.Y. 660pp.

Challies, C. N. 1975. Feral pigs on Auckland Island: status, and effects on vegetation and nesting birds. N. Z. J. Zool. 4:479-490.

Coblentz, B. E. 1977. Some range relationships of feral goats on Santa Catalina Island, California. J. Range Manage. 30:415-419.

_____, and D. W. Baber. 1987. Biology and control of feral pigs on Isla Santiago, Galapagos, Ecuador. J. Appl. Ecology 24:403-418.

Collins, P. W. 1987. A review of the population status of the Santa Cruz Island Harvest Mouse (*Reithrodontomys megalotis santacruzae*), with emphasis on their distribution and status in the Prisoner's Harbor area. Prepared for The Nature Conservancy, Santa Barbara, Calif. 71pp.

Glosser, J. W. 1988. Letter to Channel Islands National Park Service from USDA Animal and Plant Health Inspection Service, Washington D.C. 7/22/88.

Matschke, G. H. 1967. Ageing European wild hogs by dentition. J. Wildl. Manage. 31:109-113.

Mcilroy, J. C., M. Braysher, and G. R. Saunders. 1989. Effectiveness of a warfarin-poisoning campaign against feral pigs, *Sus scrofa*, in Namadgi National Park, A.C.T. Aust. Wildl. Res. 16:195-202.

Philbrick, R. N., and J. R. Haller. 1977. The Southern California Islands. Pages 893-906 *in* G. Barbour and J. Major, eds. Terrestrial vegetation of California. John Wiley and Sons. New York, N.Y.

Schuyler, P. In press. The control of feral sheep on Santa Cruz Island. *In* E. Hochberg, ed. Proc. of the Third Channel Islands Symposium. Santa Barbara Mus. of Nat. Hist., Santa Barbara, Calif.

Sterner, J. D. 1990. Population characteristics, home range and habitat use of feral pigs on Santa Cruz Island, California. M.S. Thesis. Univ. of Calif., Berkeley. 110pp.

Stone, C. P. 1985. Alien animals in Hawaii's native ecosystems: toward controlling the adverse effects of introduced vertebrates. Pages 251-297 *in* C. P. Stone and J. M. Scott eds. Hawaii's Terrestrial Ecosystems: Preservation and Management. Univ. of Hawaii, Honolulu.

Tisdell, C. A. 1982 Wild pigs: Environmental pest or economic resource? Pergamon Press, N.Y. 430pp.

Wood, G. W., and R. H. Barrett. 1979. Status of wild pigs in the United States. Wildl. Soc. Bull. 7:237-246.