

SEASONAL DIETS OF WILD PIGS IN OAK WOODLANDS OF THE CENTRAL COAST REGION OF CALIFORNIA

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Wild pigs, *Sus scrofa*, an introduced species in California, are hypothesized to compete with native species for food and to consume some native vertebrates. To assess the potential for these impacts, we collected stomach contents of wild pigs over a 1-year period to evaluate seasonal and sex-related variation in diets of wild pigs in oak woodland habitats of the central coast region of California. Diets of the sexes were similar, but diets of wild pigs varied seasonally and related to acorn mast availability during the autumn. The proportion of animal tissue in diets increased concurrently with acorns, supporting earlier studies. Acorn consumption by wild pigs may impact oak regeneration as well as native vertebrates that consume acorns.

INTRODUCTION

Wild pigs in California are hybrids of feral pigs first established during the 1800s and Eurasian wild boars, first introduced in 1925. In areas where they are not native, wild pigs are a conservation concern because their foraging activities impact a variety of plants and animals by consumption, competition, or disturbance (Laurance and Harrington 1997, de Nevers and Goatcher 1990, Howe et al. 1981). Concerns over the ecological effects of wild pigs in California have increased in recent years, as populations increased and expanded throughout oak woodland habitats (Waithman et al. 1999). Oak woodlands are a unique and diverse habitat providing watershed protection, public

recreation opportunities, commodity production for farmers and ranchers, and habitat and forage for over 300 wildlife species (Pavlik et al. 1992).

In California, wild pigs are hypothesized to compete with native species for acorn mast (Barrett 1982) and they may prey on some native vertebrates (de Nevers 1993). Rooting by wild pigs has been known to physically damage tree seedlings (de Nevers and Goatcher 1990, Becker 1985) and is hypothesized to negatively effect tree regeneration potential (Bruinderink and Hazebroek 1996, Peart et al. 1994) and alter competitive relations in plant communities in ways that favor nonnative annual plants (Dyer and Rice 1999, Kotanen 1995). To assess these possibilities, we analyzed seasonal diets of wild pigs from oak woodland communities in the central coast range of Santa Clara County California. Like other ungulates (Main et al. 1996), adult male and adult female wild pigs do not closely associate except when mating (Ilse and Hellgren 1995). Thus, male and female wild pigs may consume different food associated with differences in habitat use and nutritional needs, so we also assessed potential sex differences in diets.

METHODS

The study was conducted in northern Santa Clara County, California, on the west-facing slope of the Diablo Range on the Blue Oak Ranch (37°24.5'N, 121°44.2'W). The Blue Oak Ranch covers 1,330 ha with elevations ranging from 500 to 950 m. The study area supports several threatened plant communities, including valley oak *Quercus lobata* woodlands; blue oak *Q. douglasii* woodlands; and native perennial grasslands (Bainbridge and Kan¹ 1997).

Stomach contents of 53 wild pigs taken by rifle during 1999 were examined. Whole stomachs were immediately removed, allowed to cool, then frozen. In preparation for analysis, stomachs were thawed and sub-sampled by thoroughly mixing and then removing approximately 600 g of material. Each sub-sample represented 20 to 80 percent of the entire stomach contents. Samples were rinsed through a set of 3 consecutive sieves of decreasing mesh size (standard mesh sizes 35, 10, 5) to separate food items by size and to remove very fine particles that likely were unidentifiable (Korschgen 1962). Stomach contents were dried for 24 hours at 50°C; categorized as herbaceous vegetation, mast, bulbs and roots, animal remains, or unidentifiable debris; and weighed. All stomach samples contained small amounts of unidentifiable debris that were included when calculating dry weights of each food category, but omitted from statistical analyses. Dry weights were calculated for each food category. Vertebrate remains were identified to the lowest possible taxon by comparison with museum specimens. Diet frequency data were analyzed with a G-test (SYSTAT 8.0).

¹ Bainbridge, S. and T. Kan. 1997. Botanical Survey of Blue Oak Ranch, Santa Clara County, California. Unpublished document on file at The Nature Conservancy Regional Office, San Francisco, California.

We used data from a companion study at a nearby state park (Henry Coe State Park) approximately 15 km south of The Blue Oak Ranch (Sweitzer and Van Vuren² 2001) to assess the availability of acorns for consumption by wild pigs in the region. As part of this companion study, surveys conducted during summer 1999 were used to locate and select 15 different category IV high-mast producing oak trees (Graves 1980) for monitoring total numbers of acorns on four 1 X 1 m acorn-monitoring plots beneath the canopy of each tree during fall 1999. Two of the four 1 X 1 m acorn-monitoring plots at each tree were inside of a 3 X 3 m pig proof fenced enclosure (experimental plots) and two were exposed to wild pig foraging (control plots). The fenced enclosures were used to assess the effect of wild pig foraging on acorn survival in the companion study (Sweitzer and Van Vuren² 2001). The 15 high-mast-producing oak trees used to monitor acorn availability included 7 blue oaks; 3 coast live oaks *Q. agrifolia*; 4 valley oaks; and 1 oregon oak *Q. garryana*. Beginning in mid September 1999, the total numbers of acorns on all acorn monitoring plots beneath each tree were counted at approximately 3-week intervals until mid December (acorns were returned to the plots after being counted). Data for all acorns located on experimental and control acorn monitoring plots were summed across all 15 trees on each count date to provide an index to the number of acorns available for wild pig consumption in the region during fall 1999.

RESULTS

We collected a total of 53 wild pigs during 1999. Initial analyses did not demonstrate any statistical difference in the diets of male and female wild pigs ($G = 2.77$, $df = 1$, $P = 0.5$), so data were pooled for seasonal analyses. There was significant seasonal variation in the diets of wild pigs during 1999 (Table 1; $G = 40.3$, $df = 9$, $P < 0.01$). Herbaceous vegetation predominated in diets of wild pigs in all seasons except autumn, when the proportions of acorns and animal material increased dramatically (Fig. 1). Bulbs and roots constituted a very small proportion of the diet of wild pigs year-round. Animal material was detected in the diet during the summer and autumn, but not during winter and spring (Fig. 1). Of the 8 stomachs with animal material, 2 contained voles, *Microtus* sp.; 1 contained mule deer, *Odocoileus hemionus*; and 5 contained remains of California ground squirrels, *Spermophilus beecheyi*. The stomach containing deer remains was from a wild pig that was shot while scavenging a deer carcass. One of the wild pigs with California ground squirrel remains in its stomach (a nearly intact adult squirrel) was observed standing motionless for over 20 minutes as it intently waited above a ground squirrel burrow immediately before being shot.

Data on availability of acorns for wildlife were recorded during autumn 1999 at Henry

Table 1. Frequency of occurrence (%) of food items by season and by sex (M=male, F=female) for pigs. Numbers of pigs for each period are in parentheses.

	Winter		Spring		Summer		Autumn	
	M (4)	F (9)	M (6)	F (12)	M (6)	F (4)	M (9)	F (3)
Herbaceous	100	100	66.6	81.8	31.6	30.7	34.8	0
Acorn Mast	0	0	0	0	31.6	23.1	39.1	40
Bulbs & Roots	0	0	16.7	9.1	26.3	23.1	8.7	20
Animal Material	0	0	16.7	9.1	10.5	23.1	17.4	40

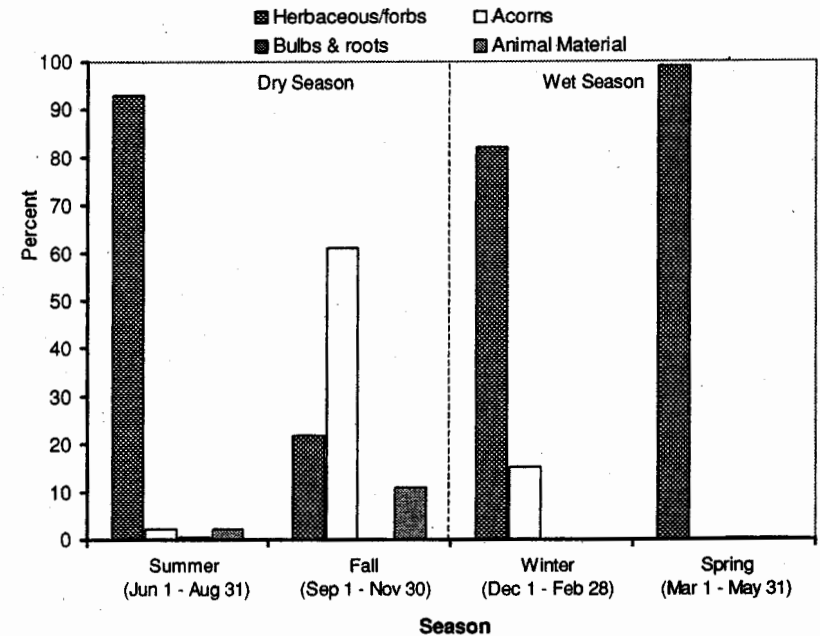


Figure 1. Seasonal variation ($G = 40.3$, $df = 9$, $P < 0.01$) in the diets of 53 wild pigs from the Blue Oak Ranch, Santa Clara County.

Coe State Park approximately 15 km south of the Blue Oak Ranch (R. Sweitzer, University of North Dakota, unpublished data). A visual comparison of wild pig diets and acorn availability data suggested that the diets closely tracked availability of acorns during the autumn and winter periods of 1999 (Fig. 2).

² Sweitzer, R.A. and D. Van Vuren. 2001. *In review*. Ecological effects of wild pigs in oak woodland ecosystems in northern California. Proceedings of the 5th Symposium on California's Oak Woodlands. Integrated Hardwood and Range Management Program, University of California, Berkeley, California.

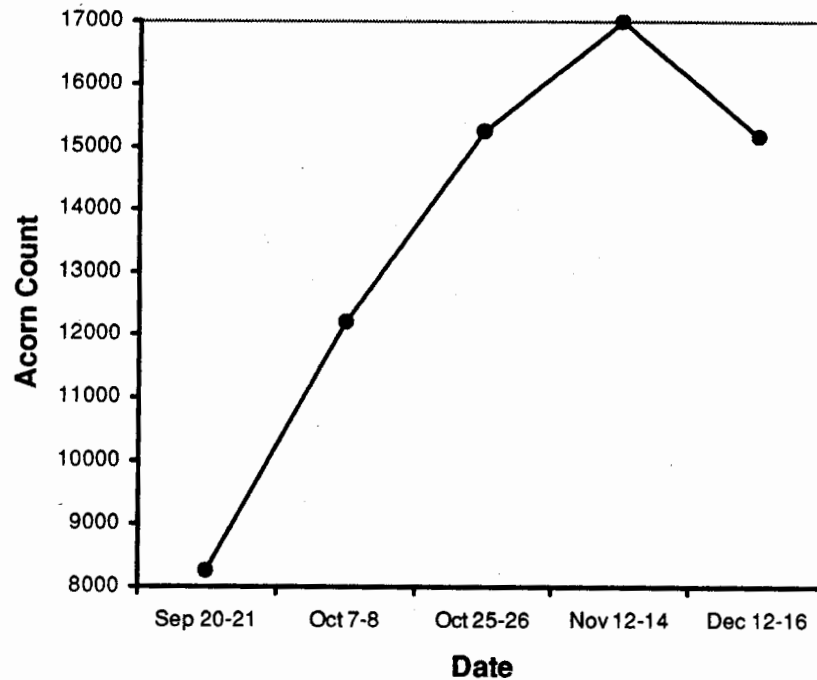


Figure 2. Data on acorn availability from plots beneath 15 category IV high-mast-producing oak trees at Henry Coe State Park, Santa Clara County that were periodically sampled during autumn 1999. Data for all acorns located on experimental and control acorn-monitoring plots were summed across all 15 trees on each count date to provide an index to the number of acorns available for wild pig consumption.

DISCUSSION

We detected no difference in the diets of male and female wild pigs, suggesting that differences in social behavior between males and females is not necessarily reflected in their foraging behavior. Except for autumn, diets of wild pigs were quite similar among seasons. The difference between autumn and other times of the year was related almost entirely to the increased availability of acorn mast during the autumn period (Fig. 1). Herbaceous plants and forbs were the primary constituents of the diets of wild pigs in all periods except when acorns predominated. Increased consumption of acorns by wild pigs appeared to closely track the increased availability of acorns during autumn. These results were similar to other studies of food habits of wild pigs in California and other parts of the United States where acorn or beech mast becomes seasonally available (Belden and Frankenberger 1990, Schauss et al. 1990, Baber and Coblenz 1987).

During autumn, acorns were the primary dietary component (Fig. 1). Acorns contain proportionally low levels of crude protein in relation to total energy (Barrett 1978), and it has been suggested that wild pigs must compensate by increasing their intake of protein when consuming large quantities of acorns (Belden and Frankenberger 1990). Animal tissue is a better source of protein than plant material (Robbins 1993), and the wild pigs sampled in this study may have increased their consumption of vertebrates and invertebrates during the autumn (Fig. 1) to compensate for the low protein content of acorns. The absence of animal matter during winter may be a result of our sampling procedure. These stomachs were observed to contain earthworms (*Lumbricus* sp.) upon collection but were not found later during analysis and may have been digested between the time of collection and analysis.

Wild pigs may negatively influence California's oak woodland ecosystems in a variety of ways (Sweitzer 1998). Our data indicate that wild pigs consume primarily acorns during the autumn. This may directly impact regeneration of oaks and secondarily other animals that consume acorns. Moreover, our data indicate that wild pigs also consume native vertebrates and the occurrence of California ground squirrels in almost 10% of stomachs suggested active predation, since carcasses of burrow-dwelling squirrels are seldom available above ground (VanVuren 2001). Previous studies have suggested that animal tissues in the stomachs of wild pigs were derived from scavenging (Baber and Coblenz 1987), but we suggest that scavenging is not as behaviorally consistent as is active predation with respect to small native vertebrates, a finding that may be important if the target prey are of conservation concern (McFarland et al. 1974).

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