between coupon users and non-users. This result is not surprising, since the average addition of $6 worth of produce per year cannot be expected to produce major dietary changes. However, coupon users who also used their own resources at farmers' markets did show significant increases in their overall consumption of certain fresh vegetables (i.e., dark orange vegetables, peppers, tomatoes) over those who did not use additional resources. In addition, subjects who returned to the farmers' market after using up their coupons showed significantly greater consumption of fresh dark green vegetables, cauliflower, cabbage and other canned or frozen vegetables in their diets.

The authors conclude that the Connecticut Farmers' Market Coupon Program was generally successful in meeting its goals—three-quarters of the program recipients used their coupons at farmers' markets to purchase fresh, local produce; some groups also benefitted by significantly increasing their overall produce consumption; and local farmers simultaneously expanded their markets.

Reviewer's Comments

California has conducted a very successful Farmers' Market Coupon Program since 1990 (federal funds were received for the first time in 1994). Since the state was not able to provide funding for the program, monies were raised from farmers' markets associations in order to get federal matching funds. In 1994, $32,000 was raised from farmers' market "sponsors" and the federal government provided another $52,000 for a total of $84,000. These monies provided for the administration of the program as well as $20 coupon booklets for 4,368 WIC participants. Almost 85 percent of these coupons were redeemed at 34 participating farmers' markets, providing fresh, local produce to thousands of pregnant and nursing women and their children. Moreover, California farmers more than doubled their initial investment from $32,000 to more than $64,000 (including in-kind contributions). Every market that participated realized at least a 50 percent gain. The Farmers' Market Nutrition Program (as it is now called) is an opportunity to benefit both California farmers and low-income consumers. Increased funding for this program would leverage additional resources and simultaneously improve the nutritional status of California's WIC participants and the economic viability of its family farmers.

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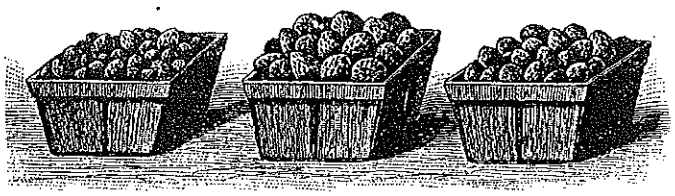
(GWF.951) *Contributed by Gail W. Feenstra*



Summary of California studies analyzing the diet of barn owls.

Chuck Ingels

Article written for Sustainable Agriculture/Technical Reviews. 1995

Farmers and ranchers are looking closely at the benefits barn owls offer as an alternative method of controlling vertebrate pests (see *Sustainable Agriculture Vol. 5, No. 1*). The diet of the barn owl (*Tyto alba*) is relatively easy to ascertain, and several dozen studies have been conducted throughout the U.S. to determine the prey species consumed (Clark and Bunck, 1991). Barn owls swallow their prey whole and later regurgitate one to two inch pellets containing undigested bones, teeth, and fur. The owls usually produce one to two pellets per day, often dropping one at their nesting site and one at a distant roosting site (Evans and Emlen, 1947). Skulls found in these pellets can be keyed out to determine the identity of the prey species.

Over 95 percent of the diet usually consists of small mammals (mostly rodents), however in some studies substantial bird remains have been found. According to Colvin (1986), each adult barn owl may consume about one or two rodents per night; a nesting pair and their young can eat over 1,000 rodents per year. Dietary studies from California and other states show that a barn owl consumes an average 50 to 60 grams of prey per day (0.11–0.13 pounds per day, 40–48 pounds per year). The actual species consumed depends on the species abundance and availability in the area.

Overview

Table 1 shows the results of several barn owl prey studies conducted in California. In many studies, meadow voles and/or pocket gophers were consumed most often, while pocket, white-footed, and house mice were also important. One notable species missing in nearly all these studies is the California ground squirrel (*Spermophilus beecheyi*). This species ventures above ground only during the day, while the barn owl hunts almost strictly at night.

Study Findings

Berkeley 1926-27. Because each of these studies took place in Berkeley and because the results of each were very similar, the percentages of each species were averaged and combined into one column. In one study (Foster, 1926), pellets were collected on one sampling date from under a nest in Wildcat Canyon, just northeast of Berkeley. In another study (Foster, 1927), pellets were collected over a period of 1 1/2 years from a nest located in a cave in Wildcat Canyon. Prey counts were separated by the dry season vs. the wet season. More shrews, Jerusalem crickets, and white-footed and pocket mice were taken during the dry season than the wet season, while the opposite was true for pocket gophers. In a third study (Hall, 1927), accumulated pellets were collected on one sampling date from a location in Berkeley.

Table 1. Food Items in Barn Owl Pellets: Summary of California References

Common Name	Scientific Name	STUDY								No. of Prey Found	% of Total Prey[2]	Avg. Weight (g)[3]
		Berkeley 1926-27[1]	SF Bay Area 1937	Central Calif. 1945	Davis 1947	Madera Co. Foothills 1947	LA Co. 1960	Placer Co. 1974	Siskiyou Co. 1978			
		%										
Calif. meadow vole	*Microtus californicus*	60	50	6	15	2	10	42	61	2,398	31	54
Pocket gopher	*Thomomys bottae*	8	21	24	26	37	2	28	0	1,053	18	156
White-footed mice	*Peromyscus* sp.	14	14	6	12	7	0	25	37	878	14	25[4]
Pocket mice	*Perognathus* sp.	1	0	36	0	43	0	0	0	609	10	15[5]
Wood rat	*Neotoma fuscipes*	0	0	3	0	0	65	0	0	90	8	271
House mouse	*Mus musculus*	3	4	2	38	0	0	0	0	348	6	18
Harvest mouse	*Reithrodontomys megalotis*	8	4	4	3	0	2	0	0	280	3	12
Kangaroo rat	*Dipodomys heermanni*	0	0	6	0	7	0	0	1	112	2	65
Roof rat	*Rattus rattus*	0	0	0	1	0	12	1	0	32	2	183
Other species[6]		6	7	13	5	4	9	4	1	388	6	
No. of individual prey found		2,480	338	958	749	513	92	660	398	6,188		
Number of pellets found		796	87	NA	280	240	NA	538	143			

[1]These values represent an average of three similar studies in Berkeley, each with similar results.
[2]These values were obtained by averaging the percentages of that prey species found in each location.
[3]These values represent an average of a wide range of weights available for each species (Source: Jameson and Peeters 1988).
[4]Based on average weights of three likely species: *P. boylii*, *P. maniculatus*, and *P. truei*
[5]Based on average weights of three likely species: *P. californicus*, *P. inornatus*, and *P. longimembris*
[6]Other species include Jerusalem cricket (*Stenopelmatus* sp.), shrew (*Sorex* sp.), broad-footed mole (*Scapanus latimanus*), white-tailed jack rabbit (*Lepus californicus*), Audubon cottontail (*Sylvilagus audubonii*), and birds.

San Francisco Bay region (Smith and Hopkins, 1937). In this study, 12 boxes were installed in trees and barns in these counties: Marin (4), Contra Costa (2), Alameda (3), and San Mateo (3). A total of 141 pellets were collected over three years. California meadow voles were found most frequently except in Marin County, where pocket gophers predominated.

Central California (Hawbecker, 1945). Pellets were collected over a wide area during the nesting seasons of several years. Three types of habitat were included in this study, ranging from a well-forested, humid region to one that is treeless and shrubless. The specific regions and important prey findings are as follows:

1. Santa Cruz and western Monterey counties (coastal Transition Zone): pocket gophers–33%, meadow voles–17%, and birds–16%.

2. Eastern Monterey and western San Benito counties (Upper Sonoran zone): pocket gophers–52%, pocket mice–17%.

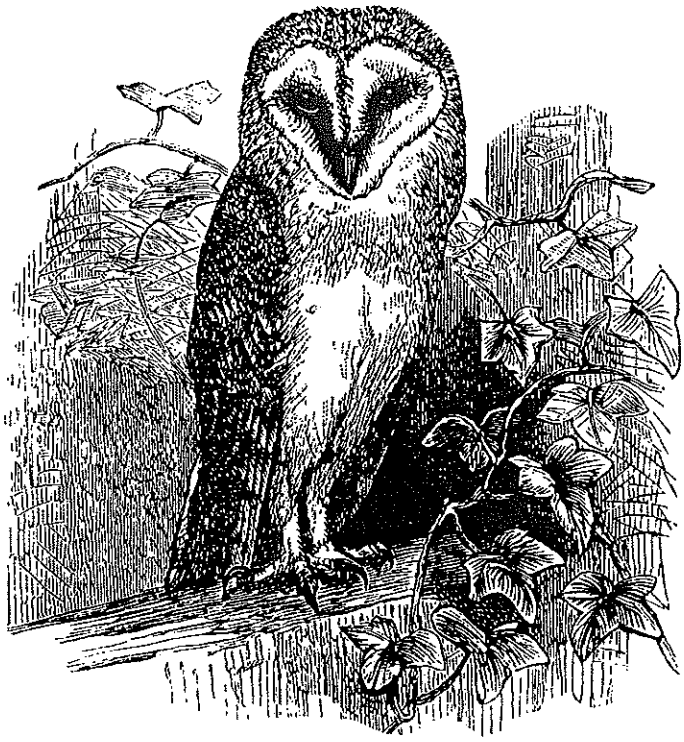
3.Western Merced and Fresno counties (Lower Sonoran Zone): pocket mice–66%.

Based on rodent trapping in several of the study areas, the barn owl was found to serve as a good sampler of the small mammals of a given area. However, the author noted that the selection of species appeared to be based partially upon numbers and ease of capture.

Davis (Evans and Emlen, 1947). An average of one pellet per day was found beneath a palm tree over a one year period. The palm tree served as a daytime roost to one barn owl. Based on nighttime observations, the owl was determined to have a hunting range of about 165 acres. About 140 acres were in open fields planted largely to grain and alfalfa and 25 were in wooded areas along Putah Creek. Animals typically associated with wooded or brushy cover, including house mice, deer mice (*Peromyscus*), harvest mice, and roof rats, comprised 57 percent of the total food items. Open field habitats, more than six times as extensive on the owl's range, contributed the remaining 43 percent of the items, which included pocket gophers and meadow voles. During the fall, the numbers of house and deer mice taken declined, while pocket gopher numbers steadily increased from winter through fall.

Madera County foothills (Fitch, 1947). This study was conducted in the blue oak-Digger pine belt of the Upper Sonoran Zone of Madera County. The region is comprised of rolling foothills broken by numerous ravines, and includes substantial grassland. Barn owl pellets were collected over four years at four sites. Computed on a prey weight basis, the pocket gopher accounted for 71 percent of the diet of the barn owls. Pellets were also collected from day roosts of great horned owls, which were far more numerous than barn owls in this area. The diet of the great horned owls consisted largely of Jerusalem crickets, woodrats, cottontails, kangaroo rats, and pocket gophers. On a weight basis, 56 percent of the diet was cottontails. For comparison, the diet of red-tailed hawks was also presented from a related study. On a weight basis, 50 percent of the diet of the hawks consisted of ground squirrels.

Coastal Los Angeles County (Cunningham, 1960). Pellets were collected once from the base of a date palm tree. Because of the abundance of wood rats and the low percent-



age of pocket gophers and meadow mice, the author concluded that the barn owls foraged largely in the chaparral-covered Santa Monica Mountains about two miles north of the collection site. Two samples of great horned owl pellets were also taken; their diet consisted mostly of pocket gophers, house mice, meadow mice, and wood rats.

Placer County (Clark and Wise, 1974). Pellets were collected at eight sites along the eastern edge of the Sacramento Valley, mostly from barns just northwest of Lincoln. On a weight basis, over half of the diet of the barn owl consisted of pocket gophers, while white-footed mice accounted for only about seven percent.

Siskiyou County (Rudolph, 1978). This study examined the coexistence and diets of barn owls and great horned owls at Tule Lake National Wildlife Refuge. The owls roosted on rock cliffs with a hunting range that included natural vegetation and agricultural fields. Pellets were collected at weekly intervals from the roosting sites. The diet of the great horned owls was very similar to that of the barn owls. Barn owls were found to hunt primarily on the wing, while great horned owls hunted primarily from telephone poles.

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(CI-PEST.137) *Contributed by Chuck Ingels*

Soil bacteria to control jointed goatgrass in integrated cropping systems.

A.C. Kennedy and C.M. Boerboom

USDA SARE/ACE Western Region Annual Report, p. 13. 1994

Editor's Note: In the fall 1994 issue of ***Sustainable Agriculture (Vol.6, No.4)****, we included a technical review that addressed the importance of soil microfauna (mainly nematodes and protozoa) in plant disease suppression. Although these soil animals represent a significant biological control potential, it is not clear whether or not that potential can be exploited in the field. The article reviewed here provides an example of how soil-dwelling organisms might be manipulated in cropping systems. The pest in this case is a weed; the biocontrol agents are soil bacteria.*

Jointed goatgrass (*Aegilops cylindrica*) is fast becoming a major threat to fall-sown small grains. It now infests an estimated five million acres nationally and is reducing growers' income by $145 million annually. Herbicides for controlling this weed are not available. The objective of this research was to develop a biological weed control method that would provide an economic benefit to grain growers affected by jointed goatgrass. The approach taken was to isolate soil bacteria that could inhibit growth of the weed.

In initial greenhouse studies, four isolated bacteria reduced jointed goatgrass growth 30 to 70 percent. These isolates were used in field tests in 1993. In the field, two of the four tested bacteria effectively suppressed growth of the weed. These two isolates reduced weed emergence, but by June, visual differences in aboveground plant growth were not evident. The effect of the bacteria was more pronounced in the latter part of the growing season, because by August aboveground growth had been suppressed by 20 to 30 percent. Researchers noted that the bacteria delayed flowering and increased anthocyanin production by the weed. Wheat growth was not affected by the bacteria. In addition, the bacteria were found to be more effective when used in combination with low rates of a synthetic herbicide.

The ability of the bacteria to survive in different geographical regions, and from season to season, is critical if this biological control method is to be successful. The researchers have been able to select for isolates that are better able to withstand desiccation, but further studies under other types of stresses are needed.

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(DEC.524) *Contributed by David Chaney*