DISTRIBUTION AND ABUNDANCE OF RODENTS IN AGROFORESTRY PLANTATIONS IN THE SAN JOAQUIN VALLEY, CALFORNIA

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Abstract: The distribution and abundance of rodents was studied on 6 eucalyptus agroforestry sites and on 5 agricultural types in the San Joaquin Valley from June 1987 through May 1989. Deer mice (*Peromyscus maniculatus*) were the most abundant rodent on 5 of the 6 study sites. Based on 14,250 trapnights, deer mice comprised 82% of the rodent captures in agroforestry plantations; California voles (*Microtus californicus*), 8%; house mice (*Mus musculus*), 7%; and western harvest mice (*Reithrodontomys megalotis*), 3%. In 9,019 trapnights in agricultural habitats (alfalfa, cotton, tomatoes, sugar beets, and fallow lands), deer mice comprised 77% of the captures; house mice, 22%, and California voles, 1%. Rodent communities within the plantations had denser populations and smaller home ranges than those rodent populations in the agricultural habitats. Rodent density was inversely related to plantation age. Densities of *Peromyscus* in the plantations ranged from 22 to 282 animals per ha, depending on the site being sampled, during the 8 quarters of the study. Estimated home ranges in agricultural habitats were more than 4 times larger than in the tree farms. Capture distribution of rodents varied significantly between study periods and most during periods of population decline.

The purpose of this study was to measure and describe the population parameters of rodent populations found in agroforestry plantations and to compare them to rodent populations from nearby agricultural fields. Estimates were made of the effects of agroforestry plantations on rodents populations common to the western San Joaquin Valley, California.

STUDY AREAS

The geometric arrangement of the 6 study sites was variable. All study sites were composed primarily of eucalyptus trees (*Eucalyptus camadulensis*) and 4 sites had boundary strips of 1 to 9 rows of casuarina trees (*Casuarina cunninghamiana*). They were located on property belonging to the Allen (2.02 ha), Murrieta (9.43 ha), Wakefield (2.02 ha), Peck (3.24 ha), Thomsen (3.44 ha), and Haynes (4.57 ha) Ranches. All sites were located in Fresno County except the Haynes Ranch which was in Kings County. Management practices on the sites, including application of irrigation water, fertilization, and management of annual plants, was irregular, non-uniform and depended on the landowner. All sites, except Wakefield, were irrigated primarily with subsurface drainage water. No mechanical or chemical control of animal species was practiced in the sites during the study. Additional data on the study sites is reported in Chesemore et al. (1990).

Agricultural study sites included alfalfa, cotton, tomatoes, sugar beets, and fallow land and were located within 1 km of either the Murrieta or Wakefield agroforestry sites. The crops were mature or near maturity when surveys were conducted and represented the most commonly occurring agricultural types in the area. Landowner permission for access determined which fields were studied.

METHODS

Rodent data were collected at regular intervals from 6 agroforestry plantations from June 1987 to May 1989. Rodent trapping grids, consisting of 8 rows of 8 Sherman livetraps (8 cm x 6 cm x 23 cm), were permanently placed within each of the 6 agroforestry study areas. All 6 grids were simultaneously trapped for 5 consecutive nights per quarter. Simultaneous sampling prevented biases in capture responses between sites due to weather conditions or moon phase. Distance between trap locations was regular and depended on the arrangement of each plantation. Traps were baited with a commercial bird seed mix and had nesting material to reduce mortality of captured animals due to adverse temperatures.

Data were collected in agricultural habitats (alfalfa, sugar beets, cotton, tomatoes, and a fallow field) from July to August 1988 to determine rodent species composition and relative abundance. Due to harvest and irrigation constraints, 100 Sherman livetraps were placed in a 10 by 10 grids in each of the 5 agricultural habitats. Trap rows were 5 m apart with 5 m spacing within the rows. Traps were closed during weeks of the full moon and periods of heavy irrigation. No trapping data were collected in agricultural habitats at other times of the year due to post-harvest conditions of the fields.

All captured rodents were identified, weighed, sexed, and marked with metal, numbered eartags

Table 3. Distribution (X^2) of rodents in agroforestry plantations, San Joaquin Valley, CA, 1987-1989. 2 x 2 contingency tables created from distibution of captures at each study site (a>3.841, $P<0.05$; a>6.635, $P<0.01$). All significant values are in bold type; values significant at $P<0.01$ are underlined. Sample sizes are >25 except those in parentheses are >5 and <25.

Site	Sampling periods 1	2	3	4	5	6	7	8
Peromyscus maniculatus								
Allen	1.86	**6.33**	(**5.66**)	3.60	2.10	2.52	3.60	(2.08)
Murrieta	1.54	**28.38**	**11.46**	**6.00**	**5.75**	**13.53**	**7.82**	**5.79**
Peck	0.53	0.69	**14.95**	1.88	2.76	1.59	**5.26**	**11.90**
Wakefield	(6.34)	(3.28)	2.97	*	*	*	**8.53**	*
Thomsen	6.33	(**5.43**)	3.62	**6.94**	(3.91)	**9.33**	**19.08**	**21.20**
Haynes	*	*	(**12.00**)	*	*	*	(**6.00**)	**25.12**
Mus musculus								
Allen	*	*	*	*	(**14.67**)	(**14.57**)	(**7.00**)	*
Murrieta	*	*	*	*	*	*	(**4.00**)	*
Peck	*	(1.12)	(**4.40**)	(0.85)	*	**7.33**	*	*
Wakefield	*	*	(**31.15**)	*	*	*	*	*
Thomsen	*	*	*	*	*	**4.67**	**23.46**	*
Haynes	(**8.00**)	(3.70)	**25.76**	(**6.07**)	*	*	(**21.00**)	*
Microtus californicus								
Allen	*	*	*	*	*	*	(**15.60**)	*
Peck	(1.08)	3.27	**24.51**	*	*	*	**14.77**	*
Reithrodontomys megalotis								
Haynes	*	(**4.77**)	2.17	(**11.60**)	*	*	(**4.63**)	*

* Sample too small for X^2 calculation.

The spatial distribution of rodent captures within the tree farms was non-random during several trapping periods (Table 3). Significant X^2 values may have been associated with disturbances in cover such as pruning of tree branches and manual clearing of low ground cover. Non-random capture distributions also may have been associated with decreases in population density. Non-random distributions were found in agricultural sites when proximity to the edge of the field was considered (Table 4). This edge effect was found for all except deer mice in sugar beets.

Table 4. Distribution (X^2) of rodents in agricultural habitats, San Joaquin Valley, CA, July-August 1988. 2 x 2 contingency tables created from distibution of captures at each study site (a>6.635; $P<0.01$). Sample sizes >25 except those in parentheses are >5 and <25.

Site	Number captured edge	center	X^2	Signif.
Peromyscus maniculatus				
Alfalfa	45	66	6.66	$P<0.01$
Sugar Beet	45	52	2.46	
Tomato	49	37	5.07	$P<0.025$
Cotton	6	13	(5.21)	$P<0.025$
Mus musculus				
Alfalfa	29	5	17.53	$P<0.01$
Sugar beet	7	25	16.75	$P<0.01$
Tomato	13	15	11.71	$P<0.01$

Population densities of Peromyscus maniculatus in the tree farms ranged from 22 to 282 per ha (Table 5). Densities at most sites were higher than previously reported levels (Blair 1940, 1942, Mohr 1947). These figures suggest irruptive conditions although little evidence has been reported for populations explosions in deer mice (Terman 1966). Estimates from plantation sites were generally higher during winter sampling periods. Summer 1988 estimates for plantation sites were comparable to densities of rodents in agricultural fields (Table 6). Agroforestry plantations appear to be valuable habitat for deer mice while the agricultural fields lie fallow. Lower population estimates in the plantations during summer months may indicate a dispersal of deer mice into adjacent fields.

Minimum home range data were sufficient for

TABLE 8. Minimum home range (m^2) and confidence intervals (95%) of rodents in agricultural habitats, San Joaquin Valley, CA, July-August, 1988.[a]

Site	*n*	*P. maniculatus*	*n*	*M. musculus*
Alfalfa	8	178.5 (49.2-307.9)	5	150.1 (37.4-263.1)
Sugar beet	8	235.3 (0.0-538.9)	5	80.4 (17.5-143.4)
Tomato	8	409.3 (149.5-669.2)	3	153.0 (0.0-1188.5)
Cotton	3	516.8 (0.0-1697.2)	0	
Fallow	0		0	

[a] *n* indicates the sample size; confidence intervals (95%) are in parentheses.

to those reported from other studies. We have reported on distribution, population density, minimum home range here because of the apparent significance of the data. Distribution within the sites and population densities were significantly different from reported levels. Heterogeneity of vegetation within the sites may have been a factor effecting the observed distributions. Population density was influenced by several factors of which habitat type and seasonality appeared to be the most important. Food availability also may be an influence. Ranked variable tests revealed a strong association of Peromyscus home range with tree density and with population density in 1988.

Agroforestry plantations appear to have produced island habitats that can support large populations of deer mice and occasionally of other rodent species. The population size appears to be negatively correlated with age of the plantation. Data from the first 2 years of study suggest a gradual reduction in overall usage of the tree farms by small mammals. The quality of the habitat will probably decrease as the trees within the plantations age, the canopy closes, and ground cover is subsequently reduced.

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