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Presently, V. P. I. and S.U. is involved in a three year multi-disciplinary project to study pine and meadow vole ecology, behavior, and control (see additional V.P.I. and S. U. papers in Proc. Fifth East. Pine and Meadow Vole Symposium). In conjunction with this research, a long-term field study has been initiated to collect seasonal data on vole densities, survivorship, and reproduction in two Virginia apple orchards. The use of these data will be fourfold: (1) to gain insight into the dynamics of Virginia vole populations; (2) to act as a reference (or control) for future field experiments involving manipulation of pine and meadow vole populations; (3) to serve as input to a computer model being developed at V.P.I and S.U. (Coyle et al., 1981); and (4) to allow comparison of our results with other vole population studies. This paper presents some preliminary results after one year of the field study (December 1979 through December 1980) and will mainly concentrate on the pine vole population data.

Two areas were selected for this study; both are located near Troutville, Virginia in the Roanoke Valley. One area is a maintained apple orchard which has had no vole control for at least two years prior to the study, but has been mowed during spring and summer. The second area is an abandoned orchard which has had no type of maintenance for three to four years. The sites are within one mile of each other; however, they differ in regard to ground vegetation, slope, and aspect.

Live-trapping was conducted on a monthly basis in each orchard beginning in December 1979. Grids were approximately 1/3 hectare in each orchard and were 6 tree rows wide and 12 or 13 trees long. Two Sherman live traps were placed at the entrance of burrows at each tree with tar paper squares covering traps. Apple pieces were used for bait. Traps were checked at least twice daily (every three to four hours) for three sequential days in each orchard. All animals captured were toe and ear clipped for identification, measured for weight and length, and examined for sex and reproductive characteristics. Pine voles were classified as juveniles, subadults, or adults by weight criteria. Juveniles were less than 15 grams. Subadults were greater than or equal to 15 grams, but less than 21 grams. And adults were greater than or equal to 21 grams. This classification was based on the weight distribution found by Miller and Getz (1969) for the three age classes.

In general during the first year of this study, voles were abundant in both orchards as indicated by the large number of animals marked and the total number of animals captured (Table 1).

Table 1. Total number of animals marked and total number of captures recorded during the first twelve months of trapping in the maintained and the abandoned orchards. Animals of questionable sex were included in TOTAL ANIMALS but not in TOTAL MALES or TOTAL FEMALES.

	MAINTAINED ORCHARD		ABANDONED ORCHARD	
	PINE	MEADOW	PINE	MEADOW
TOTAL ANIMALS	699	34	194	296
TOTAL MALES	326	10	96	121
TOTAL FEMALES	298	17	93	158
TOTAL CAPTURES	2274	61	652	814

Pine voles were the dominate small mammal trapped in the maintained orchard; however, more meadow than pine voles were marked and captured in the abandoned orchard (Table 1). Monthly capture data for male and female pine voles is presented in Table 2. In both orchards the greatest number of pine voles were captured in the winter and spring and the lowest number during the summer and early fall. Although sex ratios varied from month to month, the yearly totals do not appear to be different from a 1:1 ratio (Tables 1 and 2).

Table 2. Total number of individual male and female pine voles captured each month in each orchard type. Animals of questionable sex are not included.

	MAINTAINED ORCHARD			ABANDONED ORCHARD		
MONTH	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
DEC	90	78	168	23	28	51
JAN	48	67	115	9	22	31
FEB	52	70	127	14	15	29
MAR	51	59	110	25	22	47
APR	106	110	216	18	17	35
MAY	66	79	145	13	7	20
JUNE	60	62	122	17	12	29
JULY	16	14	30	8	7	15
AUG	7	7	14	1	0	1
SEPT	13	8	21	1	0	1
OCT	49	38	87	16	17	33
NOV	63	50	113	28	15	43
DEC	56	67	123	16	14	30

In Table 3 the minimum number of voles known alive (MNA) in each orchard is given. MNA was calculated for a designated month by adding the number of individual animals captured in that month and the number of individuals which were marked prior to that month, not caught in that month, but captured subsequently. Hilborn et al. (1976) concluded from computer simulations that MNA underestimated actual population size of five species of voles by 10-20%. Population estimates of pine voles using MNA in the maintained orchard ranged from 243 animals/ha in August to 798 animals/ha in April. In the abandoned orchard pine vole estimates ranged from 27 (Aug., Sept.) to 162 (Dec. 1979) animals/ha and meadow vole estimates from 30 (July) to 381 (Dec. 1979) animals/ha. Often, especially during the summer months, many more animals were known to be alive each month (Table 3) than were captured (Table 2). This result would suggest that vole trappability varied each month and drastically declined during the hot, dry summer and early fall of 1980. Perhaps, the lower number of voles indicated during July, August, and September and the higher numbers in winter and spring (Tables 2 and 3) may reflect the problem of trappability rather than true population trends.

Table 3. Minimum number of voles known alive each month on the 1/3 hectare grid in each orchard.

	MAINTAINED		ABANDONED	
MONTH	PINE	MEADOW	PINE	MEADOW
DEC	176		54	127
JAN	184		44	115
FEB	202		46	103
MAR	209		53	90
APR	266		44	46
MAY	191		25	29
JUNE	174	5	31	49
JULY	92	2	16	10
AUG	81	5	9	20
SEPT	86	13	9	18
OCT	133	9	38	34
NOV	147	8	48	17
DEC	125	3	30	14

In general the age structure of the captured population in the maintained orchard each month was 5-10% juveniles, 15-20% subadults, and 75-80% adults (Table 4). In the abandoned orchard juveniles were frequently lacking in the monthly trapping and generally for the year, subadults and adults constituted 5-30% and 60-90% of the captured population, respectively. In August and September only one subadult male was trapped in the abandoned orchard (Table 4), consequently accounting for the 100% subadult composition of the captured population during these months. Again, low trappability, and therefore, few captures of voles during the summer and early fall of 1980 is most likely influencing these data.

Table 4. Percent on a weight basis of juvenile (JU), subadult (SA), and adult (AD) pine voles captured monthly in each orchard. Sample size is indicated in parentheses. Data for January are not included because many animals were not weighed this month.

	MAINTAINED ORCHARD			ABANDONED ORCHARD		
MONTH	JU	SA	AD	JU	SA	AD
DEC	7.7(13)	8.3(14)	84.0(142)	5.9(3)	3.9(2)	90.2(46)
FEB	5.6(7)	19.4(24)	75.0(93)		10.3(3)	89.7(26)
MAR	9.6(11)	16.5(19)	73.9(85)		15.2(7)	84.8(39)
APR	11.6(27)	25.4(59)	62.9(146)		2.9(1)	97.1(33)
MAY	6.0(9)	16.1(24)	77.9(116)		5.0(1)	95.0(19)
JUNE	13.8(19)	8.7(12)	77.5(107)	12.9(4)	3.2(1)	83.9(26)
JULY	9.7(3)	22.6(7)	67.7(21)	6.7(1)	33.3(5)	60.0(9)
AUG	7.1(1)	14.3(2)	78.6(11)		100.0(1)	
SEPT	13.0(3)	8.7(2)	78.3(18)		100.0(1)	
OCT	9.3(8)	26.7(23)	64.0(55)	9.1(3)	18.2(6)	72.7(24)
NOV	6.2(7)	39.8(45)	54.0(61)		25.6(11)	74.4(32)
DEC	4.0(5)	15.2(19)	80.8(101)	6.7(2)	10.0(3)	83.3(25)

Table 5. Mean monthly weight (g) of adult male and female pine voles in each orchard. Sample size is indicated in parentheses. Data for January are not included because many animals were not weighed this month.

MONTH	MALE	FEMALE	MALE	FEMALE
DEC	26.0(81)	27.5(61)	26.0(21)	25.7(24)
FEB	26.3(39)	26.4(53)	26.5(13)	25.8(13)
MAR	26.6(37)	26.5(48)	25.1(20)	23.6(19)
APR	25.3(68)	25.3(78)	24.6(16)	25.9(17)
MAY	26.2(52)	26.5(64)	24.6(12)	27.6(7)
JUNE	26.6(49)	29.7(56)	25.9(14)	26.3(12)
JULY	27.0(10)	28.8(11)	24.0(4)	24.0(5)
AUG	23.8(5)	27.8(6)		
SEPT	25.6(12)	23.3(6)		
OCT	24.4(30)	25.8(25)	25.0(12)	23.6(12)
NOV	24.5(33)	24.5(28)	23.7(18)	25.6(14)
DEC	24.7(49)	25.2(52)	24.1(14)	26.7(11)

Mean monthly weight by sex for adult pine voles is given in Table 5. Average weight of adult male and female pine voles in the maintained orchard during the first twelve months of this study was 25.7 g and 26.4 g, respectively. In the abandoned orchard during the same period, average adult male and female weight was 25.0 g and

25.3 g, respectively. Adult female weight in both orchards showed greater variation during the year than did adult male.

To examine aspects of pine vole survival in these orchards, the number of months between first and last capture of marked animals was calculated (Table 6). Generally, as expected, as the number of months between first and last capture increased, the number of animals in each category decreased. In the maintained and abandoned orchards, over 50% of marked pine voles were captured in only one month (see 0 months column in Table 6). However, survival appears to be higher in the maintained orchard when compared to the abandoned. Twenty (11%) of the original 176 animals captured in December 1979 were captured in December 1980. This estimate of longetivy is probably an underestimate since it is possible that animals from the original group may be captured in subsequent months as the study continues.

Table 6. Months between first and last captures of marked pine voles in the maintained (M) and the abandoned (A) orchards.

		MONTHS BETWEEN FIRST AND LAST CAPTURES												
		0	1	2	3	4	5	6	7	8	9	10	11	12 TOTAL
NUMBER	M	368	87	54	30	41	25	29	13	14	7	5	6	20 699
	A	107	29	20	8	14	6	4	4		2			194

As previously stated, these results are preliminary at this point. Computer programs are being developed to examine seasonal age and weight dynamics, survivability, trappability, reproduction, movement, and spatial distribution of pine voles. Reports of this continuing research will be given at future symposia and meetings.

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