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Seasonal Forage Availability in Relation to Energy
Requirements of Pine Voles in Two Orchard Types

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Results from previous work on pine vole populations and habitat interactions (Cengel et al. 1978; Noffsinger 1976) suggested that pine vole populations were quite sensitive to seasonal changes in the quantity, species composition, and nutritive value of available forage. This conclusion was based on decreases in both reproductive performance and physical condition of pine voles collected from abandoned orchards in the fall as compared to voles taken from maintained orchards during the same season. Utilizing information from these investigations, a "follow-up" study was designed to investigate food availability and nutrient composition, food consumption, food digestibility, and energy requirements of pine voles. Results from this bioenergetic approach to studying pine vole populations, coupled with detailed knowledge of their population dynamics, should provide useful information for identifying critical or weak points in the ecology of populations as well as for assessing the effects of various management or control strategies applied to biological (orchard) systems. Data from this research on ecological energetics of pine vole populations will ultimately be included as part of an overall population energetics model which will be used for simulating both natural and man-induced habitat changes and predicting their effect on pine vole populations (Coyle & Tipton, unpublished). This paper summarizes the major points obtained from a bioenergetic study conducted during 1978 and 1979 in an orchard abandoned for 9 years and a maintained orchard, both located near Daleville, Virginia.

Findings of Studies Conducted

Net primary production estimates of above ground herbaceous for areas beneath apple tree canopies and for areas outside canopies within both maintained and abandoned orchards indicated that during the summer, fall, and winter, the maintained orchard had much greater herbaceous biomass than the abandoned orchard.

During the period from August to January, apple drops accumulated on the ground and provided an additional food source to supplement the herbaceous vegetation available to voles. During the winter season, apples comprised 77 percent of the total biomass available and 79 percent of the total or gross energy available in the maintained orchard. In the abandoned orchard, apples comprised 33 percent of the total energy and 34 percent of the total biomass. During the winter season, apple biomass on the ground was significantly greater in the maintained orchard than in the abandoned orchard. During other seasons, there was no difference between orchards in available apple biomass on the ground.

To determine which forages occurring in the orchards were preferred by pine voles, a series of 9 feeding trials were conducted using 14 forages. Food items were ranked in order of decreased preference, based on these choice tests. Apple fruit was a highly preferred food item

among all voles tested and was completely consumed before substantial amounts of other forages being offered to voles at the same time were consumed. Selection and consumption of the remaining 13 food items indicated that voles were very diverse in their feeding habits, e.g., voles consumed to some degree all 7 forb species tested. This diversity of food habits may be important for easing the transition between seasonal food supplies. Also, in this study, forbs were preferred over grasses. The low palatability of maturing grasses appeared to be the result of higher fiber concentrations. In maintained apple orchards which are mowed continually, however, a greater supply of low fiber grass forage becomes available from constant regrowth.

Forbs were a preferred forage; however, they constituted only a very small portion of the net primary production available in each orchard. Voles appeared to be quite selective in what they ate. For example, orchard grass was the most abundant plant species in the maintained orchard but was found to be quite low in digestibility and preference. Several of the highly preferred plant species such as clover, dandelion, and plantain are characteristic of open fields and can be shaded out by other plants which grow more erect. The prolific nature of poison ivy was mainly responsible for the nearly complete elimination of these preferred forbs from the abandoned orchard, whereas mowing operations in the maintained habitat encouraged the survival of preferred forages.

It appeared from the quantitative and qualitative analysis of the seasonal primary production in both orchard habitats, that the vole population in the abandoned orchard was generally surviving in a lower quality habitat. The quality of habitats were lowest and the differences between the 2 orchards were greatest during the winter season. The abundant energy source which was available from apples during the fall season was greatly depleted by mid-winter. This was especially true within the abandoned orchard.

Using information collected during this study on available primary production of preferred herbaceous plants and apple fruits, in conjunction with data on seasonal digestibility of vole stomach contents determined by the lignin-tracer technique (Noffsinger 1976), the total amount of digestible energy available to pine voles in the two orchards during each season was estimated. In the maintained orchard the lowest value for total digestible energy (DE) available occurred during the winter season. However, in the abandoned orchard the DE value for summer was 18 percent lower than the winter value. Although herbaceous plant production was considerably lower during winter than during summer in the abandoned orchard, the increased DE value for winter was the result of a greater biomass of high energy apples available during the winter season.

By comparing the seasonal DE values of available forage to values of digestible energy required by adult male and female voles, an estimate of the number of adult voles which can be maintained on the available digestible energy reserves in each orchard was made. Data required for the calculation of seasonal DE requirements for maintenance of adult voles was obtained by Lochmiller (unpublished) during another phase of this study which utilized standard techniques to determine the daily metabolizable energy requirements for maintenance at controlled temperatures which approximated seasonal ambient temperatures. It is apparent that energy availability in the abandoned orchard during all seasons was considerably limited in comparison to that which was

available in the maintained orchard. The seasonal carrying capacity for each orchard, expressed as voles/ha, indicated that during summer the maintained orchard could support 16 times as many voles as the abandoned orchard and 7 times as many during the winter.