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DISPERSAL AND SOME IMPLICATIONS FOR CONTROL OF THE CALIFORNIA GROUND SQUIRREL

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ABSTRACT: Data from current research and from the literature indicate that a knowledge of dispersal of the California ground squirrel can help to develop control strategy. An understanding of the rate and extent of dispersal may help reduce poor results due to patchy control. A knowledge of dispersal distance can help to determine the size of a buffer zone of control which may reduce the rate of reinvasion. The seasonal timing of dispersal is predictable in the California ground squirrel, and this can help to establish follow-up control.

INTRODUCTION

Dispersal is an important factor in the population biology of ground squirrels, and it is of prime importance in squirrel control. All of those involved in control are aware of the important role of dispersal in repopulation following population reduction. However, these kinds of movements have not often been dealt with in terms of how they might directly relate to the development of pest control strategy.

This paper examines the relationship between dispersal and control of the California ground squirrel, Spermophilus beecheyi. I will present some examples and data to illustrate (1) the potential importance of the rate and extent of dispersal following population reduction, (2) that a knowledge of dispersal distance can be helpful in establishing buffer zones of control, and (3) that the seasonal timing of dispersal is predictable and can also aid control of ground squirrels.

Dispersal will be defined as any movement from a former area of residence (home range) to a new area of residence (Michener and Michener 1977, Boag and Murie 1981). This is a simple but practical definition of dispersal when interest is in the population consequences of movements.

THE RATE OF DISPERSAL

It is commonly known by most involved in ground squirrel control that the reduction of a local population often results in the rapid movement of individuals from nearby populations into the controlled areas. This is due to the tendency of ground squirrels to move from high- to low-density areas.

This form of movement has been documented in the literature on ground squirrels (Spermophilus spp.) Grinnell and Dixon (1918) and Evans and Holdenried (1943) discussed the movement of California ground squirrels from areas of higher density to those of lower density. The same has been recorded for the Uinta ground squirrel (S. armatus) (Slade and Balph 1974). Michener (1979) found that more Richardson's ground squirrels (S. richardsonii) immigrated into a population in a year when the population was at a low density than in years of high densities. Carl (1971) reported that the Arctic ground squirrels (S. undulatus) he studied formed two kinds of populations during the active season, colonial and refugee populations. Surplus individuals unable to withstand aggressiveness of other squirrels during territory formation left the colony and formed refugee populations. These new populations were short-lived because of high mortality caused by flooding. The formation and fate of these populations are analogous to regularly controlled pest populations.

The rate at which these reinvasion movements occur may be important in ground squirrel control. Where ground squirrels (S. beecheyi) were gassed and trapped on a 6-acre (2.4 ha) wheatfield, Garlough (1920) reported that within the next 20 days 700 squirrels were taken in 300 traps placed along fence lines bordering the field which was adjacent to an uncontrolled field. In a similar study Alsager (1972) removed all squirrels on an 8-acre (3.3 ha) plot while attempting to evaluate different methods of control of S. richardsonii in Alberta, Canada. A density of 28 squirrels per acre (69 per ha) was determined before removal, and at 20 days following this count Alsager found a density of 29 squirrels per acre (71 per ha), mostly juveniles.

I am currently involved in two research projects on California ground squirrel populations in which recolonization has been monitored. One is my dissertation project which is under the guidance of Dr. Walter E. Howard and Rex E. Marsh; it is being conducted at the University of California's Hopland Field Station in Mendocino County. The other is an ongoing study of a population near the U.C. Davis campus. It is part of a statewide Integrated Pest Management project being conducted by Cooperative Extension and under the guidance of Dr. Terrell P. Salmon. These two studies will be referred to hereafter as Hopland and Davis, respectively.

Results from these two studies also indicate the rate at which immigration can occur. In February 1981, all resident squirrels at the Davis study site (5.6 ha, 12 acres) were removed by trapping. The area is adjacent to cultivated farmland and consists of noncrop land overgrown with weedy vegetation. This plot contains a discrete squirrel colony because it is surrounded on all sides by an unoccupied boundary. As a result of immigration, the original resident density was attained in 4 months. Thirty-one adults were initially removed, and then immigrating squirrels were trapped, individually marked, and released. In June the estimated minimum resident population consisted of 33 ground squirrels,

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21 adults which immigrated and 12 juveniles which were born on the area. It is interesting to note that most dispersing ground squirrels are normally young-of-the-year. The reason that repopulation occurred by adults was simply because the initial removal was done early in the year before the juvenile dispersal period. From data collected later in the year, it is known that young squirrels immigrated onto the study area in much greater numbers than adults. For example, in August alone, 43 juveniles moved onto the area, while only 4 adults immigrated, even though the population was no longer at low density.

I have maintained three continuous-removal plots at Hopland for 3 years. Each of these plots contains a squirrel colony separated from others in the area. All resident squirrels were removed, and then all immigrating individuals were trapped off on a continuous monthly basis. This situation differs from the Davis study because I am not allowing actual repopulation to occur. Therefore, I am measuring movement onto the plots under conditions in which a favorable, empty habitat is being perpetuated—presumably favorably—because it was occupied by squirrels initially. Nevertheless, the results are fairly similar to those of the Davis study. On one plot, residents were removed in early spring, and within 5 months 27 squirrels had immigrated. The original resident density was 20 on the second plot, and 13 squirrels moved onto it in 7 months. I could not determine the resident density on the third plot because it was treated with strychnine just before I began work on it. I removed 10 squirrels which survived the control, and in the next 6 months I removed 43 squirrels.

If ground squirrel control is done in such a way that, over a large area a patchwork pattern of control results, then the rapid movement of squirrels from the higher density uncontrolled areas to the low-density controlled areas will result in inadequate control (Dana 1962). This is also why the most effective squirrel control programs are those which encompass large areas such as a third or a half of a county in a single year.

DISTANCE OF DISPERSAL

A frequent question is: "How wide should a buffer zone of control be around the primary control area to reduce the rate of reinvasion by ground squirrels?" This question is difficult to answer because there are little data available concerning how far ground squirrels move when they disperse. The current studies at Davis and Hopland do not address this aspect of dispersal. However, information from two published studies provide some insight into the order of magnitude expected in long-range movements and thereby provide some useful information for developing control strategy.

Fitch (1948) studied the California ground squirrel on the San Joaquin Experimental Range in Madera County. He recorded the distance between trap sites for 1,043 movements; 90% were under 300 yds (275 m), 9% were between 300 and 650 yds (275 and 596 m), and 1% exceeded 650 yds (596 m). Evans and Holdenried (1943) studied S. beecheyi in Alameda County. They recorded somewhat longer movements than did Fitch, but they recorded only the single maximum distance moved between captures for each ground squirrel. For 427 maximum distances, 81% were under 300 yds (275 m), 13% were between 300 and 600 yds (275 and 550 m) and 6% were greater than 600 yds (500 m). These two studies give only a rough approximation of dispersal distance for this species, because dispersal is subject to many biological and environmental variables.

At Hopland I gained some insight into how far ground squirrels might disperse. I studied two adjacent colonies by trapping, marking, and releasing ground squirrels. In 3 years, 263 individually marked squirrels were caught on the two areas combined. Only 11 of these individuals were captured on both plots, yet they were separated by only 150 m.

Based on these limited data, I believe that a buffer zone of control would have to be on the order of at least 200 to 300 m in order to significantly reduce the rate of reinvasion. The location of the buffer zone around a field will depend on the location of surrounding squirrel colonies.

Kalinowski and de Calesta (1981) tested the ability of a controlled buffer zone to reduce damage to alfalfa by Belding's ground squirrels (S. beldingi). They reasoned that, since the "normal movement radius" of this species is about 40 m, then a buffer zone of 60 m should reduce damage caused by ground squirrels entering fields from adjacent areas. They tested this idea in a replicated experiment. In fields undergoing the same baiting treatment, the addition of a treated border around some of the fields reduced alfalfa loss from 25% to 18%; although the difference was not statistically significant, it was in the expected direction. Perhaps if they had used a larger buffer zone the difference would have been greater. Where it is feasible, a larger border approximating average dispersal distance, rather than the smaller distance representing home-range movements, might significantly reduce movement into the primary control area. Nevertheless, the study by Kalinowski and de Calesta, possibly the only one attempting to quantify the use of buffer zones in ground squirrel control, is important in showing the direction that field experimentation in squirrel control should continue. It is only with studies such as this one that definitive answers to questions about control strategy in relation to dispersal will be answered.

TIMING AND DURATION OF DISPERSAL

If the seasonal timing of dispersal can be predicted, then it may be possible to plan control to more effectively reduce damage by immigrating ground squirrels, especially if populations adjacent to the area cannot be controlled. The importance of being able to predict dispersal movements is that follow-up control methods can be applied to protect the perimeter of the field just prior to the time of movement of the squirrels. This may reduce the rate of reinfestation and the amount of control which will be required the subsequent year.

One difficulty in comparing data from different areas is the occurrence of geographic variability in the seasonal activity of ground squirrels. Figure 1 shows the degree of variability in timing of emergence of young from their natal burrows and the period of their dispersal at Hopland and Davis. Emergence occurs approximately 2 months earlier at Davis compared to Hopland. Toward the southern part of its range, in the San Joaquin Valley, S. beecheyi emerges in early April, and dispersal begins about the latter part of May (Fitch 1948). In Monterey County, these two time periods occur at about the same time as in the San Joaquin Valley (Dobson 1979). Populations in Alameda County emerge in the latter part of May and disperse in early July (Evans and Holdenried 1943). There is some year-to-year variability in the timing of emergence and dispersal at a given locality, but it is usually no more than a few weeks (Grinnell and Dixon 1918, Evans and Holdenried 1943, Fitch 1948).

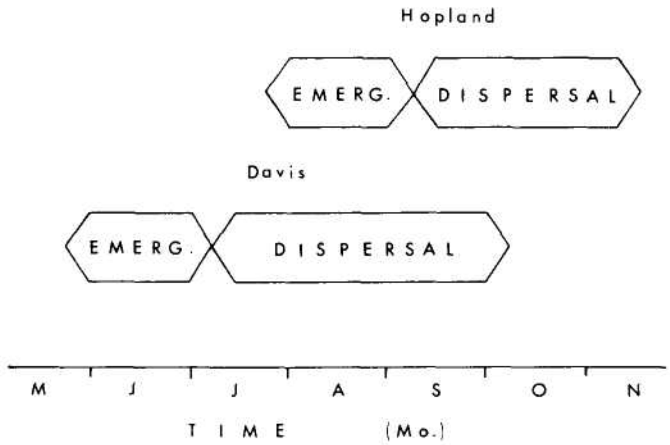

Fig. 1. Time periods (in months) for emergence and dispersal of juvenile California ground squirrels at the Davis and Hopland study sites.

Despite this variability, dispersal is fairly predictable if it is looked at on a relative time scale rather than strictly according to the calendar. Dispersal is predictable if it is compared with the time that emergence occurs; specifically, if the time from first emergence is known, then the beginning of the dispersal episode will occur approximately 6 weeks later. This time period was consistently 6 weeks plus or minus about 1 week for the Hopland and Davis studies and for the three studies cited above. The first emergence of young from their natal burrows is a fairly obvious event and one which can be simply observed; it would not be necessary to trap or spend large amounts of time in the field.

In the Central Valley of California, the time for control is determined primarily by the combination of good bait acceptance and maximum surface activity of all the age and sex classes. All the young are above ground at this time, and not too many of the adults have begun to estivate. This time for control corresponds roughly with the midpoint between the end of emergence and the beginning of dispersal (Fig. 1). However, immigration into the control area can be expected to occur soon, especially if the area is within dispersal distance of uncontrolled squirrel populations. Also, the control operation, by reducing the population, has created favorable habitat for colonization. If this scheme is correct, it suggests that immediate follow-up control, using alternate methods (e.g., trapping, anticoagulants), should be undertaken. The importance of this follow-up control will, of course, depend on the specific situation—for example, whether the control site consists of rangeland or a high-value crop such as an almond orchard.

CONCLUSION

Even though the results I have reported are based on limited data, they at least show that if more attention is given to dispersal of ground squirrels, more effective control may result. The indicated relationships between dispersal and various aspects of control are necessarily general because of the limited amount of data. Much more work needs to be done on this aspect of ground squirrel biology, particularly in relation to distance of dispersal in various kinds of habitats and the rate and direction of movements in terms of different densities of source and recipient populations.

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