HABITAT MANAGEMENT TO CONTROL GROUND SQUIRREL POPULATIONS

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ABSTRACT.

Two major strategies for controlling ground squirrel pests are direct removal and habitat management. Beyond the probable effects on non-target species from the widespread distribution of poison baits, the strategy of direct ground squirrel control is founded on an ignorance of animal ecology. So long as suitable ground squirrel habitat remains unaltered, squirrel removal campaigns will be followed by the growth and re-establishment of squirrel populations to damaging levels. Habitat management of ground squirrels is an ecologically based method of ground squirrel population control. This method involves breaking the ground squirrel predator-watch system by revegetation of denuded ground, encouraging predation and destroying existing burrow systems.

INTRODUCTION

This paper addresses ground squirrels as burrowing pests on water control structures (e.g. levees and canal banks), but the conclusions are broadly applicable to other ground squirrel problems. Three aspects of ground squirrel management are considered: impact of control practices on wildlife, direct control, and habitat management.

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THE IMPACT OF GROUND SQUIRREL CONTROL ON OTHER WILDLIFE

Enormous amounts of poisonous baits are placed in the environment every year to control vertebrate pests. In 1976 over 800 tons of anticoagulants, Compound 1080, and zinc phosphide were distributed in California for ground squirrel control (Clark 1978). Debates on the impact of these baits on non-target populations have long taken place; however, little hard experimental evidence of these impacts is available. It is extremely difficult to carry out a field experiment that includes the necessary statistical design to effectively demonstrate impacts on non-target species.

Secondary kills occur when a predator dies as a result of feeding on an animal that has consumed poison bait. Elton (1966) emphasized the likelihood of this event when he described the "race for resources between birds and mammals hunting for carrion, insects, and the bacteria of decomposition." Akopyan (1953 cited in Elton 1966) followed the fate of corpses Of 296 ground squirrels in the U.S.S.R. Two thirds of the remains were removed by vertebrates before decomposition.

While the possibility of secondary kills from strychnine and 1080 (both in use today) has been well documented (Environmental Protection Agency 1980), anticoagulants are often assumed safe in this regard. However, Mendenhall and Park (1980) carried out a series of experiments feeding rodents poisoned with six anticoagulants to various owl species. The owls either died or experienced sublethal hemorhaging from four of the six bait types. Savarie et al. (1979), in a similar set of experiments, documented lethal doses of anticoagulant-poisoned rodents to coyotes and various degrees of toxicity in golden eagles. These studies demonstrate that anticoagulant baits have the potential to reduce populations of predatory species of birds and mammals. The extent of field incidence of secondary poisonings and the impact of these poisonings on populations of predatory species remains unknown.

Even materials which clearly have substantial negative impacts on wildlife may take years to remove from the market. Thallium sulfate, introduced into the United States in the late 1920s, is considered by most observers to have a sizeable non-target kill associated with its use (Gratz 1973). In spite of early field observations of this effect (Linsdale 1931), its use as a bait to control vertebrate pests was continued for decades and only suspended in California in 1971.

DIRECT CONTROL

Ground squirrel management by both amateurs and professionals has primarily been approached as a problem of direct control, which means poisoning, trapping, shooting, or any other technique which results in the death or physical removal of animals from the population. This strategy is based on the common assumption that if ground squirrels are causing injury, removing individuals will reduce the injury proportionally. However, the reproductive potential of these animals is so great that so long as the habitat remains unaltered, ground squirrels will reoccupy the same space and return to their former numbers. Although direct control has a role to play in keeping ground squirrels under control, a dependence on animal removal will at best furnish temporary relief; in the long term, these efforts often fail and may even exacerbate the problem.

Fitch (1948) estimated that natural predation on rangeland in the Sierra Nevada foothills removed three ground squirrels per acre per year out of a squirrel population having a potential for annual increase of 5.8 squirrels per acre; roughly one-half of the squirrel "surplus" may have been removed by predation. Dunford (1977) suggested that the absence of predation allowed ground squirrels to reach high densities in his study areas. These studies suggest that predation may effectively reduct the mean densities of squirrels in a given area.

In spite of this evidence for the positive roles of predation in the regulation of ground squirrel numbers, the professional pest control literature often points out that predators do not control ground squirrels, thus implying that human action is needed. However, the direct control exerted by people on squirrel population is also predation. All the arguments applying to natural predation apply here, including the ability of squirrel populations to rebound from the effects of predation.

Predation pressure rarely causes extinction, even of local populations, but other effects of predation are well known. The litter size of a given population is probably partly an expression of predation loss. Like many small mammals, squirrels have the capacity for a rapid response to a drop in their numbers. Degree of embryo resorption (Tomich 1962) and survival, breeding success and dispersal in first-year animals (Slade and Balph 1974) may all vary to increase reproductive output during periods of low population densities. These responses occur whether the population reduction was due to disease, flooding, natural predation or human predation.

Using population models, such as those constructed for coyotes (Connolly and Longhurst 1975) with demographic parameters appropriate to ground squirrels, we have found that a sustained annual removal of 80-90% of the population is necessary to eradicate a population. At removal rates less than this, the squirrel population rapidly replaces lost members. In fact, population health may actually be sustained by the annual removal of a portion of the animals. Even if the 90% level of removal is achieved in a control campaign, continued for two or three seasons, and eradication achieved, emigation of ground squirrels from nearby areas will reoccupy the habitat if it has not been modified.

HABITAT MANAGEMENT

Like every organism, the ground squirrel is adapted to live under a particular set of environmental conditions which fulfill its life needs in accordance with the physical design and behavior of the animal. It is necessary to characterize the nature of ground squirrel habitat requirements in order to discover opportunities to change the habitat and thereby reduce ground squirrel numbers on a permanent basis.

The propensity of California ground squirrels (Spermophilus beecheyi) and their relatives (genera Spermophilus and Cynomys - Hall 1981) to occupy certain environments has long been noted (Linsdale 1946, Owings and Borchert 1975, Daar et al. 1981). Ground squirrel colonies are most likely to be found in areas of open ground or soils where vegetation is greatly reduced during all or part of the year. Ground squirrel habitats may include elevated areas including sloping ground and rock outcrops or logs. Ground squirrel burrows are found in open, cleared areas. Live trapping experiments performed in the spring of 1980 demonstrated that the squirrels are most attracted to open areas. This work was done near flood control levees on Cache Creek, a tributary of the Sacramento River. Traps were set in tall grass beneath walnut trees and in open areas near brush piles. Trapping success was significantly higher in the open-area traps.

Why do ground squirrels prefer open areas? Studies of squirrel behavior and ecology (Balph and Stokes 1963, Owings et al. 1977, Hoogland 1981) have shown that efficient colonial behavior for the purpose of avoiding predation by natural enemies and for controlling the effects of dominant conspecifics requires the high visibility that is provided by a disturbed or open area largely free of vegetation.

The pattern of ground squirrel response to an approaching predator involves three steps: detection, giving a warning signal, and escape to a burrow (Owings et al. 1977). Although there is considerable variation in the likelihood of alarm calling (Sherman 1977), squirrels nonetheless depend heavily on alarm calls for predator avoidance. This is supported by the response of squirrels to alarm calls in playback experiments (Leger and Owings 1979). Many animals watching for predators are much more effective than a single animal (Hoogland 1981). This predator-watch system, requiring the association of number of individuals, works so well that it can be more effective than the strategy of hiding or staying out of sight to avoid being seen by a predator. For this system to operate efficiently the necessity of a clear visual arena to enable an individual to see both predators and conspecifics becomes evident. In order to maintain a line of vision, ground squirrels sometimes will actively cut vegetation, not for food, but to clear visual obstructions (Hoogland 1981).

Besides predation, colonial or semi-colonial rodents must continually be concerned with the invasion into their territory of dominant conspecific animals which threaten to usurp space, mates and destroy young. Observations (Steiner 1972) that young squirrels are most vulnerable to intraspecific attack in dense vegetation underlines the value of a denuded area for squirrel safety and integrity of their social system.

A comparison of two closely related prairie dog species contrasts two different adaptive strategies of predator avoidance in spermophilous rodents (Hoogland 1981). The white-tailed prairie dog (Cynomys leucurus) exists at low population densities in high vegetation and depends more on crypticity for predator avoidance than does the black-tailed prairie dog (C. ludovicianus), which lives in higher densities in environments largely denuded of vegetation and depends on the predator alarm system. The California ground squirrel may have the behavioral flexibility to exist in both environments: where vegetation is high, population densities are kept low; where vegetation is sparse, high densities which permit the function of the predator alarm system are found.

Before making recommendations on how knowledge of the predator-watch lifestyle of ground squirrels can be used to keep ground squirrels in check, I want to address a question sometimes posed when discussing this strategy: Why get involved in squirrel habitat management on levees (for example) when adjacent land use, which may produce abundant squirrel food, cannot be regulated? Areas with agricultural food sources for squirrels provide the most difficult test of ground squirrel control methods. Ground squirrels have a catholic diet, consuming a large range of plant (and some animal) materials (Fitch 1948, Schitoskey and Woodmansee 1978). Some plants are not taken, while others are much preferred. So it is natural that field and orchard crops, because of their abundance, nutrition and ready availability in some seasons, will be utilized by ground squirrels. These readily available food sources may increase the survival of first-year animals and raise the density of ground squirrel populations beyond what it would be without the farmers' crops. Foraging time and effort is better spent in the farmer's field or orchard than in habitats where food is more sparsely distributed.

The critical question for habitat management of ground squirrels in an environment of enriched food supplies then becomes: Can ground squirrels tolerate destruction of their predator-watch social system and maintain their populations in the presence of bountiful food supplies? My supposition, supported by numerous field observations (Vorhies and Taylor 1940, Bond 1945, Linsdale 1946), is that in spite of food availability, vegetation that disrupts the ground squirrel social system will render the habitat unsuitable for ground squirrel occupancy. We are currently engaged in a more rigorous field experiment to test the power of deliberate modification of the vegetation to reduce ground squirrel population levels.

MANAGEMENT RECOMMENDATIONS

Habitat management to reduce ground squirrel populations involves increasing mortality and breaking the predation detection and alarm system. This could be accomplished by encouraging predation pressure, changing the physical form of the habitat, and actively destroying existing burrow systems.

Maintenance of a high level of predation or attempted predation will encourage ground squirrel reliance on the predator detection system requiring denuded soils. The threat of predation may be as important as actual predation in causing squirrels to avoid vegetationally unsuitable habitat. Several approaches may be needed to maximize the impact of predators. Poisonous baits should be used only with extreme care in order to eliminate the secondary kill of predators. Predator control campaigns should be carefully evaluated and regulated. Landowners and others should be educated as to the value of predators in reducing pest rodent populations, and in the intrinsic value of predator populations. Finally, installing raptor perches may be an effective means of heightening raptor pressure on ground squirrels, especially in areas devoid of suitable, natural perches.

The establishment of vegetation to create visual disruption can be accomplished by either encouraging indigenous vegetation or deliberately installing plant species with desirable characteristics (Daar et al. 1981). Exploitation of land by livestock can directly encourage ground squirrel populations (Linsdale 1946 and Daar et al. 1981). The elimination of this influence can allow the recovery of vegetation.

A final tactic of habitat management to be used in conjunction with restoring vegetation and increasing predation pressure is to destroy the burrows of well established squirrel colonies. A ground squirrel burrow system usually exists through many generations. Established burrow systems will be abandoned only with extreme reluctance. Ground squirrels appear to be attracted to holes and cavities in the ground, so unused burrow systems probably are reinhabited easily, while ground squirrels forced to dig new burrows experience high stress and mortality (Dobson 1979). Squirrels should be eliminated and the burrows destroyed; then while new vegetation is being established, the area should be monitored and steps taken to eliminate any immigrants attempting to reopen unused burrows.

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