DECISION-MAKING VARIABLES IN CALIFORNIA GROUND SQUIRREL MANAGEMENT

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ABSTRACT.

Management of California ground squirrels (*Spermophilus beecheyi*) involves a complex of decision-making variables. These variables can be grouped in categories consisting of detection and monitoring, damage assessment, population dynamics, natural history, control options, and future management strategies. An understanding of these variables is essential if biologists are to make logical decisions for preventing or reducing California ground squirrel damage.

INTRODUCTION

When more information is available to the decision-maker, confidence that decisions are both accurate and appropriate is increased. This rule-of-thumb also is applicable to California ground squirrel (*Spermophilus beecheyi)* management. California ground squirrels cause significant damage to agricultural crops and to structures (Jacobsen 1918, Storer 1949, Dana 1962, Ingles 1965:134, Clark 1975:552-1, Cummings and Marsh 1978:253, Marsh and Howard 1979, Salmon 1981, Tomich 1982:203, Salmon and Lickliter 1984:42), and they are the most important sylvatic rodent in plague (*Yersinia pestis*) epidemiology in California (Nelson 1980, Marsh et al. 1981).

Management of California ground squirrels involves a complex of decision-making variables: detection and monitoring, damage assessment, population dynamics, natural history, control options, and future management strategies. These categories can be organized using a flowchart (Figure 1). A decision-maker or manager should analyze all subsystems within this model to arrive at some economic, effective, and environmentally sensitive management strategy to prevent or control California ground squirrel damage. In this paper we review major decision-making variables and identify areas in which there are critical data gaps.

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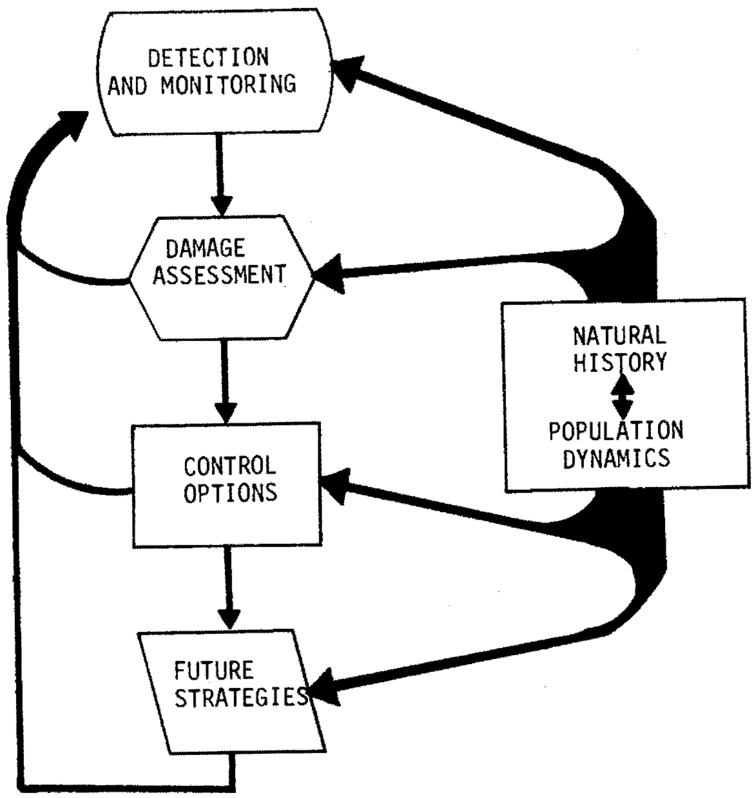

FIGURE 1. Relationships among major decision-making variables for California ground squirrel management.

MAJOR DECISION-MAKING VARIABLES

Detection and Monitoring

Detection is the first step in the decision-making process; correct and timely identification of the species causing damage is an essential first step in any wildlife damage prevention program. Incorrect identification not only results in wasted time and money in controlling the wrong species, but also in further damage by the real pest during the control attempt. Additionally, increased costs to control a larger pest population may be incurred.

Once the potential for damage is recognized, a monitoring program is needed to alert the manager to population buildups or reinvasion. Written records are useful for determining temporal and spatial patterns of damage and population growth. Population monitoring also helps assess the efficacy of control efforts.

Damage Assessment

After California ground squirrels have been identified as the pest species, the next step is to identify the extent and pattern of damage to the particular crop. Economic loss from crop damage is a major part of the cost-benefit analysis. If managers can predict the occurrence and degree of damage, they can plan future investments more effectively and increase the accuracy of the cost-benefit comparison. However, we have few quantitative measures of damage or potential for damage in relation to numbers of ground squirrels, and we do not yet understand how other variables influence damage. These damage patterns are a major data gap (Timm and Johnson 1982:292).

California ground squirrels cause agricultural damage both directly and indirectly. Indirect damage is associated with the burrow systems. Direct damage includes damage to entire plants, damage to only the harvestable portion of plants (the crop or produce), and damage to irrigation pipes caused by gnawing. Both direct and indirect damage may reduce current or future production, and increase harvest or production costs. An important distinction must be made between damage to the harvestable crop (e.g., nuts, sugar beets) and damage which occurs to perennial or long-lived plants (e.g., orchard trees, alfalfa plants), because damage to a plant can also reduce or eliminate future production. Damage caused by loss of future production has not been well quantified (Laidlaw 1982).

Avoidance of California ground squirrel damage requires that a manager be able to predict potential damage to a crop. Effective predictions depend on the recognition of invasion potential or the likelihood that ground squirrels will colonize a crop or nearby area. For a particular crop, invasion and damage potentials are independent of one another and are important concerns in the decision-making process. For example, a ditch bank with ground squirrels adjacent to a mature apricot orchard has a high invasion potential but a low damage potential. Conversely, that same ditch next to an almond orchard again has a high invasion potential and now a high damage potential.

Population Dynamics

A knowledge of seasonal population changes, rates of population growth, and dispersal patterns is a prerequisite to damage prediction (Salmon et al. 1982, Stroud 1982, Holekamp 1984). The selection of an appropriate control method relies upon knowing how a particular population will respond to control methods. For example, what is the population response to control initiated before versus after the spring birth pulse in California ground squirrels? Is control even necessary, given the current population levels, time of year, and potential of surrounding habitat to support high populations? What is the carrying capacity for ground squirrels in the crop and surrounding habitat? We now have a computer model which incorporates many of the dynamical features of California ground squirrel populations (Stroud 1983). With this type of model, one can simulate control decisions and predict potential population responses.

Natural History

Knowledge of the biology of California ground squirrels obviously is important. Breeding chronology, seasonal activity patterns, burrow site selection, food preferences, and taxonomic distinctions are all relevant to decisions made regarding control needs. Murie and Michener (1984) have reviewed many aspects of sciurid biology that may be useful.

Control Options

Once a problem or a potential problem is identified and a decision is made to reduce a California ground squirrel population, a wide variety of control techniques are available. These techniques include exclusion, trapping, shooting, fumigants, acute toxicants, and anticoagulants. All of these techniques can remove ground squirrels. Salmon and Schmidt (1984) provide a review of these techniques.

A ground squirrel control program is effective when it reduces the population below some economic threshold (Keerthisinghe 1984) and maintains it at or below that level. Determining the optimum economic threshold level for vertebrate pests is difficult (Marsh 1982, Timm 1984), especially in comparison with insect pests (Mumford and Norton 1984).

Every control situation requires decisions about which control techniques are likely to be most effective (Salmon and Schmidt 1984). Local environmental conditions, availability and experience of labor, potential hazards, and economic considerations all are important variables. Economic comparisons must include labor and material costs and projected economic losses, both with and without control. These considerations are discussed in more detail in Salmon and Lickliter (1983). Salmon and Schmidt (1984) summarize control options as functions of crop value, squirrel density, and size of control area.

Future Management Strategies

Finally, after control measures have been implemented, or an option of no control has been chosen, future management strategies should be considered. Detection and monitoring become a primary focus, past attempts and results are analyzed, and long-term effects of damage are determined. There are many variables associated with the prevention of California ground squirrel damage. Determining the relative importance of these variables in a particular situation before damage begins will reduce costs and increase effectiveness.

CONCLUDING COMMENTS

Decision-making models can be valuable aids for managing rodent pests. Simple flow-chart models have been published for control of ground squirrels (Salmon 1981) and house mice (*Mus musculus*) (Timm 1979), and a computer model for evaluating pocket gopher (*Geomys bursarius*) control decisions also is available (Case and Timm 1984).

Some of the important variables are difficult to quantify. These include the tolerable mortality of nontarget species (Marsh 1984) and considerations of human ethics regarding consumptive use of wildlife, animal suffering, and environmental values (Schmidt and Bruner 1981, Kellert 1984).

Salmon and Lickliter (1983:18) have argued that no single measure or comparison is adequate in making decisions about the use of control materials. Trade-off considerations are realistic and are to be expected. Additionally, in many problem situations there can be more than one correct decision. Since a decision-maker is responsible for his or her decision, it is important to demonstrate that the decision was the right one in the prevailing circumstances (Williams 1981:2). A detailed understanding of the important decision-making variables is essential if biologists and managers are to make logical decisions regarding an effective program preventing California ground squirrel damage.

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