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March 1976

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OPERATIONAL ASPECTS OF SUCCESSFUL GROUND SQUIRREL CONTROL BY AERIAL APPLICATION OF GRAIN BAIT

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ABSTRACT: By County Ordinance the County Agricultural Commissioner has been charged with rodent suppression in Fresno County, California. For nine years personnel from the Agricultural Commissioner's Office have conducted a county operated and funded program of ground squirrel suppression through the use of aerially applied zinc phosphide treated squirrel oat groats. Planning procedures, relative costs and operational aspects of the program are outlined. This technique of ground squirrel suppression has been shown to have many advantages over hand application of rodent baits. No known hazards to non-target wildlife species have been demonstrated.

By direction of a Fresno County Ordinance, the Agricultural Commissioner is charged with conducting rodent suppression programs. In certain rangeland areas away from water courses and populated areas, the Agricultural Commissioner has elected to broadcast zinc phosphide treated oat groats over and near ground squirrel colonies by aircraft. This method was selected because of the effectiveness of the technique and low cost compared with other suppression methods. It was also determined a safe and effective method of control after studies were conducted by Rex E. Marsh, Specialist, Department of Animal Physiology, University of California, Davis, in 1968; and explored on a limited basis by Howard, et al., in 1956.

Fresno County, comprising some 6,000 square miles, has led the nation's farm counties for over two decades in total gross value of agricultural output. Agriculture is highly diversified, producing over 200 crops in a wide area of the county. Cropland inventory shows 1,178,144 acres in Fresno County. The topography of the county varies widely from very flat lands found on the Westside to the steep slopes found in some of the range areas. Almost every type of soil may be found in Fresno County ranging from clays through sands to coarse sandy loams. Soil depths range from less than one foot to in excess of 50 feet. Water supplies vary widely, depending on the locality.

The lower foothill areas of Fresno County are generally occupied on a year-round basis with the economy based on livestock operations, field crops, citrus, deciduous fruits and nuts, and limited recreational sites. Small commercial enterprises are also located throughout these areas -- often at road intersections.

Vast areas of undeveloped land are found in the lower foothills and the topography varies widely from almost flat or gently rolling slopes to steep sloping hills. Soils of the lower foothills consist of material weathered from several different kinds of rock. Soil depths generally range from one to three feet with the texture ranging from coarse sandy loams to the various clays. Water is in very limited supply throughout most of the area. Vegetation cover consists mostly of annual grasses and forbs with trees and shrubs growing in some places up to, but not including, chaparral and woodland areas. The tree anemone, *Carpenteria californica*, is a relatively rare species which may be found at the upper edges of this area. Valley vegetation consists of annual and perennial grasses, field crops, vines, trees, and shrubs.

Wildlife is found in abundance throughout the county and includes pheasant, mourning dove, meadow lark, woodpecker, scrub jay, red-tailed hawk, golden crown sparrow, flicker, road runner, blue jay, owl, towhee, turkey vulture, blackbird, starling, and many other species of birds. The California condor, peregrine falcon, and southern bald eagle are occasionally reported in Fresno County. These are classified as endangered by the California Department of Fish and Game.

Many mammals are found in Fresno County. Species include cottontail, deer, bobcat, weasel, squirrel, California jack rabbit, bat, pocket gopher, various species of mice, coyote, skunk, raccoon, beaver, opossum, and many others. Some mammals classified as rare or endangered include the spotted bat, *Euderma maculatum*; Fresno kangaroo rat *Dipodomys nitratoides exilis*; and San Joaquin kit fox, *Vulpes macrotus mutica*.

Reptiles are found throughout the county. Various snakes including gopher snake, rattlesnake, king snake and garter snake have been recorded. The giant garter snake, Thamnophis couchi gigas, is a rare species found in Fresno County. Lizards are prevalent throughout the county and the blunt-nosed leopard lizard, Crotaphytus wizlizenii silus, is now classed as endangered.

Ground squirrels, Spermophilus beecheyi fisheri, are a major pest of rangeland in many parts of Fresno County. They compete with livestock for forage and are responsible for substantial losses to cereal and other crops. The magnitude of the problem is exemplified by the fact that in California alone over 5,000,000 acres of range and crop land may be treated annually to suppress ground squirrel populations for economic or public health reasons.

In 1968 it was estimated that ground squirrels cause an annual loss of over eight million dollars to California agriculture through their depredations (Dana, 1971). They are also known as a host for several rodent borne diseases which are transmissible to humans, such as sylvatic plague. Their effect on nests of California valley quail at the San Joaquin Experimental Range was reported by Glading (1938). It was concluded that 30 percent of the unsuccessful nests resulted from ground squirrel depredations.

The use of treated grain bait results in the suppression of ground squirrel populations to a low level in the following areas of concern:

1. Increases agricultural productivity.
2. Allows for more successful nestings by native bird populations.
3. Minimizes the transmittal of rodent borne diseases to humans.
4. Increases food available to other native wildlife species and livestock.

Bait dispersal by aircraft for ground squirrel control coupled with hand baiting operations, both of which are under the supervision of experienced county agricultural inspectors, increases safety to non-target species. The use of zinc phosphide reduces the chance of secondary poisoning of non-target species. Aerial baiting outmodes the recruitment of large seasonal crews to conduct organized county squirrel control programs. The ability of the pilot to distribute bait close enough to the colonies has significant bearing on the success of the control program. Pilot qualifications for aerial application of rodenticides include:

1. Pilot to apply zinc phosphide bait under supervision of staff members of the Fresno County Agricultural Commissioner's Office.
2. Pilot must be familiar with the following:
 - a. Biology and ecology of the California ground squirrel.
 - b. Laws and regulations on the use of rodenticides.
 - c. Control technique, both ground and air, for ground squirrels.
 - d. Safety factors for man, domestic animals, and wildlife.
3. Pilot must pass a field examination to test proficiency in:
 - a. Calibration of aircraft to desired application rate and swath width.
 - b. Field application of clean grain on squirrel habitat.
 - c. The ability to distinguish squirrel burrows from gopher, badger, kangaroo rat, or other rodents.
 - d. The ability to determine and stay within property boundaries.

Ground squirrel baiting by aircraft has a definite advantage over hand baiting for a number of reasons :

1. Larger Treated Area

The average area treated each year by hand over a three-year period was 3-7% of the total acres involved. During these years an attempt was made to treat a solid block area by the hand baiting method. This involved large crews on horseback. Often the timing was off due to the unavailable manpower and the large areas to be covered. Consequently, many areas were not treated. In addition to this problem, the over all fractional coverage left many untreated areas to quickly reinfest the treated areas. Coverage by aircraft has been a minimum of 65.5%, increasing the area that can be covered by 17 times plus -- a substantial gain.

2. Less Cost Per Acre

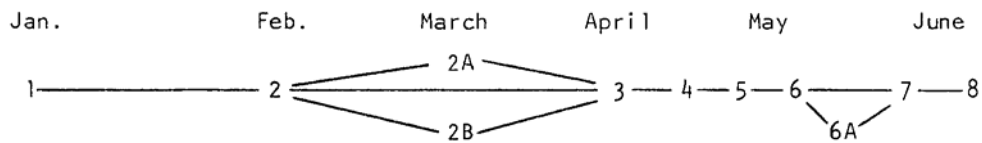
The cost to the county has decreased from 52¢ (per acre (3.7%) by hand or horseback in 1974 to 9¢ by aircraft (65.5%). A factor in this savings is that aerial application is an organized program using less personnel than is required to treat by foot or horseback and does not conflict with other ranch work that often takes priority. Squirrel control work is not postponed by the rancher which causes loss of man hours, travel time, and unnecessary use of equipment.

3. Improved Efficiency

Natural buildup of squirrels is much slower when large block areas are thoroughly treated. The two "rest years" also results in a slower squirrel comeback. Small, isolated, bothersome infestations can be quickly and easily treated with minimum labor. Ground squirrel programs can be planned better to coincide with peak bait acceptance periods. County employees can be used on other programs resulting in further savings.

To determine the target dates for the various activities of the program, a simplified time activity chart (Fig. 1) was established to set the latest allowable dates for the aerial application program. This time period was set between January and June 1975.

One of the important results obtained by using this network plan approach is that it usually results in a more realistic estimate of how long the total project will take. The major tasks are broken into smaller and shorter activities, each of which can be more accurately estimated as to require duration. As an illustration, the entire estimated flying time needed for the project can be determined. Certain variables may be taken into account such as weather, squirrel population, bait acceptance, etc.



1. Get property Print-out from the Assessor
2. Research property Feb. & March.
 - 2A. Type letters before April 1.
 - 2B. Shoot squirrels to determine starting date.
3. Mail letters April 1.
4. Hire pilot before April 15.
5. Post maps from return letters May 1.
6. Mix toxicant starting May 1.
 - 6A. Pre-treatment survey week of May 5. Reports to State & C.F. & G.
7. Start fly on May 12.
8. Post-treatment survey and survey and reports.

Figure 1. Activity chart for aerial control operations on east side of Fresno County in 1975.

The following principal activities were scheduled, in this order:

1. Get county property assessment roll from the Assessor

This computer print-out has all of the names of property owners, parcel numbers, and current addresses in book form. One person may have property in one or more of the book sections. The acreage of the properties is also noted on this print-out. Generally, properties with less than 40 acres are omitted from treatment by aircraft. However, these owners are contacted by inspectors during this time and are offered assistance in controlling their ground squirrels by hand application, if warranted.

2. Research of property, February-March

Often one person owns or controls several properties through leases in the proposed control area. These holdings are posted on a "property list" to be mailed to that person for confirmation or correction. A card file is compiled based on this information and is used as a reference when maps are prepared.

3. Preparation of correspondence

Letters to property owners of 40 acres or more within the area to be treated are prepared for mailing.

4. Collect squirrels to determine starting date

Samples of squirrels are collected by shooting and embryo development is noted. The breeding season varies as much as one month from year to year. Weather and available feed have much to do with this variation. The embryo count helps to determine the amount of toxicant that must be prepared in advance. Usually when young squirrels are six to eight weeks old they will take grain, providing natural grasses have dried.

5. Mail letters - April 1

There are from 600 to 1,000 letters to be mailed depending upon the area to be treated. Individuals are asked to sign and return an enclosed "Consent" form that indicates to us they wish to be omitted, or wish to participate in the program. These letters contain:

- a. Property description for confirmation.
- b. "Consent." This form requires a signature of the person in charge of the property giving the County permission to place treated bait on their property for the purpose of controlling ground squirrels.
- c. A brief description of the toxicant along with an antidote.
- d. The location where the toxic bait can be obtained for hand application.
- e. An addressed envelope for prompt "Consent" return.

6. Hire pilot before April 15

This is done far enough in advance to allow processing of bids through the Purchasing Agent. (Funding is provided by the county through the Agricultural Commissioner's budget as squirrel control is mandated by County Ordinance). The pilot must be licensed by the California Department of Food and Agriculture to qualify to do this type of application. He must also be registered with the Department of Agriculture in the county that requires his services. The aircraft hopper must be of a type that will provide the desired pattern over the colony of ground squirrels to be treated. During this period ranch air strips must be located and permission obtained for their use.

7. Prepare maps from returned letters by May 1

Topographical maps prepared by the U.S. Geological Survey are best suited for this purpose. The details of these maps are very helpful for locating land marks in establishing ranch boundaries. The map sizes are such that the pilot can easily carry them during application. The areas to be treated are usually colored green. When no treatment is requested, or when letters have not been answered, the areas are indicated in red. These maps are thoroughly reviewed by the pilot and the Senior Agricultural Inspector in charge of the project before applying each load.

8. Mix toxicant starting May 1

A tentative amount of toxicant is prepared before actual application begins. This is based in part on the embryo count and past application surveys. Only 1.6% zinc phosphide treated oat groats is used by aerial application. The treated bait is placed in 50 pound bags for convenient handling, and is stored on pallets in a locked warehouse.

9. Pre-treatment survey week of May 5(Predators and other wildlife)

The next step is to conduct bait acceptance tests to make sure squirrels will continue to take the preferred bait after it has been treated with the toxicant. For this purpose a predetermined area is selected in which the approximate number of squirrels is known. In acceptance tests the bait is scattered in a similar manner as is done in the control procedure. If bait acceptance is satisfactory and resulting control is deemed to be satisfactory, control measures are started as soon as possible. Special attention is given to the presence of all non-target wildlife species. Their quantity and general condition is also noted. The general population of mammals is based on actual observations and on the presence of their tracks and skats. Bird species and their numbers are estimated by visual observations.

10. Start the "Fly-on"

The pilot is first oriented to the ranch boundaries by means of the topographical maps and special instructions from time to time at the landing strip. Detailed instructions are given to the pilot on areas not to be treated, i.e., around farm buildings, public roads, streams, water troughs, properties that are excluded by choice, or by neglect to return "Consent," etc.

Ground to air communications are used in all operations to help keep the pilot oriented. A modified seed sowing gate attached below the aircraft is calibrated to apply about 6 pounds per swath acre. This delivers a pattern of an average of 2 - 3 kernels of toxic grain per square foot over a swath of 35 to 40 feet wide. The baits are generally applied from 10:00 A.M. to 4:00 P.M., which is the time of day when squirrels are most active. The grain bait is dropped from a height of about 50 feet and at air speeds of 90 to 95 miles per hour. Grain baits are sufficiently heavy that drift presents no problem with winds not exceeding 15 miles per hour.

11. Post-treatment survey

This survey is necessary to determine the degree of success of the project. The program is not intended to eradicate ground squirrels, but to keep their population at a tolerable level. Thus, the program need be repeated only every third year. Squirrel colonies in the many inaccessible areas are now able to be given special attention. Because of their location, control had never been realized previously and these areas were suspected as being the source for

The survey also determines the impact of zinc phosphide treated baits on non-target species. The general mammal and bird populations are carefully compared with the pre-treatment survey observations. In addition, an intensive search is made for carcasses of the non-target mammals and birds. If any are found, they are sent to the California Department of Food and Agriculture Chemistry Laboratory.

for analysis to determine the cause of death. During the years of aerial application only one brown sparrow was found in 1969. This bird, which was not posted, discovered by personnel of the California Department of Food and Agriculture and the California Department of Fish and Game.

CONCLUSIONS

Bait dispersal by aircraft for ground squirrel control has many decided advantages over hand baiting methods. It outmodes the recruitment of large seasonal crews to conduct organized county squirrel control programs, which is increasingly difficult because of insufficient available labor. Aircraft can cover large areas quickly and easily at the optimum time for achieving maximum control. Aircraft can provide a more thorough coverage by treating remote mountain clearings and steep and rocky canyons which may be nearly inaccessible by horseback. Squirrel populations in such areas have often been overlooked in baiting from horseback, leaving natural rodent reservoirs to reinfest the adjoining range.

Bait dispersal by aircraft for general squirrel control coupled with hand baiting operations, both of which are under the supervision of experienced county agricultural inspectors, increases safety to non-target species.

The use of aircraft to disseminate toxic grain baits for ground squirrel control was studied by Rex E. Marsh, Associate Specialist in Vertebrate Ecology, University of California, for three years (completed in 1968) and on a limited basis by Howard, et al., in 1956. This research proved it was a safe and effective method of control.

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