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## AIRCRAFT AS A MEANS OF BAITING GROUND SQUIRRELS\*

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Aircraft might soon become an important tool for baiting ground squirrels (Citellus beecheyi beecheyi and C. b. fisheri) on California rangeland. Until recently, almost all squirrel control has been conducted by the hand-baiting method, with grain bait scattered from horseback in spoon-size amounts near squirrel burrows.

Ground squirrels are considered a major pest of rangeland in many parts of the West. They not only compete with livestock for forage but also 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 6,000,000 gross acres of range and crop land are treated annually to suppress ground squirrel populations for economic or public-health reasons.

For the past three years, studies have been under way to explore the merits of aircraft for baiting Beechey and Fisher ground squirrels. Last year, in an experimental operation, 150,000 acres of squirrel-infested rangeland were treated in San Luis Obispo County, California, under the supervision of the County Agricultural Commissioner.

The effectiveness of broadcast baiting from the air relies on the natural ability of the squirrels to forage extensively for seed during certain times of the year. The success of aerial baiting depends not only on the voracity of foraging and the distance over which foraging takes place, but also on the availability of natural foods and the amount of vegetative cover. Acceptance of aerial broadcasted toxic grain bait is best after the range forage has dried up, when squirrel activity is maximum and they are feeding nearly exclusively on seeds.

To apply squirrel baits effectively by air, pilots must be trained to recognize squirrel colonies and typical squirrel habitat so that bait can be applied in a short swath (spot broadcasting) close to each colony. Even an experienced pilot may take a while to get the hang of it, but once he becomes proficient he can do an amazingly effective job of baiting. The ability of the pilot to distribute bait close enough to the colonies has a significant bearing on the success of the control operation.

Aircraft has been found to be exceedingly valuable for dispensing squirrel baits (Fig. 1). Several different craft have been used experimentally, including a Snow, Cessna 180, Stearman, Piper Pawnee, and a Bell G-2 helicopter. Most ideally suited to bait application are slower, more maneuverable planes with good forward and downward visibility. The slower planes give the pilot additional reaction time to deposit bait on the desired areas, it is expected that smaller fixed-wing craft will be used to a greater extent, because their operational cost is low. Helicopters have some decided advantages, with their excellent maneuverability and ability to land almost anywhere, but their higher cost of operation may limit their use for squirrel control.

Hopper capacities need not be large (400 to 500 lbs), but the hopper should be scrubbed with detergent and washed out with hot water or steam-cleaned before it is used for squirrel baits. Bait acceptance (and, thus, effective control) may be critically influenced by any contamination of baits with insecticides, fertilizers, herbicides, etc.

The standard gates on many pest-control aircraft need some modifications before they can deliver sufficiently low rates of squirrel bait (crimped oat groats-hulled oats that have been slightly steam rolled). The minimum gate opening to deliver a constant uniform flow of bait has been found to be approximately 1/2 inch, which usually exceeds the desired rate of 6 lbs/acre. Problems of proper bait delivery have been solved by blocking off 1/2 to 3/4 the length of the gate. Modifications have been accomplished by attaching plates to the gate or the hopper, depending on the equipment, to restrict the bait flow. Since the hopper may be opened and closed as frequently as a thousand times to deliver 500 lbs. of bait, spot broadcasting is greatly aided by spring-loaded gates that close automatically when the pilot releases the handle. The linkage to the gate control lever should be snug,

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\*This paper represents only a portion of that which was delivered at the conference. A manuscript elaborating on other aspects of aerial baiting has been submitted elsewhere for publication.

and the stops tight, so that the gate opening will always be precisely the same regardless of the number of times it is opened. Automatic counters, coupled to the release lever, record the number of times the pilot opens the gate. Such counts are especially useful in determining the magnitude of the squirrel infestation.

Since narrow swaths produce effective control with the least amount of bait, swathmasters or other deflecting vanes should be removed to permit the grain bait to drop directly from the hopper into the air stream (Fig. 2 and Table 1). The swath width and bait deposit pattern is determined by the wing vortexes and prop wash. Fig. 3 shows bait deposit profiles for three fixed-wing craft. Hopper agitators tend to break up the bait kernels and are not generally needed for good bait flow.

Table 1. Aircraft used experimentally in aerial applications of bait for ground squirrel control, giving swath widths produced with deflecting vanes removed.

Aircraft	Horse power	Wing span	Width of swath produced
Snow (Ag Commander)	450	38 ft.	45
Bell G-2 (helicopter)	260	-	30
Cessna 180	225	36 ft.	40-45
Stearman	450	33 ft.	43-45
Piper Pawnee	150	36 ft.	34

Applications are best from heights of about 50 ft., above the trees, at air speeds below 90 mph. For reasons of safety, in mountainous terrain the pilot must sometimes fly higher. Experience thus far indicates that early morning is the best time of day to apply the bait. Grain baits are heavy enough that drift is no problem in calm air, but winds of 15 mph or greater greatly decrease the accuracy of bait placement. Invaluable for directing the operation is an assistant on the ground, in radio communication with the pilot (Fig. 4).

With a 34-ft. swath calibrated at 6 lbs/acre, the pilot of a Piper Pawnee can apply, by spot broadcasting, a load of 500 lbs in approximately one hour and ten minutes. Subject to exceptions, approximately 1 to 2 thousand acres of moderately infested rangeland can be treated in one hour. Because of the expense, aircraft will be most economical on ranches of 1,000 acres or more which have a moderate to heavy ground squirrel population. Aircraft for squirrel baiting are hired on an hourly basis, with the cost varying with the type of plane.

When environmental conditions were conducive to excellent bait acceptance, control of ground squirrels on many ranches has been good to excellent (90 percent or better) from crimped oat groats treated with sodium fluoroacetate (compound 1080) at concentrations of 0.056 to 0.113 percent (1 to 2 oz/100 lbs).

Baits of 1080 have been used for developing the aerial technique because 1080 is the most effective acute squirrelicide known and, at the concentrations used, is in general less hazardous to bird life than are squirrel baits containing lethal agents such as strychnine or zinc phosphide. Use of 1080 is restricted by law to certain qualified groups, which places the responsibility for its proper use in aerial baiting in the hands of trained individuals. In California, the laws and regulations governing the use of 1080 and aerial applications of rodenticides provide safeguards against the indiscriminate use of aerial application of ground squirrel baits. The concept of aerial baiting of squirrels will become increasingly valuable as new and more selective rodenticides are developed.

Bait dispersal by air for ground squirrel control has many decided advantages over the hand-baiting methods previously used. It outmodes the recruitment of large seasonal crews to conduct organized county squirrel control programs, which is increasingly difficult because of insufficient available labor. With aircraft control, ranch hands will not have to be taken away from other duties to assist in squirrel control, often at a critical time when cattle roundup or harvesting is in progress. Aircraft can treat large acreages quickly and easily at the optimum time for achieving maximum control. Aircraft can often 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.

With a proficient pilot the use of aircraft for disseminating grain baits to suppress population levels of Beechey and Fisher ground squirrels has proven to be an effective tool under the proper ecological conditions. The technique is now considered to be a significant advance in control methodology and a further use of aircraft in this "fly-on" age of agriculture.

Fig. 3. Swath patterns made by three different aircraft (Piper Pawnee, Snow, and Stearman). Each pattern represents the mean of two individual counts on the same swath. The rates of bait application for the three craft are not the same, with the average number of kernels per square foot indicated at the extreme left. The prop wash causes the deposit pattern to be shifted slightly to the left and increases the density of bait on that side.

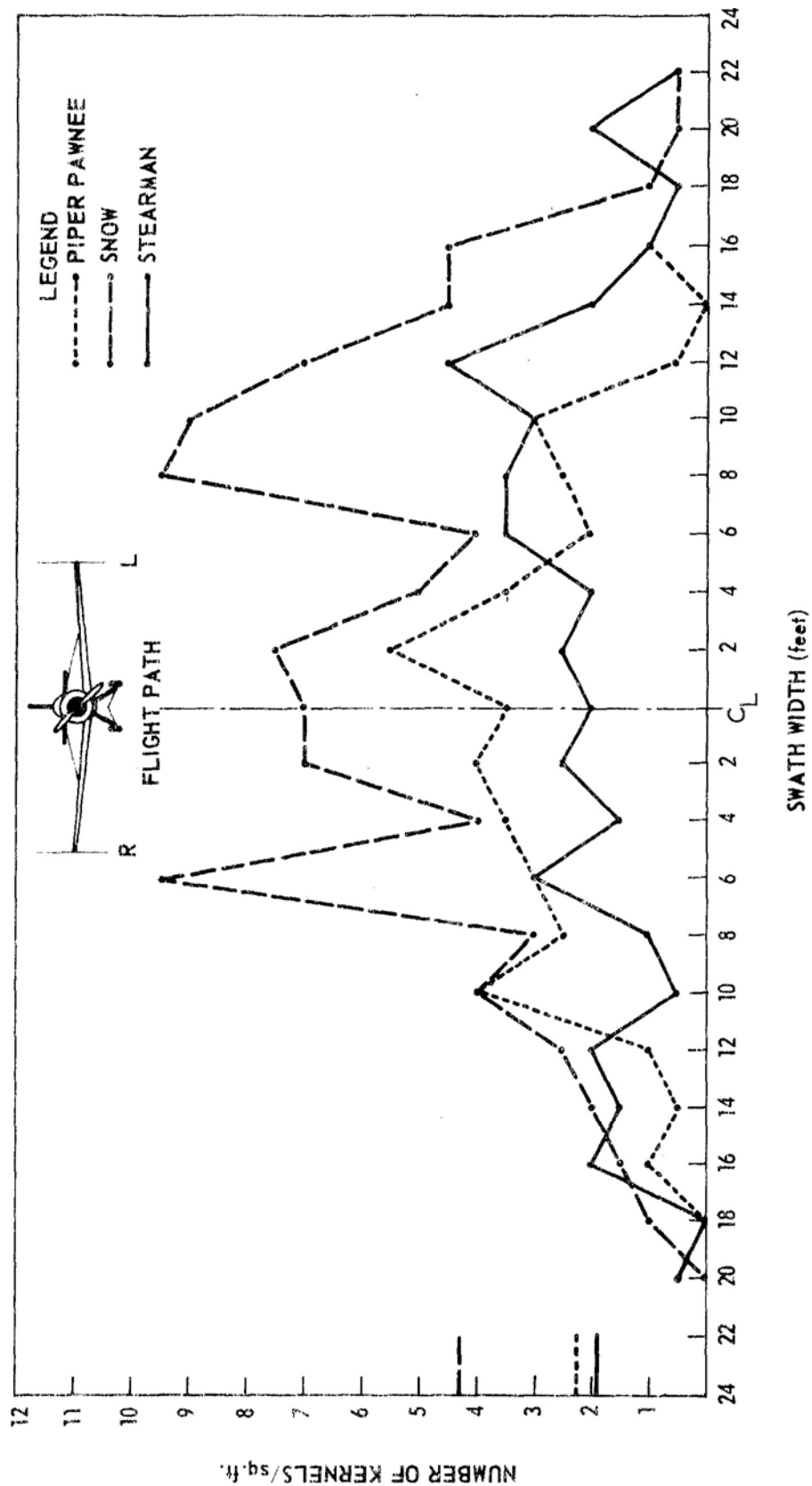




Fig. 1. Rolling rangeland is treated for squirrel control from altitudes of about 50 feet with a Piper Pawnee. Bait is applied on or in the vicinity of each squirrel colony.



Fig. 2. Gate assembly beneath a Stearman is exposed by removal of all deflecting vanes. This permits bait to drop directly from hopper, deliverately creating a narrow swath.



Fig.3. Portable radios used for ground to air communications have proven invaluable for directing the baiting operation