RADIO TELEMETRY - KEY TOOL IN PORCUPINE CONTROL-METHODS RESEARCH

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Abstract: Radio telemetry was selected as a tool to implement a two-year study (1964-66) of porcupine (*Erethizon dorsatum*) on a 4-square mile area in northeastern California. During the period of September 1964 through September 1966, 58 porcupine were ear-tagged, of which 12 males and 8 females were transmitter-tagged. One to seven porcupine with transmitters were afield at once, and were usually monitored 1-4 times per week for a total of 958 animal-days. Twenty-five to 30 percent of the population was immature, about 60 percent was adult, and the balance subadult. No drastic alteration in age class was observed during the 2-year period (Table I). A definite use pattern of habitat-types was displayed from May to December each year. Alfalfa was the primary food from June to September, and some pine trees near the fields also girdled. The maximum known distance traveled from a timber day-roost to alfalfa during one night was less than one mile. Quills and normal body buoyancy permit a porcupine to swim easily, and tagged animals frequently swam the creek on the area. After the first alfalfa freeze in September, the diet altered to inner bark and needles of pine. A gregariousness was first observed in October, and 2-3 were observed in a single tree through December. Single porcupine were observed during the balance of the year. The scrotal testes position was first observed during August 2-10, 1966, and as late as mid-December on four transmitter-tagged adult males. It appeared that lactation occurred in this population from May through August. Juniper "wolf" trees and much-girdled pine were frequented most during colder, stormy periods. The definition of home range, as commonly used, cannot be applied to the porcupine movement patterns observed on the research

area, because no den or focal point activity was identified. High porcupine-use trees near springs, reservoirs, creeks and areas of succulent ground greenery (wet weather drainages) are choice sites for toxicant placement.

INTRODUCTION

Adequate knowledge of porcupine movement and behavioral patterns is essential to the intelligent application of reductional control methods in the northeastern California pine-juniper type to reduce damage by these rodents. Information on their behavioral patterns and daily and seasonal movements has a direct bearing on the distribution and timing of control efforts. The objective of this research project was to examine the environmental parameters, including topographic features, vegetative types, precipitation, temperature, and the physiology (sex, age, and reproductive state) of porcupine, in order to correlate these factors with their movement and behavioral patterns.

Standard marking methods, such as ear-tags and color markings, generally provide only cursory data limited to infrequent accounts of individuals. Radio telemetry equipment, however, permits discreet monitoring of specific animals for prolonged periods of time under varied environmental conditions. Porcupine are basically nocturnal; thus, biotelemetry offered an effective way to monitor their movements during their most active periods.

METHODS AND MATERIALS

Research Area Selection and Description

The specific localities investigated were northern California areas having numerous porcupine, as indicated by U. S. Forest Service kill records. Road counts and night spotlighting in alfalfa fields provided a general indication of the population levels. An adequate road system permitting travel throughout the area was pertinent to site selection, due to telemetry equipment limitations.

A 4-square-mile area was selected, six miles south of Adin, along the extreme northwestern border of Lassen County, California. The predominant vegetative types are cutover timberland, sagebrush flats, and limited cultivated fields--primarily alfalfa. The vegetative cover consisted of juniper (Juniperus occidentalis Hook.), ponderosa pine (Pinus ponderosa Laws.), Jeffrey pine (P. jeffreyi Grev. and Balf.), incense-cedar (Libocedrus decurrens Torr.), white fir (Abies concolor (Gord. and Glend.) Lindl.), and miscellaneous forbs and grasses. Elevation ranges from 4,355 to 5,247 feet. Lava rimrock outcroppings are prevalent on the area, and provide limited shelter for porcupine. Willow Creek flows through the area, providing the primary source of free water. The U. S. Forest Service agreed to refrain from control measures on the area during the research period.

Appreciation is expressed to Kenneth Smith and Ernest Staine of the Modoc National Forest, to the Bureau of Land Management, Redding District, and to Haskell Parks, a rancher at Adin, for their generous assistance with this investigation.

Equipment

Four 3-element, 11-meter antennae (Mosley Electronics, Inc. 4610 N. Lindbergh Blvd., Bridgton, Missouri), were erected as semi-permanent installations on the research area. The antennae were attached vertically (vertical polarization) to 20-foot masts of two 10-foot sections of heavy-wall, metal pipe. Each mast was supported by three guy-wires attached to a slip-collar which permitted antenna rotation. The degree of rotation was indicated on a compass-rose assembly. Azimuths of transmitter-tagged porcupine were obtained at two or more antennae, and plotted on the area map to establish the animal's precise location by triangulation.

In addition, two directional loop antennae were constructed to facilitate animal detection. One was mounted on top of a vehicle; the second was designed for hand-held use in areas inaccessible by vehicle and to help determine the exact location of each animal. The directional capacity was accentuated by adding a 6-inch wire to the directional (hot lead) side of the loop.

The basic unit of the system was a portable, 12-channel, transistorized receiver (S. L. Markusen, Electronics Specialties, Rt. 2, Box 1550, Cloquet, Minnesota) calibrated to receive the six frequencies (30.05,-.06,-.07,-.17, -.18, and -.19 megacycles per second) assigned to the station for experimental use. The transmitter signals were efficiently monitored by the receiver's 0.1 microvolt sensitivity as audible pulsations and microampere meter deflections. A R388, tube-type, 110 volt a-c receiver was secured on loan from the U. S. Army Electronics Command. This unit weighed 75 pounds, and was installed in a vehicle. A 12-volt d-c inverter supplied the 110 volts a-c power for operation. Under all conditions the R388 was more sensitive than the Markusen receiver. Two transceivers (Cadre Industries Corp., Endicott, New York), normally used for voice communication, were modified to substitute as field receivers by adding receiving crystals at the animal transmitter frequencies. The animal transmitter signals registered as static fluctuations because these receivers did not possess a beat frequency oscillator (BFO) in their circuit. This in turn limited signal reception.

The transmitters were constructed on photo-etched component boards, and were powered by 2.7 v.d-c at 0.5 to 8.0 milliamperes drain. All transmitters were of the pulsed, Cochran type, suggested by B. J. Verts (personal communication, 1961-62) as the most functional and practical unit available for this research. Workable transmitter life varied from 25 to 53 days depending on current drain, and battery type and size. Two low-temperature, mercury cells (Mallory, RM3WAT2, 1.4 v.d-c, 2200 milliwatt hours) were substituted for the four Mallory, RMIRT2, 1.35 v.d-c, 1000 milliwatt hour cells. This resulted in longer transmitter operation at lower (0^{o} to 35^{o}F.) temperatures. The weight of transmitter and power package varied from 80-120 grams dependent on the battery type and number used.

All transmitters were encapsulated with General Electric silicone rubber, RTV-602(clear) or RTV-11(opaque). An adhesive-sealant RTV-108 was used to seal the points on the transmitter where the antenna-collar protruded. The encapsulating material provided a moisture-proof seal, and could be removed and reapplied for field transmitter repair or battery replacement. Limited ulceration of the jaws of porcupine occurred in 1965, which was attributed to the transmitter package shape. The abrasions were eliminated by elongating the package.

Flourescent Paint Color Code

A flourescent paint color code was tested to identify individual porcupine under varying light conditions. The code consisted of combinations of stripes, dots, and circles painted on the back and tail, which permitted identification of about 20 animals. It provided spotlight identification for about two weeks, after which time the paint wore off.

Capture Technique

Porcupine were located by spotlight and hand-captured on the ground by the tail-grab method. Animals found in trees were removed by a cage-capture process. This entailed placing a wire-mesh cage between a porcupine and the tree bole, then hazing the animal into the cage by tapping it on the nose with a telescopic pole. The caged porcupine was then lowered to the ground with a light rope.

Each captured porcupine was sexed, aged (immature, subadult, and adult), weighed, and tagged. Aluminum, color-coded sheep ear-tags were used. The colored tags identified each animal as to sex (yellow for female, red for male), and year of first capture. A 1-inch wide band of quills and hair circumventing the neck was sheared from each porcupine to be transmitter-tagged. The transmitter collar-antenna was snugged in place and the joint soldered, which then activated the transmitter. During the period from September 1964 through September 1966, 58 porcupine were ear-tagged, of which 12 males and 8 females were transmitter-tagged. One to seven procupine with transmitters were afield at once, and were usually monitored one to four times per week, for a total of 958 animal-days. Information relating to estrus, parasites, capture and release dates, and location, food habits, distance traveled, transmitter data, etc., was filed on Unisort Analysis cards. This system permits fast and efficient retrieval of detailed information.

RESULTS AND DISCUSSION

Age and Sex Composition

The porcupine population on the study area as determined by tag and release was a minimum of 37 during May through December 1965, although this probably was not the total population. In January 1966 40 Explorer Scouts of Boy Scouts of America, aided in conducting a strip census of the entire research area. Lincoln index calculations indicated approximately 40 porcupine in the area. Known positions of transmitter-tagged porcupine were used to verify census results. Twenty-five to thirty percent of the population was immature, about sixty percent was adult, and the balance, subadult. No drastic alteration in age class was observed during the 2-year period (Table I).

Males were slightly more prevalent than females. A minor sexing error may have existed with the immature age class, because the urogenital orifice of porcupine does not permit sexing by external characteristics. Palpation of the pelvic girdle readily determines the sex by the presence or lack of a baculum, except that it is more difficult with immature animals.

Reproduction Activities

Male and female porcupine, as verified by telemetry, were observed in the same tree on four occasions. In many instances two were seen together, but only the monitored animal's sex could be determined. This gregariousness was first observed in October, and two or three were observed in a single tree through December. Lava ridge tops sparsely covered with juniper and valleys well mantled with pine were most frequented by porcupine during October to December. The movement of eight transmitter-tagged males increased during October, which might be attributed to diet alteration discussed below, and the start of estrus.

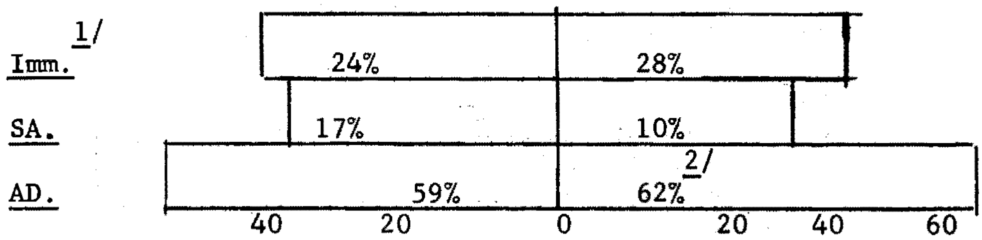
Four males recaptured during the fall were found to have quills impaled on the chest and forelegs resulting from mating activities. The scrotal testes position was first observed during August 2 to 10, 1966, and as late as mid-December on four, transmitter-tagged, adult males. This testes descent from the abdominal position to a scrotal one is a prerequisite for breeding.

Both male and female have obvious mammae. No discernible variance in size or shape was between sexes evident during estrus, except that the brown hair circumventing the mammae darkened and enlarged on females at this time. No readily

Table I. Population Dynamics of the Willow Creek Porcupine Group (January 15, 1965 to August 9, 1966).

AGE COMPOSITION

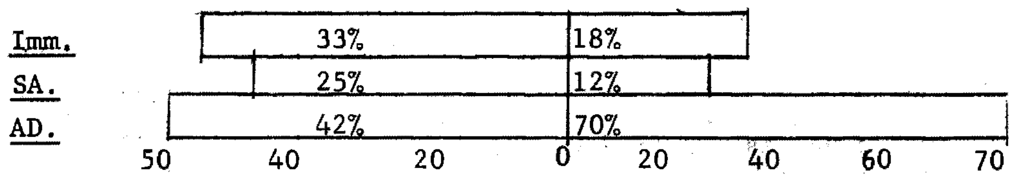
1965 (29 animals) 1966 (53 animals)



Percent of Total Population

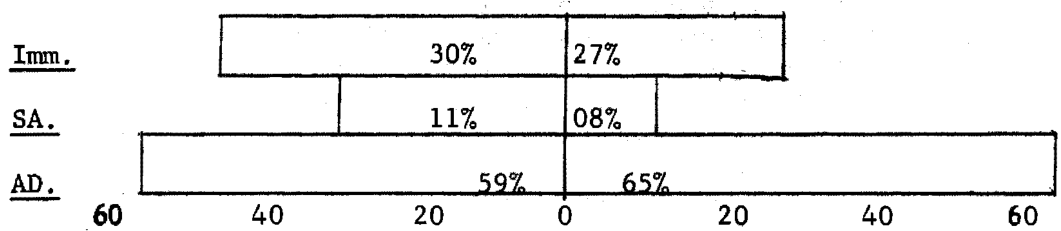
SEX COMPOSITION

Female (12) 1965 Male (17)



SEX COMPOSITION

Female (27) 1966 Male (26)



Percent of total population

1/ Immature: Less than one year old (young of year).
Subadult: Older than one year, but less than two years.
Adult: Older than two years, based on weight and size.

2/ Includes 7 recaptures of animals marked in 1965.

identifiable external characteristics were observed at the female urogenital orifice, which would verify that a female had been bred. Two adult females captured in mid-August 1966, were lactating. It appeared that lactation occurred in this population from May through August. The maximum weight of an adult female with fetus was 28 pounds, and the greatest adult male weights recorded were 30, 30½, and 31 pounds.

Movement Patterns vs. Food Habits

A definite use pattern of habitat-types was displayed from May to December each year. During this period, porcupine almost exclusively used two major vegetative types--alfalfa and timber. Alfalfa was the primary food from June to September, but some pine trees near the fields were also girdled. The porcupine normally traveled nightly from a timber day-roost or creek-bank lair, to feed in alfalfa. The maximum known distance traveled from a timber day-roost to alfalfa during one night was less than one mile. Some individuals remained for weeks in creek thickets adjacent to alfalfa fields. Quills and normal body buoyancy permit a porcupine to swim easily. Monitored individuals frequently traveled across Willow Creek without apparent cause, other than to "get to the other side". Such movements did not appear related to food preference (e.g., pine vs. juniper, alfalfa vs. pine).

After the first alfalfa freeze, the diet consisted of tree materials, principally inner bark and needles. Movement was generally restricted after this occurred, except during estrus. Three porcupines remained continuously in individual pine trees for periods of 3, 7, and 16 days in mid-winter, and needles and inner bark were the only foods eaten during this period. The tops of these three trees had been previously girdled, and it seems probable that such trees are attractive to porcupine. The maximum known distance traveled by a porcupine (adult male) during 19 mid-winter days was 1.7 miles, in a rambling fashion, during which time the diet consisted of pine needles, bark, and juniper "berries".

Relationship of Temperature, Precipitation and Diet to Porcupine Habitat Type Use

Porcupine use of dense willow thickets bordering Willow Creek increased during July to September when temperatures reached 80° to 95°F. Considerable evidence (disturbed soil, quills, hair, and feces) found on "benches" adjacent to the creek indicated extended periods of activity. Various transmitter-tagged procupines were monitored in the willow thickets during the day; however, no girdling or consumption of willow was observed. Increased alfalfa consumption occurred during the same period (Fig. I). Use of willow thickets might indicate that evaporative cooling by flowing water and shade enticed porcupines to reside near the creek and alfalfa.

Minimum temperatures fell from the mid-forties to an average of 29°F. during September 16-20, 1965. That freeze largely destroyed the alfalfa, and may have also destroyed other succulent plants, forcing porcupine to modify their diet. Observation, primarily by spotlighting, indicated that feeding on alfalfa declined sharply from September to October, and feeding on pine increased (Fig. 1). Porcupines observed in trees during May to October normally were located near the trunk and shaded from the sun. As fall temperatures declined, use of arboreal habitats increased, and porcupine could be seen basking in the upper half of trees on the sunny side. This trend continued into winter. Juniper "wolf" trees and much-girdled pine were frequented most during colder, stormy periods. Lava talus slopes were rarely used during any season of the year.

Abnormally heavy precipitation fell during August 1966, but no unusual porcupine activity was observed which might be attributed to the increased rainfall.

Mortality

During one mid-winter observation, monitoring revealed an erratic and weakened signal. The transmitter was located with the hand-loop 25 feet from a dead, adult female porcupine. Fresh coyote scats and tracks were present, but the exact cause of death was not determined because the carcass parts were widely distributed. The coyotes may have been scavengers. The loss of this individual terminated 98 consecutive days of data collection.

Natural mortality appeared to be very limited. Only one carcass was found during the two years which could be attributed to natural causes. The mortality rate among immature porcupine was apparently high (11 during 1966) during alfalfa mowing operations. Some adults were also killed in this manner. Highway kills increased on the portion of road which paralleled the creek. The increase in road kills in 1966 may have been

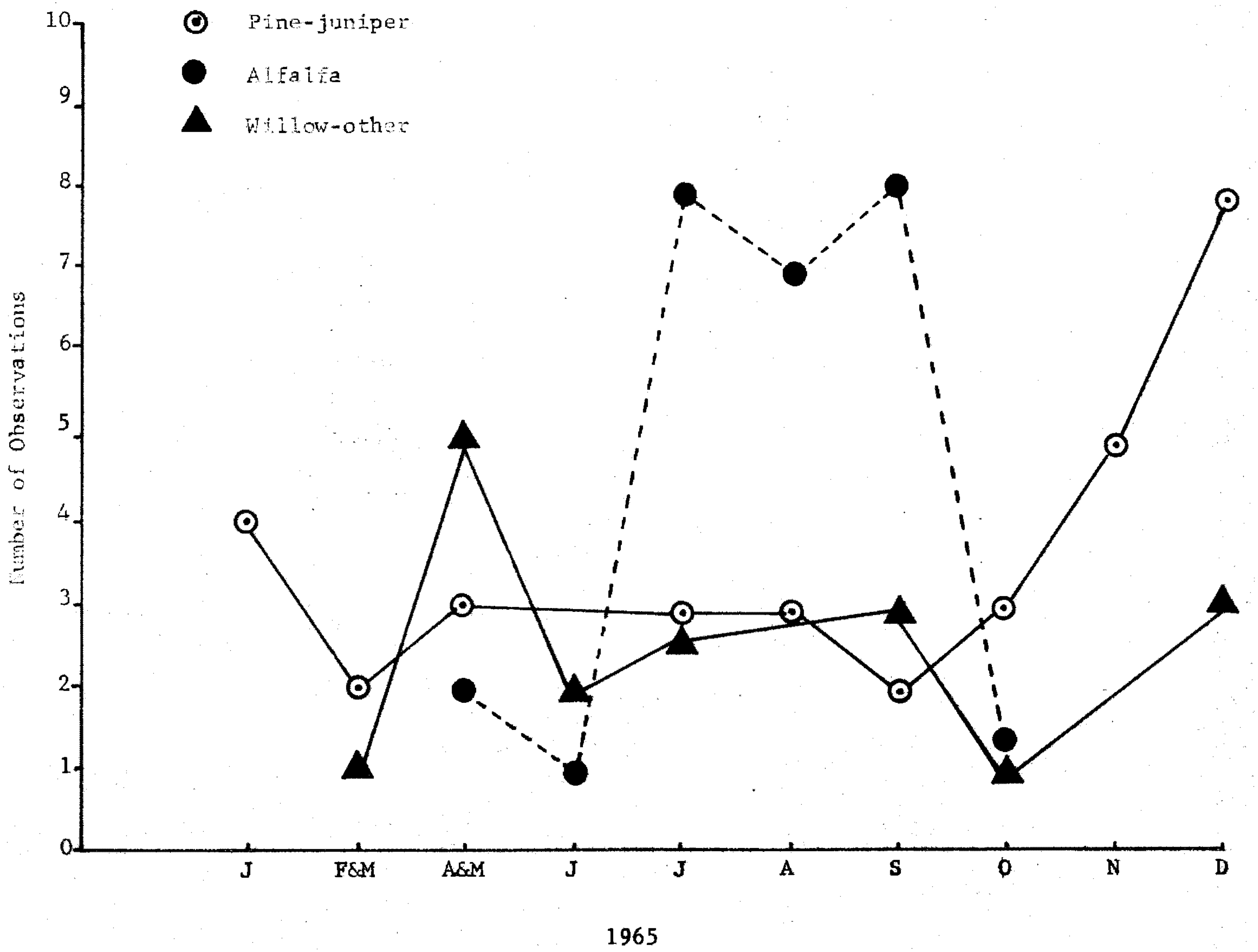


Fig I. Monthly use by porcupine of three habitat types on the Willow Creek research area as determined by biotelemetry.

influenced by severe drought conditions, which may have caused the porcupine to seek alfalfa and water across the highway.

CONCLUSIONS

The definition of home range, as commonly used, cannot be applied to the porcupine movement patterns observed on the Willow Creek area because no den or focal point of activity could be identified. Instead, porcupine appeared to wander, except when influenced by estrus, specific food preference, and temperatures. Movement and activity patterns are most appropriate terms for the mobility exhibited. Definite movement patterns were determined during specific activity periods or habitat use, such as daily movement from a loafing area to alfalfa. These patterns were based on monitoring both sexes for 958 animal days. The habitat types used and the movement patterns displayed were modified after succulent foods froze in late September. At that time there was a transition from an alfalfa diet to pine needles and inner bark. Temperature, vegetative types, and estrus appeared to be closely interrelated because they directly affected porcupine movement. Precipitation, topographic features, and animal age did not appear to limit their movement.

In this terrain, selection of high-use trees ("wolf" juniper and snaggy, girdled pine) for toxicant placement would expose that control measure to the most porcupine. Haphazard placement of toxicants (salt-strychnine blocks) by inexperienced personnel will not provide the desired degree of control, and may result in undesirable public reaction.

High porcupine-use trees near springs, reservoirs, creeks, lakes, and areas of succulent ground greenery (wet-weather drainages) are choice sites for toxicant placement. Wolf-trees on lava rims and ridge-tops typical of northeastern California are used frequently by porcupine during the entire year. Claw marks on lower branches, and fecal accumulation below such trees aid in their identification.

Placement of toxicants in trees afford greater exposure to porcupine than ground stations, where snowfall may inactivate the toxicant for two to six months. Correct tree placement can provide control near public-use areas such as camp grounds and summer resorts, where ground stations are clearly not applicable.