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# AN INTEGRATED PEST MANAGEMENT APPROACH TO ROOF RAT CONTROL IN OCEANFRONT RIPRAP, VENTURA COUNTY, CALIFORNIA

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ABSTRACT: During the summer months of 1979, public agencies in Ventura County received complaints which pointed to a rodent infestation of campground areas along the north coastal strip. Investigations revealed a widespread infestation of oceanfront riprap by roof rats (*Rattus rattus*). Visual surveillance, trapping, baiting and population-estimating techniques and results are described and discussed. Implementation of integrated pest management practices resulted in the reduction of rat populations to a no-complaint level and provided a framework for a long-term maintenance program.

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## INTRODUCTION

The north coastal area of Ventura County in Southern California is a popular area for beach homes, campers, surfers, bicyclists and fishermen. For several miles between the City of Ventura and the county line near Rincon Point, access to the ocean is widely available along the old Pacific Coast highway which served as the main north-south roadway between Ventura and Santa Barbara. Following the construction of a new freeway on right-of-way located farther from the shoreline, the old highway was used primarily for access to beach houses, campgrounds and the ocean while bicyclists enjoyed its relatively uncrowded thoroughfare as part of the coastal bikeway. Where the roadway was separated from the beach by only riprap composed of large rocks, it became popular as an unregulated camping area with ocean frontage. Some of the "campers" developed into semi-permanent residents as they parked their recreational vehicles or converted buses for long periods of time. Two small campgrounds, Hobson County Beach Park and Faria County Beach Park, provided minimal campground facilities for a limited number of visitors on a fee basis. These parks are operated by the County Parks Department which provided on-site park managers and a small concession stand at each park. Located at the southern end of the old highway is a larger beach park which was operated by the State Parks Department.

In 1979, the old highway was reduced to two travel lanes with a designated bike path. The western edge of the roadway, where it was separated from the beach by only a short distance, was lined with parking spaces to serve as a linear "campground" for recreational vehicles which would be assessed user fees in the same manner as the above-mentioned beach parks. Two areas of marked spaces were created in this fashion and together they are referred to as the Rincon Parkway. Revenue from the user fees are utilized to offset the costs for placement and maintenance of trash dumpsters and chemical toilets at intervals along the parkway. A county park ranger patrols and collects fees from the beach parks and parkway users.

As a result of the conversion of unregulated areas to fee areas with restrictions governing the length of visits, all of the former long-term "campers" were displaced from the area. During the first summer of operation as a fee area, the parkway and beach parks became sources of complaints to the Parks Department and the County Environmental Health Department. Users were reporting that the area was infested with rats. Initial discussions between one of the authors (RTS) and the ranger revealed that rodents were a commonplace sight at night along the roadway. Park managers said that rodents were also seen in the two beach parks where they had never seen any rats prior to that summer. The campers reported seeing "small furry animals" at the periphery of campfire areas, and owners of motor homes complained of hearing animals climbing on the undercarriages of the vehicles at night. As a result of the complaints, and at the request of the Parks Department, the Ventura County Environmental Health Department began investigations of the problem in late 1979 and provided limited assistance in correcting the problem over the next 28 months.

Following is a summary of the rodent surveillance and control efforts which were directed to the situation during that period. After identifying the nature and extent of the problem, our intention was to implement integrated pest management techniques to control the problem and to provide an environmentally sound long-term program for keeping rodents below a nuisance threshold. The reader should bear in mind that we are not reporting on a formal study but rather on a practical approach, with limited resources, to an identified nuisance and potential public health problem involving rodent pests.

## METHODS

An initial survey was conducted to determine the location of infestations and which rodent species were involved. The survey consisted of two components: visual surveillance for signs of rodent activity and live-trapping for species identification. Control was attempted using chemical suppression measures and environmental management. In addition, some simple rat feeding studies were carried out.

## Visual surveillance

Following the decision to convert the shoulder of the old coast highway to a fee area, the Department of Parks and Recreation provided designated "campsites" by painting lines to form rectangular blocks along the edge of the old road closest to the ocean. Each site measured 40 feet by 25 feet and was designed to accommodate the parking of recreational vehicles only. The spaces were numbered beginning with the area just south of Hobson County Beach Park and concluding with space number 290 in the area just north of Emma Wood State Beach Park (Figure 1). Two distinct areas of numbered spaces were created, separated from one another by a strip of oceanfront private residences. Area I covered a span of 1.9 miles and included the two small beach parks plus the strip of 199 marked spaces along the parkway between them. Area II began just south of the residential strip and included spaces marked 200 through 290 plus a short strip of unmarked frontage near the south end of the parkway where it reaches Emma Wood State Beach Park. This area covered 1.2 miles of oceanfront roadway. We took advantage of this permanently marked area by deciding to make observations at locations separated by blocks of ten spaces. These 21 sites, together with 2 in Hobson Park and 1 in Faria Park, provided a total of 24 survey locations in Area I. Area II provided 14 sites along the marked spaces and unmarked strip near Emma Wood Park. Two additional locations were selected from the residential strip where two beach access frontages were available. At each of the 40 inspection sites, we spent 2 minutes each searching for rodent droppings or other signs of rodent activity. For each location we recorded the presence or absence of signs, the type of habitat in the immediate search area, food sources in the form of garbage and any unusual harborage conditions.

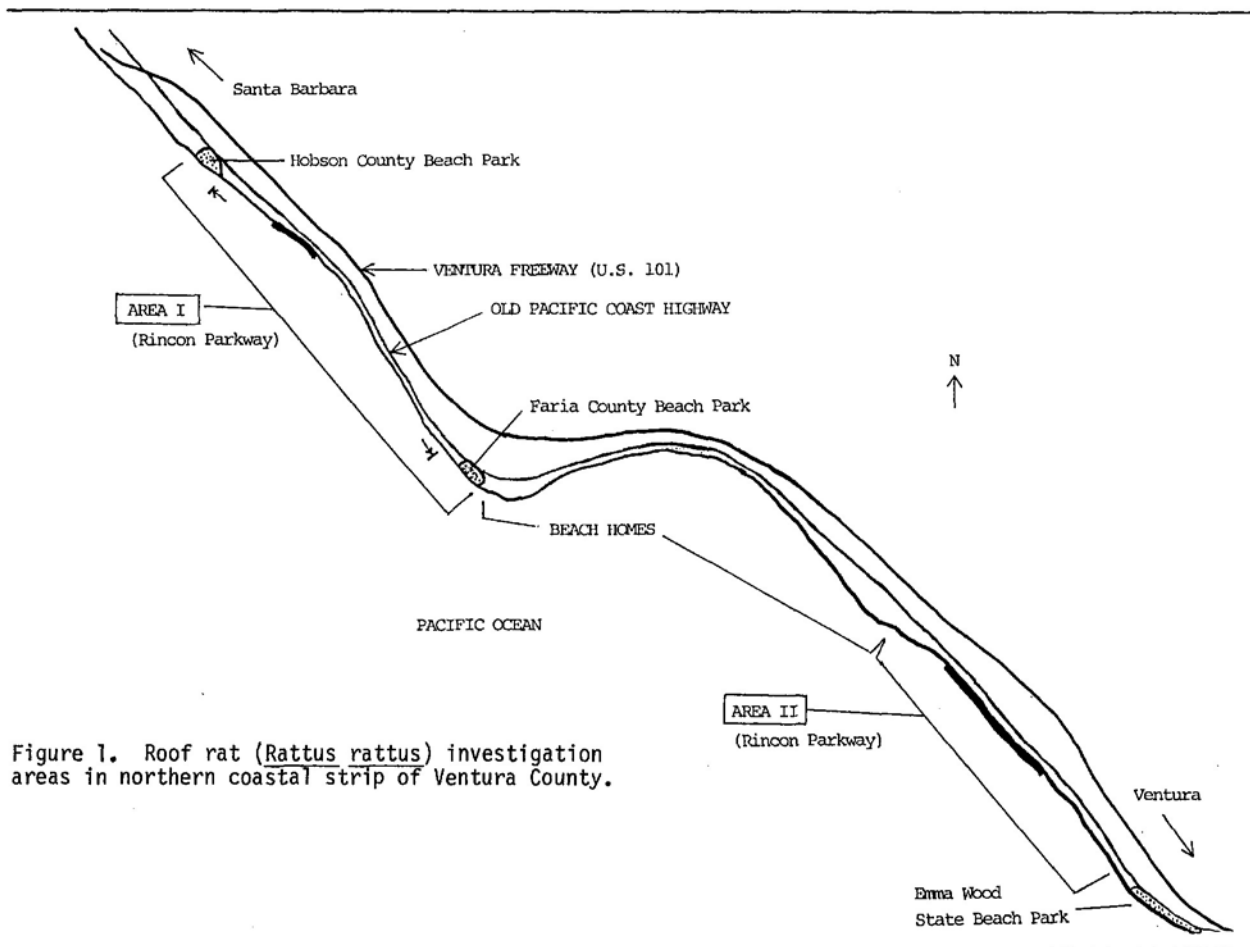


Figure 1. Roof rat (*Rattus rattus*) investigation areas in northern coastal strip of Ventura County.

## Trapping

Trapping was conducted on six separate occasions over a 28-month period in Area I. Initially, a combination of Sherman and Tomahawk #201 traps (15 and 10 respectively) was used. In all subsequent trapping endeavors, the Tomahawk type was used exclusively. Traps were baited with rolled oats, fruit and peanut butter and then selectively placed at locations exhibiting signs of rodent activity or suitable harborage. Traplines were set late in the afternoon and picked up the following morning. The six dates of trapping are included with other information in Table 1.

Table 1. Trapping survey results at Rincon Parkway, Ventura County. (Area I)

Month/Year	No. traps	Capture rate	Animals captured		
			<u>Rattus</u> <u>rattus</u>	<u>Spermophilus</u> <u>beecheyi</u>	<u>Neotoma</u> <u>fuscipes</u>
Nov/79	25	40%	10	-	-
Feb/80	25	28%	5	-	2
Mar/80	25	8%	2	-	-
Oct/80	25	88%	17	4	2
Mar/81	25	20%	4	-	1
Mar/82	32	16%	3	1	1
		<b>Total</b>	<b>41</b>	<b>5</b>	<b>6</b>

### Suppression

Control measures featuring the use of commercially prepared bait blocks (0.0052% conc. diphacinone-treated grain in paraffin) were conducted on two occasions. A "demonstration" program, to establish procedures and guidelines for the Parks Department, was conducted in February 1980 in Area I. A total of 61 baiting sites was established: 15 at Hobson County Beach Park, 10 at Faria County Beach Park and 36 in the riprap area between the two parks. In the latter area, blocks were placed at every fifth marked space in order to make bait available to rodents at 200-foot intervals. Blocks were tied together with stainless steel wires which carried both a station identification number and the manufacturer's poison warning tag. Each set of blocks was lowered into the spaces among the rocks comprising the riprap and positioned to make them inaccessible to children and pets. Plastic flagging secured at the top of the riprap provided a visual clue for quick access to bait locations during bait replenishment visits. Initially, each baiting site was supplied with three blocks weighing approximately 71 grams each. Blocks were checked and replenished every 2 days to insure a constant supply of bait over a 2-week period. During each of these visits, the amount of bait consumed since the last inspection was recorded. At the end of the baiting period, all remaining bait was collected from the 61 sites. Bait consumption at each of the locations was tallied and a total consumption figure calculated for Area I.

Following a resurgence of rat activity during the summer of 1980, a second round of baiting was carried out by the Environmental Health Department under a pay-back agreement with the Parks Department. Baiting procedures and materials were the same as those described above. Placement of bait took place in March of 1981 and, as in 1980, included only Area I. During this period, only the total bait consumption was recorded.

### Environmental Sanitation

In order to reduce the amount of food available to the rodent population in the study area, standard environmental management recommendations for rat control were provided to the Parks Department which held responsibility for the parkway and beach park campgrounds. In particular, the parks personnel were encouraged to provide adequate trash and garbage disposal capability in the form of covered dumpsters in the parks and parkway, and to arrange for timely pickup and disposal. Covers were recommended for the smaller trash receptacles located in the campsites of the two beach campgrounds. On-site park managers were asked to assist by discouraging campers from leaving pet foods exposed and by eliminating rat harborage in the vicinity of their recreational vehicles. Outdoor water faucets were checked for leaks and structural modifications recommended to exclude rodents from entering restroom and shower facilities.

### Caged Rat Feeding Study

In order to estimate the number of rodents killed during the suppression program with, anticoagulant bait blocks, feeding studies were conducted with roof rats caught during live-trapping surveillance along the parkway. Rats collected in 1980 were transported to the facilities in Moorpark where they were individually housed in steel-mesh cages and supplied with bedding, water, and bait blocks as the sole source of food. Animals were checked every 12 hours and a record kept for each rat to show the amount of bait block consumed, the weight of the animal at death and, in half-day increments, the time from feeding commencement to death.

## RESULTS

### Visual Surveillance

During the initial survey in November 1979, we found signs of rat infestations at 96% of the sites in Area I, 36% of those in Area II and one of two locations in the predominantly residential strip between the two parkway areas. Of the 40 sites inspected, 25 (63%) were characterized as riprap habitat, 8 (20%) were associated with concrete seawalls, and 7 (17%) were dirt bluffs with vegetation consisting primarily of introduced iceplant. For the habitat types, 21 (84%) of the riprap, 2 (25%) of the seawall and 5 (71%) of the dirt bluff sites showed signs of rat infestations. Ten (25%) of the sites had garbage and refuse associated with them. Wherever street drainage pipes emerged through the riprap or bluff habitats, we invariably found signs of rat activity in the form of droppings and footprints. The heaviest infestations, based upon the density of droppings observed, were found in the two beach parks located at the north and south ends of Area I. Discarded items such as food cartons and cosmetic tubes often showed evidence of gnawing by rats to reach the residues.

### Trapping

The results of trapping on 6 nights during the 28-month period are presented in Table 1. From a total of 157 traps we recovered 41 root rats (*Rattus rattus*), 5 ground squirrels (*Spermophilus beecheyi*) and 6 dusky-footed wood rats (*Neotoma fuscipes*). The highest rate of capture (88%) was achieved during October of 1980, while the lowest rate (8%) was reached in March of 1980, 1 month after the initial control program using the anticoagulant bait blocks. The two rats caught in March 1980 came from traps set in Faria County Beach Park, within 200 feet of the residential strip adjacent to the southern edge of Area I. The high number of rodents trapped in October 1980 confirmed complaints received during the preceding months that the rat population had become a problem again during the period of high use by summer visitors to the parkway area.

### Suppression

During the initial baiting program conducted in 1980, rodents consumed a total of approximately 18 kilograms of bait blocks. Most of the feeding activity was prevalent during the first 8 days of bait exposure, and after 13 days there was no further feeding activity detected at baiting locations in the riprap adjacent to marked spaces nor in the riprap at Faria County Beach Park. Light feeding by smaller rodents, perhaps mice, continued at one area of Hobson County Beach Park until day 16 of bait exposure. All 61 sites were accounted for in terms of bait and materials.

In March of 1981, rodents consumed bait totaling just over 11 kilograms. The same trends in feeding activity were observed during this baiting period. No further complaints nor sightings of rats by park personnel occurred following this work. Trapping results indicated, however, that the roof rat population persisted at a low density.

### Environmental Management

Following initial suppression of the rodent population with anticoagulant poison in 1980, periodic drive-by inspections by one of us (RTS) were made in the beach parks and along the parkway to assess the effectiveness of park personnel and equipment in providing environmentally sanitary conditions. On several occasions both trash cans and dumpsters were found to be uncovered and overflowing with trash and garbage. Scheduled pickups by the Parks Department provided only short periods of relief to the situation as the very high visitor usage and unauthorized disposal of large refuse items overwhelmed the capability of the system to cope with the problem. Brief inspections along the parkway riprap revealed during the summer of 1980 that considerable amounts of discarded food items were being tossed into the rocky areas.

With the resurgence of rat activity, confirmed by complaints and trapping at the end of the 1980 summer season, our recommendations to increase the efficiency of trash pickup and disposal were followed with the placement of additional dumpsters in the park and parkway areas. Modifications to the pickup schedule were made in order to increase the frequency of pickup during the high-use period of summer and early fall. Subsequent inspections in 1981 and 1982 indicated that an adequate system of garbage pickup and disposal was in operation. There was, however, a continuing problem with uncovered trash containers in the beach parks.

### Caged Rat Feeding Study

The results of bait-block feeding by roof rats held in confinement are summarized in Table 2. Rats which ranged in weight from 80 grams to 195 grams (mean = 145.8 g.) consumed bait in amounts ranging from 105 grams to 270 grams (mean = 161.1 g.). The average consumption of active ingredient (0.0052% diphacinone) per rat was taken from the table values given for individual rats. Using this information, we calculated an estimate for the numbers of rats killed during the baiting programs in 1980 and 1981. This approach suggests that approximately 110 and 70 rats, respectively, were eliminated. The time-to-death for caged rats closely approximated the length of time when active feeding in the field was observed.

Table 2. Anticoagulant bait block feeding by caged roof rats from Rincon Parkway, Ventura County.

Animal no.	Days to death	Bait consumed (g.)	Animal weight at death (g.)	Active Ingredient consumed (mg.)	A.I. per kg. body weight (mg.)
1	8	270	160	14.04	87.75
2	8	150	115	7.80	67.82
3	5	145	195	7.54	38.67
4	6	210	170	10.92	64.24
5	6	195	140	10.14	72.43
6	6	105	85	5.46	64.24
7	8	125	105	6.50	61.90
8	6.5	155	155	8.06	52.00
9	8	130	150	6.76	45.07
10	8	150	145	7.80	53.79
11	7	190	180	9.88	54.89
12	9.5	130	80	6.76	84.50
13	6.5	180	150	9.36	62.40
14	7.5	145	155	7.54	48.65
15	7.5	155	180	8.06	44.78
16	7	175	150	9.10	60.67
17	7.5	125	150	6.50	43.33
18	7	165	135	8.58	63.56
19	7	160	170	8.32	48.94
<b>Total</b>	<b>136.0</b>	<b>3,060</b>	<b>2,770</b>	<b>159.12</b>	<b>1,112.53</b>
<b>Mean</b>	<b>7.2</b>	<b>161</b>	<b>146</b>	<b>8.37</b>	<b>58.55</b>

## DISCUSSION

Roof rat populations are known from a number of habitat types in Ventura County. Residential developments which are older than 15 years often are found to harbor these pests, particularly when the houses were built on or adjacent to former fruit and nut orchards. Outbuildings on older ranches are often infested as are buildings in older urban areas and in one of the port areas on the coast. On large ranches where grain feeds are constantly exposed, roof rats are found in burrows around foundations. The infestation along Rincon Parkway was novel and impressive in terms of adaptation. Roof rats adapted to a habitat which provided very little food outside of the garbage provided by human visitors to the area. In the immediate vicinity of the riprap, we found only a few naturally occurring food sources. Other than a few isopod crustaceans and occasional dead birds on the beach, there were only native plants typical of the coastal sage scrub community. Our trapping experience in the county indicated that this native plant community does not usually provide adequate roof rat habitat.

Although the infestation was investigated primarily because of the nuisance created for the parks, we also were concerned because of the interaction among these domestic rats and native rodent species. Ventura County is one of several counties in California with a history of plague (*Yersinia pestis*) in native rodent populations. The north coastal area lies at the western edge of interconnected hills and mountains where plague-exposed rodents have been collected during the past few years. Native rodents trapped in the parkway carried fleas which are known vector species for plague transmission.

The resurgence of rat activity during 1980 pointed out the importance of subscribing to as many of the integrated pest management practices as are feasible in order to maintain pest numbers below a nuisance threshold. Brooks (1975) states that rat populations reduced 90% by poisoning can multiply to their former level in less than a year. Although baiting at the parkway had reduced rats to very low in early 1980, the failure to fully implement environmental management recommendations allowed the rats to again reach a nuisance level (i.e., complaints) and required additional baiting during the seasonal lull in 1981. Since the changes in trash pickup and disposal were made, no reports of complaints or sightings were received by public agencies. Low-level infestations persisted as indicated by inspections and trappings in 1981 and 1982.

The numbers of rats estimated as killed during the two periods of anticoagulant baiting are probably conservative. Caged rats were observed feeding on bait while the animals were in advanced

stages of poisoning. Their feeble condition would have rendered them incapable of movement from burrow to bait under field conditions. Under the caged conditions, rats probably continued to ingest bait beyond the amount needed to cause death. This is suggested by the amount of active ingredient recorded for each rat in Table 2.

#### LITERATURE CITED

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