PROCEEDINGS

FOURTH
INTERNATIONAL CONFERENCE
ON
WILDLIFE BIOTELEMETRY

AUGUST 22, 23, 24, 1983

APPLIED MICROELECTRONICS INSTITUTE

AND

TECHNICAL UNIVERSITY OF NOVA SCOTIA

HALIFAX, NOVA SCOTIA

CANADA

EDITED BY

DOUGLAS G. PINCOCK

EFFECT OF SIMULATED RADIO-TRANSMITTERS ON CAPTIVE BLACK-TAILED JACK RABBITS

Key words: behavior, black-tailed jack rabbit, effect of transmitter, Lepus californicus, vulnerability to predation

Alice P. Wywialowski and Frederick F. Knowlton, US Fish and Wildlife Service, Predator Ecology and Behavior Project, Utah State University UMC 52, Logan, UT 84322.

Radio-transmitters are commonly used in wildlife research to determine movement patterns of free-ranging wildlife, but the effect of wearing a transmitter on the behavior of a mammal has received little attention in the literature. The effect of transmitters has been studied mainly among game birds, including red grouse, Lagopus lagopus scoticus (Boag 1972, Boag et al. 1973, Lance and Watson 1977); willow grouse, Lagopus lagopus lagopus (Erickstad 1979); spruce grouse, Canachites canadensis (Herzog 1979); pheasants, Phasianus colchicus (Johnson and Berner 1980, Warmer and Etter 1983); woodcock, Scolopax minor (Ramakka 1972); mourning dove, Zenaida macroura (Sayre et al. 1981); wild turkey, Meleagris gallopavo (Nenno and Healy 1979); ducks, Anas, Axis, and Aythya (Greenwood and Sargeant 1973, Gilmer et al. 1974, Perry 1981); and herring gulls, Larus argentatus (Amlaner et al. 1979); and small mammals, Lemmus, Microtus and Peromyscus (Banks et al. 1975, Hamley and Falls 1975, Smith and Whitney 1977). The main transmitter effect noted, if any, was increased grooming or comfort movements by the transmittered animals.

Mech (1967) suggested radio-telemetry as a technique to study predation and it has been used to study mortality patterns of black-tailed jack rabbits, Lepus californicus, (Stoddart 1970), white-tailed deer fawns, Odocoileus virginianus (Cook et al. 1971) snowshoe hares, Lepus americanus (Brand et al. 1975), moose calves, Alces alces (Ballard et al. 1981), and pronghorn fawns, Antilocapra americana (Barrett 1981). In all of the above studies, mortality rates of the collared animals were not considered to be effected by the collar. Warner and Etter (1983) found that survival rate decreased with an increase in the ratio of radio weight to body weight of hen pheasants. Before using telemetry to study movement and mortality patterns of black-tailed jack rabbits, we needed to determine whether the transmitter packages would affect jack rabbit behavior, and whether it would affect its carrier's vulnerability to predation. This study was conducted to determine whether behavior or vulnerability varied between jack rabbits with and without transmitters. Long-term effects of carrying a transmitter were not considered.

METHODS

The study was conducted with simulated radio transmitters in pens at the Predator Ecology and Behavior Research Site (PEBRS) near Millville, Utah. Radio-transmitters were simulated by filling 1.8 x 2.7 x 4.3 cm^3 wooden blocks with molten lead until the block weighed 50 $\pm$ 1 g. Plastic-coated, webbed collar material was attached to the simulated

transmitter with electrical tape.

Black-tailed jack rabbits were captured in Curlew Valley, Utah, or produced in pens from that stock at PEBRS. Vegetation in the pens consisted of short grasses and forbs. Protection from prevailing westerly winds and afternoon sun was provided by 25 shelters of 0.6 x 0.6 m^2 plywood positioned at about a 30-degree angle with the ground. Partial or complete snow cover was present during the study.

In mid-November 1978, jack rabbits living in 2 2-ha pens were captured and placed in holding cages. Distinctive marks for individual recognition were produced with a hair lightner on the jack rabbits. Jack rabbits were held overnight to allow their fur to dry. Half of the jack rabbits from each pen were randomly selected and fitted with simulated transmitters and all were released into their original pens.

Observations were taken from a 9 m tower located in the northeast corner of pen A and southeast corner of pen B. Observations spanned the period when natural lighting was adequate to identify individuals. At 10 minute intervals, the activity of all jack rabbits was recorded for each individual. Categories of activity included directional movement, sitting, grooming, feeding, or other. Directional movement and other were later combined because both activities were uncommon. Observations were grouped by 5-day intervals from the day of release. Observations of jack rabbit activity were stopped before the vulnerability to the coyote phase of the experiment began.

Percentages of each activity for each jack rabbit for each 5-day interval were calculated. RANDTEST was used to test for significant differences in activites between collared and noncollared jack rabbits. RANDTEST is a computer program that performs a randomization test which is similar to a t-test and has its power, but does not require assumptions that the populations sampled are normal nor that the population variances are equal (Green 1977).

During the predation phase of the study, pens were usually checked at least once daily to ascertain the state (presence and dead or alive) of all jack rabbits. Jack rabbits in pen A ($n = 12$) were subject only to natural avian predators. After observations of activity were complete, a captive-reared coyote was placed in pen B with 16 jack rabbits. The coyote remained in the pen until he had killed all jack rabbits.

Cause of death was determined by examining the jack rabbit remains, if present. Avian predator kills were distinguished from mammalian kills by bones stripped of flesh versus body parts that appeared severed without bare bones present. Some jack rabbits could have died and been scavenged by black-billed magpies, Pica pica, but this was unlikely because no jack rabbits appeared unhealthy or lethargic before being found dead. The Wilcoxon rank sum test was used to test for differences between collared and noncollared rabbits in their order of death (Hollander and Wolfe 1973).

RESULTS

Sixty-five observations of activity were recorded for each of 28 rabbits in the first five days of the study for a total of 910 records (Table 1). Overall, a minimum of 11,694 observations of individual rabbits were recorded during the 31 days of behavioral observations. The jackrabbits did not seem to habituate to their collars. Skin irritation from the stiff collar material may have increased comfort movements.

Throughout the study, collared jack rabbits groomed more frequently than noncollared jack rabbits; this difference was usually significant at $P < 0.10$ (Table 1). Also, in days 11-15 after marking noncollared hares sat more than collared. Increased grooming by collared hares seemed to occur at the expense of sitting. Grooming may have been less detectable during the first time period because snow and fog made observations difficult the day after the jack rabbits were released. Minor insignificant differences occurred in the other categories.

During the study, wild avian predators only killed jack rabbits in pen A although they had equal access to the hares in pen B. The pens were the same size (2 ha) and shape (square), and were adjacent to each other. Within pen A, an immature golden eagle, Aquila chrysaetos, struck and killed a collared jack rabbit at 1230 hour on 14 November, 3 days after the jack rabbits had been collared and released in the pen. Although all other kills appeared to be avian caused, actual incidents of predation were not witnessed. Four jack rabbits (3 noncollared and 1

collared) remained in the pen on 12 March when the experiment ended. Only 1 of the first 6 jack rabbits killed was noncollared, leaving only 1 collared jack rabbit with 5 noncollared ones for the remainder of the avian predator kills. The order of death was C C CN C C N N (C = collared, N = noncollared). The absence of a space between letters indicates that order of death was unknown. The distributions of collared and noncollared deaths in time were likely different ($0.071 \leq \underline{P} \leq 0.125$ due to the order of third and fourth deaths being unknown) by the Wilcoxon rank sum test.

Three food deprived coyotes sequentially introduced into pen B were each left in the pen for about 30 minutes. Although they chased the hares, they killed none. Subsequently, one food deprived coyote was left in the pen continuously. The first two days it killed no rabbits. Over the following 2 weeks it killed all 16 rabbits, averaging 1 rabbit per day. From observations of chases by the coyote, he did not appear to be able to kill at will. The rate of killing was not constant, and the order of death was NNC NC C N N N NNCCCCC. Using the Wilcoxon rank sum test, the order of death was not different ($0.052 \leq \underline{P} \leq 0.399$ are possible extreme values due to multiple kills) between collared and noncollared hares.

DISCUSSION

Increased grooming by jack rabbits observed in this study is similar to the increased comfort movements of radio-collared waterfowl

(Greenwood and Sargeant 1973, Gilmer et al. 1974) and herring gulls (Amlaner et al. 1979). Canvasbacks, Aythya valisineria, continued to pull at transmitters attached with a loop harness until they dislodged the unit or died (Perry 1981). Three birds retrapped within 9 days of instrumentation showed weight losses of about 22% of their body weight (Perry 1981). Mobility of collared jack rabbits did not appear to be hindered, nor did they noticeably lose weight. Though stiff plastic-coated collars caused severe skin irritations in this study, later designs had a 2.45 cm flat, nylon, climbing rope for a collar that did not produce skin irritations on either penned or wild jack rabbits. The softer and more pliable climbing rope should have affected behavior less than the stiff plastic used in this study. The importance of using proper material should be a major consideration in collar attachment for other studies.

Vulnerability to avian predators was higher for collared jack rabbits. The order of coyote caused deaths was not different between collared and noncollared rabbits but mulitple kills confounded the results. Survival time of hen pheasants was less for those with higher radio-transmitter to body weight at capture ratios (Warner and Etter 1983). The range of the ratios for hen pheasants was 2.3 to 3.3%. Ratio of the transmitter to body weight of rabbits in this study averaged 2.4%. Future experiments should use a series of choices between collared and noncollared prey for better analysis of results. A larger sample size should also be obtained. Further experimentation in a larger pen with natural vegetation or prey escape areas, and a larger

sample size might give a more definitive answer to the question of differential vulnerability of collared versus noncollared jack rabbits for both mammalian and avian predators in the field.

Acknowledgements.-- R. Burns, S. Cherry, R. Davison, R. Griffiths, T. Knowlton, N. Sayles, B. Steele, C. Stoddart, M. Stoddart and J. McDonald assisted in capturing jack rabbits. Special thanks to M. Collinge, C. Harris and M. Sweeny for help in marking, collaring and checking jack rabbits for wear resulting from collars; and C. Harris and C. Stoddart for help in constructing simulated radio-transmitters. D. R. Anderson and D. L. Turner gave advice for statistical analyses. G. W. Smith, K. P. Reese, and J. R. Cary commented on the manuscript. This project was made possible through funds from the Predator Ecology and Behavior Project of the USDI, Fish and Wildlife Service.

LITERATURE CITED

AMLANER, C. J., JR., R. SIBLY, and MCCLEERY. 1979. Effects of telemetry transmitter weight on breeding success in herring gulls. Int. Conf. Wildl. Biotelem. 2:254-259.

BALLARD, W. B., T. H. SPRAKER, and K. P. TAYLOR. 1981. Causes of neonatal moose calf mortality in south central Alaska. J. Wildl. Manage. 45:335-342.

BANKS, E. M., R. J. BROOKS, AND J. SCHNELL. 1975. A radiotracking study of home range and activity of the brown lemming (Lemmus trimucronatus). J. Mammal. 56:888-901.

BARRETT, M. W. 1981. Environmental characteristics and functional significance of pronghorn fawn bedding sites in Alberta. J. Wildl. Manage. 45:120-131.

BOAG, D. A. 1972. Effect of radio packages on behavior of captive red grouse. J. Wildl. Manage. 36:511-518.

BOAG, D. A., A. WATSON, and R. PARR. 1973. Radio-marking versus back-tabbing red grouse. J. Wildl. Manage. 37:410-412.

BRAND, C.J., R. H. VOWLES, and L. B. KEITH. 1975. Snowshoe hare mortality monitored by telemetry. J. Wildl. Manage. 39:741-747.

COOK, R. S., M. WHITE, D. O. TRAINER, and W. C. GLAZENER. 1971. Mortality of young white-tailed deer fawns in south Texas. J. Wildl. Manage. 35:47-56.

ERIKSTAD, K. E. 1979. Effects of radio packages on reproductive success of willow grouse. J. Wildl. Manage. 43:170-175.

GILMER, D. S., I. J. BALL, L. M. COWARDIN, and J. H. REICHMANN. 1974. Effects of radio packages on wild ducks. J. Wildl. Manage. 38:243-252.

GREEN, B. F. 1977. A practical interactive program for randomization tests of location. Am. Statist. 31:37-39.

GREENWOOD, R. J., and A. B. SARGEANT. 1973. Influence of radio packs on captive mallards and blue-winged teal. J. Wildl. Manage. 37:3-9.

HAMLEY, J. M., and J. B. FALLS. 1975. Reduced activity in transmitter-carrying voles. Can. J. Zool. 53:1476-1478.

HERZOG, P. W. 1979. Effects of radio-marking on behavior, movements, and survival of spruce grouse. J. Wildl. Manage. 43:316-323.

HOLLANDER, M., and D. A. WOLFE. 1973. Nonparametric statistical methods.. John Wiley and Sons, New York, N. Y. 503pp.

JOHNSON, R. N., and A. H. BERNER. 1980. Effects of radio transmitters on released cock pheasants. J. Wildl. Manage. 44:686-689.

LANCE, A. N., and A. WATSON. 1977. Further tests of radio-marking on red grouse. J. Wildl. Manage. 41:579-582.

MECH, L. D. 1967. Telemetry as a technique in the study of predation. J. Wildl. Manage. 31:492-496.

NENNO, E. S., and W. M. HEALY. 1979. Effects of radio packages on behavior of wild turkey hens. J. Wildl. Manage. 43:760-765.

PERRY, M. C. 1981. Abnormal behavior of canvasbacks equipped with radio transmitters. J. Wildl. Manage. 45:786-789.

RAMAKKA, J. M. 1972. Effects of radio-tagging on the breeding behavior of male woodcock. J. Wildl. Manage. 36:1309-1312.

SAYRE, M. W., T. S. BASKETT, and P. B BLENDEN. 1981. Effects of radio-tagging on breeding behavior of mourning doves. J. Wildl. Manage. 45:428-434.

SMITH, H. R., and G. D. WHITNEY. 1977. Intraperitoneal transmitter implants--their biological feasibility for studying small mammals. Int. Conf. Wildl. Biotelem. 1:109-117.

STODDART, L. C. 1970. A telemetric method for detecting animal mortality. J. Wildl. Manage. 34:501-507.

WARNER, R. E., and S. L. ETTER. 1983. Reproduction and survival of radio-marked hen ring-necked pheasants in Illinois. J. Wildl. Manage. 47:369-375.

Table 1. Mean of the percentage of time collared and noncollared jack rabbits spent in four activities by 5-day intervals.

Number of Days After Marking	Number of Observations of Each Jack Rabbit	Treatment[a]	Number of Jack Rabbits	Percent of Time			
				Sitting	Grooming	Feeding	Other
1-5	65	C	14	79	10*[b]	5	6
		N	14	82	7	4	7
6-10	124	C	13	80	9	7	4
		N	14	81	7	6	6
11-15	94	C	12	72**[c]	13**	6	9
		N	14	77	9	7	7
16-20	36	C	12	83	7**	5	5
		N	14	86	3	4	7
21-25	69	C	12	81	7	5	7
		N	14	84	5	4	7
26-31	52	C	12	69	15*	9	7
		N	14	73	9	7	11

[a] C = collared, N = noncollared

[b] * = 0.05 p 0.1

[c] ** = p 0.05