SAN DIEGO COYOTE STUDY: DEVELOPMENT OF A COYOTE POPULATION DYNAMICS MODEL

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Abstract. Since the intensive trapping program (1966-1970) maintained in San Diego County for the removal of rabies vector species, information has been desired by wildlife agencies to assess vector species population-levels for future assistance in predator management programs. The objectives for the development of a coyote population dynamics model are discussed. These include: a census method, population structure determination and an estimation of movement and activity parameters. Four telemetry systems were evaluated for their use in wildlife studies with special reference to coyote investigations.

INTRODUCTION

The occurrence of rabies in the wildlife of San Diego County reached epizootic proportions in 1966, when 55 animals were diagnosed as rabid. The incidence of rabies in wildlife decreased to 24 reported cases in 1967, 5 positive cases in 1968, 6 positive cases in 1969, 2 positive cases in 1970 and 4 cases in 1971. To combat this disease and prevent further spread of the infection, the United States Department of Interior, Bureau of Sport Fisheries and Wildlife was contracted by San Diego County to effect a predator removal program in 1966. A summary of wildlife vector species trapped and clinically analyzed for rabies in San Diego County, 1966-1969 (Table 1), indicates coyotes as the predominate species removed, yet incidence of rabies in coyotes was the least of the four target species removed. This discrepency initiated investigation by local humane groups and trapping was discontinued July 1, 1970.

Subsequent to these investigations, a study was initiated by the Bureau of Ecology at San Diego State College to determine the effects of the disease and the predator removal program on the local populations of predators in San Diego County. Thus far, only one species, the coyote (Canis latrans) has been extensively studied. Currently data is collected on the population dynamics of this species with the proposed completion, expected by January 1973.

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MATERIALS AND METHODS

The San Diego Coyote Study was undertaken in March 1971, to develop field techniques for the live, unharmed capture of coyotes to be marked and released, and to determine some method for accurately estimating densities of coyote populations based on trap-line yields.

A survey of capture methods included steel traps with offset jaws: with burlap padding, with rubber padding and without padding. The relative efficiency of several types of trap sets was quantified into the average number of trap nights per coyote captured for each particular type of trap set. Different baits were compared as well as blind (trail) sets. This information was collected over four months; traps were maintained for a total of 3,158 trap nights. A total of 26 coyotes were captured with 2 coyotes being recaptured, once each, leaving a net total of 24 coyotes captured for the first time.

Body measurements were recorded for each coyote captured and these included weight, maximum width of the zygomatic arch, maximum width of the upper canines, maximum width between the nostrils, skull length, hind foot length and ear length.

Four telemetry systems were evaluated for their application and use with the current coyote study. These systems were compared to determine the optimum system available for use in the local coastal-sage chaparral community. One coyote was released with a transmitter on January 20, 1972 and his movement and activity has been recorded.

RESULTS

The results of the most humane and efficient mode of capture studies indicated reduced foot damage with traps padded with rubber weather stripping as compared to unpadded traps or traps padded with burlap. The cuts on the foot were reduced from an average of 5.3 cm long for unpadded traps to 2.0 cm for burlap-padded traps to a low 0.8 cm long for rubber-padded traps.

The relative efficiency of baited traps as compared to unbaited or blind trap sets indicated the efficiency of capture by baited trap stations was inversely proportional to the length of time the traps were maintained. Blind (trail) sets showed a consistent take for each of the four months during the trapping program. The average number of trap nights per coyote captured was 164 for coyote-urine sets, 156.4 for putrified coyote-gland (stink-bait) sets and 83.5 for blind sets.

The body measurements which were collected from each coyote captured, indicated some correlation between these parameters and the age of the coyote. The determination of an accurate aging method for live coyotes would be useful for the prediction of the direction of changes in population size in a given area.

The movement and activity of coyotes were most effectively monitored with the use of telemetry equipment. The home range and dispersal patterns for coyotes are essential in estimating an ecologically relevant coyote density. Further study on a coyote census method has shown the significance of parameters, such as the population structure, where a necessary element is accurate aging of live coyotes. Other factors affecting coyote density are recruitment and mortality within the population. These parameters can be quantified more precisely in conjunction with a telemetry study of day-to-day movement than by any other method.

- SIDE A -

SPECIMEN RECORD CARD

COLLECTOR [ ][ ] 1 2 | LINE NO. [ ][ ][ ] 3 4 5 | MO. [ ][ ] 6 7 | DAY [ ][ ] 8 9 | YR. [ ][ ] 10 11 | ANIMAL NO. [ ][ ][ ] 12 13 14

(15) SOURCE
1 [ ] Jaw Trap
2 [ ] Box Trap
3 [ ] ....Trap
4 [ ] Shot
5 [ ] Found Dead
6 [ ] Road Kill
7 [ ] Unknown
8 [ ] ....
9 [ ] Lab Subm.
(SEE OVER)

(17) TRAP BAIT
1 [ ] Urine
2 [ ] Gland
3 [ ] Egg
4 [ ] Fish
5 [ ] Pet Food
6 [ ] Fetid
7 [ ] Other:
....

(19) SPECIES
1 [ ] Coyote
2 [ ] Bobcat
3 [ ] Gray Fox
4 [ ] Strip. Sknk.
5 [ ] Spot. Sknk.
6 [ ] Badger
7 [ ] Opossum
8 [ ] Raccoon
9 [ ] ....

(21) DISPOSAL
1 [ ] Removed
2 [ ] Released
3 [ ] Tagged
4 [ ] Recapture

TAG NO. [ ][ ][ ][ ] 23 26

(28) AGE
1 [ ] Unweaned
2 [ ] Young
3 [ ] Adult
4 [ ] Old
5 [ ] Unkn.

(30) SEX
1 [ ] Male
2 [ ] Female
3 [ ] Unkn.

(31) REPROD. STATUS
(MALES)
1 [ ] Testes Develp.
2 [ ] Testes Regres.
3 [ ] Unkn.
(FEMALES)
4 [ ] Eosterus
5 [ ] Embryos
6 [ ] Resorbtion
7 [ ] Lactating
8 [ ] Unkn.

EMBRYO NO. [ ] 33

OVER

- SIDE B -

LABORATORY DIAGNOSIS

LAB NO. (35 TO 40)

WEIGHT (Lbs) [ ][ ][•][ ] 42 45

(47) RABIES TEST
1 [ ] Flur. Antbdy.
2 [ ] Mse. Inoc.
3 [ ] Negri Bdy.

(49) DIAGNOSIS
1 [ ] Positive
2 [ ] Negative
3 [ ] Not Done

ADDITIONAL INFORMATION

LOCALITY: ....

T.S. [ ][ ] 51 | R.E. [ ][ ] 54 | SEC. [ ][ ] 57 | ELE. [ ][ ][ ][ ] 60 63

(65) SOURCE (Lab. Sbm.)
1 [ ] Found Dead
2 [ ] Dead on Rd.
3 [ ] Shot
4 [ ] Trapped
5 [ ] ....

(67) CONTACTS
1 [ ] Multiple
2 [ ] Human
3 [ ] Dog
4 [ ] Cat
5 [ ] Livestock
6 [ ] ....
7 [ ] Unkn.

LAB SUBMISSIONS

NAME ....

ADDRESS ....

....

TELEPHONE ....

Field Records (completed by trappers)

TRAPLINE RECORD

COLLECTOR [ ][ ] 1 2 | LINE NO. [ ][ ][ ] 3 4 5 | MON. [ ][ ] 6 7 | DAY [ ][ ] 8 9 | YR. [ ][ ] 10 11

(13) TYPE
1 [ ] Rabies Control
2 [ ] Livestock Prot.
3 [ ] Combination
4 [ ] Pop. Status
5 [ ] ....

No. Box Traps [ ][ ] 15 16
No. Jaw Traps [ ][ ] 17 18
No. other [ ][ ] 19 20
....

NO.	BAIT
[ ][ ] 22	Urine
[ ][ ] 25	Gland
[ ][ ] 28	Egg
[ ][ ] 31	Fish
[ ][ ] 34	Food
[ ][ ] 37	Fetid
[ ][ ] 40	....

LENGTH (Mi) [ ][ ][•][ ] 42 45

DAYS IN USE [ ][ ][ ] 52 54

MILES ADDED [ ][ ][•][ ] 47 50

HOURS SPENT [ ][ ][•][ ] 56 59

LOCATION .... VEGETATION ....

T. S. [ ][ ] 61 | R.E. [ ][ ] 64 | SECS. [ ][ ] 67 [ ][ ] 69 [ ][ ] 71 [ ][ ] 73 [ ][ ] 75 [ ][ ] 77 [ ][ ] 79

Figure 1. Recommended data format for field and laboratory records of rabies vectors in computer-compatible numerical coding.

The "coyote population dynamics model" would employ a semi-annual trapping effort with a standardized trapline (25 traps set at 0.3 to 0.5 mile intervals for a total length of not less than 7.5 miles, nor greater than 12.5 miles) operated for two to three weeks to assess breeding and post-whelping coyote populations. During these trapping efforts, telemetry transmitters would be attached to coyotes released, and estimates then made for home range, dispersal (immigration and emigration), recruitment and mortality. Combining the data gathered from the trapping and telemetry efforts, an accurate estimation of the coyote population for a given area could be determined to validate the basic model. One validation with trapping and telemetry data per major ecosystem should provide reliable population parameters specific for a given biome.

Preliminary investigations on Camp Elliott, San Diego County, have shown the coyote population in this area to be essentially the same during the removal trapping program (1969-1970) as found during the current study (1971-1972). Thus, a preliminary indication is that any reduction in density of this species can be regained after one breeding season. Manipulation of the coyote density model indicated that the density on this study area could lie between 0.75 and 2.2 coyotes per square mile, depending upon verification of assumed coyote home ranges for this type of habitat.

Subsequent to these preliminary investigations and based upon the necessity of telemetry data concerning movement and activity parameters for coyotes, an evaluation of telemetry systems was conducted to determine the system most suitable for use on coyotes. Evaluation of the four telemetry systems tested, primarily considered: range of the transmitters as a function of terrain, directional characteristics and angular resolution. Upon completion of these tests, the systems were evaluated as to their practical application in wildlife investigations based upon current knowledge of the species movement and their native habitat.

The results indicated rapid attenuation of signal strength for the high-frequency (150 MHz) transmitter when transmission was obstructed by foliage or other natural obstructions. The range of the low-frequency (11 m) transmitters was similar for the three tested when differences due to power output were calibrated. The attenuation of signal strength amounted to an average loss of 35.6% (range 38.0 - 31.9%) for the low-frequency transmitters, when transmission was compared over natural obstructions to line of sight transmission at ground level.

The FR-206 receiver, manufactured by Ocean Applied Research, San Diego, California, showed an angular resolution dependent upon the distance from the transmitter and capable of determining the direction and approximate distance from one fix on the transmitter signal. Ocean Applied Research also manufactures a visual display receiver which produced similar results. The Johnson Messenger 350 receiver also had an angular resolution dependent upon the distance from the transmitter, but was not capable of determining the absolute direction of the transmitter. It was found that a minimum of two fixes on the transmitter signal were necessary before the location of the transmitter could be determined using the Johnson Messenger 350 receiver.

Based upon the results of this study and data collected on the first coyote released with a transmitter, the most appropriate telemetry system for use on coyotes would be the 250 milliwatt, 11 m transmitter manufactured by Ocean Applied Research. The increased power output of this transmitter is necessary to effectively increase the range, so that a minimum amount of time be spent in locating the tagged animal. This was substantiated by the 3.6 miles of movement recorded in the first two days on the transmitter-tagged coyote released on Camp Elliott, January 20, 1972. Monitoring the coyotes' movements can be done most efficiently with the Ocean Applied Research, FR-206 portable receiver, which may be used as a mobile or hand-held receiver, when manual tracking by foot becomes necessary to pinpoint precise animal locations. Fast-moving animals can be located by one fix with this receiver.

DISCUSSION

The followup of any intensive predator removal program is recommended to assess the impact on the populations of vector species around the established primary foci. The animals trapped should have as complete an autopsy analysis performed as feasible. This is not only for basic data on the ecology of rabies, but also for the monitoring of other zoonoses.

Table 1. Summary of wildlife vector species trapped and clinically analyzed for rabies in San Diego County, 1966-1969. Data from County Veterinarian's Office.

Species	Year	Number Trapped	Number Analyzed	#Analyzed/ # Trapped	Number Positive Rabies	# Positive/ # Analyzed	# Positive/ # Trapped	68-69 State Incidence[4]
Coyote (*Canis latrans*)	1966	545	31	5.6%	3	9.6%	0.5%	
	1967	1,931	26	1.3	3	11.5	0.1	
	1968	980	11	1.1	0	0.0	0.0	
	1969	856	14	1.6	2	14.2	0.2	
	Total	4,042	82	2.0	8	9.7	0.1	0.5%
Bobcat (*Lynx rufus*)	1966	142	32	22.5	10	31.2	7.0	
	1967	600	20	3.3	8	40.0	1.3	
	1968	219	6	2.7	2	33.3	0.9	
	1969	111	21	18.9	3	14.2	2.7'	
	Total	1,072	79	7.3	23	29.1	2.1	1.0
Grey Fox (*Urocyon cinereoargentius*)	1966	207	72	34.7	38	52.7	18.3	
	1967	366	30	8.1	7	23.3	1.9	
	1968	84	25	29.7	2	8.0	2.3	
	1969	12	7	58.3	0	0.0	0.0	
	Total	669	134	20.0	47	35.0	7.0	2.0
Skunks (*Mephitis mephitis* and *Spilogale putorius*)	1966	81	29	35.8	4	13.7	4.9	
	1967	302	29	9.6	2	6.8	0.6	
	1968	209	27	12.9	1	3.7	0.4	
	1969	136	33	24.2	0	0.0	0.0	
	Total	728	118	16.2	7	5.9	0.9	80.0
Opossum (*Didelphis marsupialis*)	All	53[1]	0	---	--[2]	---	---	---
Raccoon (*Procyon lotor*)	All	14[1]	0	---	--[2]	---	---	---
Badger (*Taxidea taxus*)	All	10[1]	0	---	--[2]	---	---	---
Mountain Lion (*Felis concolor*)	All	1[1]	0	---	--[2]	---	---	---
Miscellaneous	All	111	---	---	2[3]		---	---
GRAND TOTAL		6,700	413	6.2%	90	21.8%	1.3%	---

[1] Data for FY '67 and '68 only, included in miscellaneous for '66 and '69.
[2] Released after capture.
[3] Bats in 1967.
[4] Breakdown of positive cases only: that is, 80% of positive cases in the state, 1968-1969, were skunks. Data to analyze state breakdown by actual incidence not immediately available.

Data on the population dynamics and ecology of coyotes could easily be obtained during any trapping program. Standard information such as the date, location, and number of trap-nights should be kept on all trapping activities as well as other species-specific information. A proposed record card for each animal captured as well as a card for each trap-line is illustrated in Figure 1. These data can then be used to accurately assess population trends in carnivore communities.

Since rabies is predominately a disease of carnivorous predators, immediate research is needed on the principal vector species to determine the population dynamics and natural history of these species so that accurate predictions can be made concerning their probable involvement in a rabies epizootic. Movement and activity parameters are essential for these species, so that foci areas of removal trapping can be precisely designated. These parameters are essential to predict the possible spread of an endemic rabies outbreak and to confine the disease in as small an area as possible. The inter-species relationships among these predators is also needed to determine contact between species and help resolve the ecology and epidemiology of this disease.

The objectives of the San Diego Coyote Study will meet these needs for one species, the coyote. This study is presently planning an intensive telemetry study on coyotes to implement and validate the proposed coyote population dynamics model. This model will include: determination of a census method, determination of the population structure and determination of movement and activity parameters as functions of sex, age, time of year and habitat.

Upon completion of these objectives, trapping records for past years may be looked into and accurate estimates made for the population densities of coyotes captured during previous trapping programs. By this method, some estimation as to the role of the coyote in the ecological balance of nature may be determined and wildlife agencies involved can make educated decisions concerning coyote management.

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