POPULATION ESTIMATE OF MULE DEER AND MOUNTIAN LION EVALUATION IN BOULDER COUNTY, 1990.

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SUMMARY

This report presents current data on the study conducted Spring, 1990. Using the Lincoln-Peterson estimate, the mean population was calculated at 1319 with a standard error of 132.7 and a 95% confidence interval of 1319 plus or minus 260 or 1059-1579.
In comparison from 1983 to present there has been a general increase in population with small decreases in 1987 and 1989.

In evaluation of the Lincoln-Peterson, less than 5% of the deer population was marked indicating possible inaccurate estimation, but because our intention was for population estimates and trends, exact numbers were not necessary.

Based on re-observations over the period from 1983- 1989, it looks as if most of the animals remained in the general vicinity from which they were originally trapped and marked. As the deer population increases and as human tolerance increases, it is my belief that there will be an increase in residential use of the deer, as well as, the distinct possibility that the mountain lion will follow.

INTRODUCTION

Accurate estimates of wildlife population are a major objective of most management programs(City of Boulder, 1987). The City of Boulder Parks and Open Space personnel have been engaged in one such study pertaining to the movement of the mule deer in Boulder county. Beginning in 1983 a study was introduced because of an apparent increase in the number of deer moving into the city. This movement resulted in damage to a number of residential homes as well as, an increase in deer-vehicle collisions. In 1984 it was determined to continue and expand the study with focus on long-term trends and management options(City of Boulder, 1987).

The deer population was estimated using the Lincoln-Peterson method which is a long established mark-recapture method. This year was the last of the ongoing 8 year study using this particular population estimate method. Thus it is the purpose of this study to summarize the trend in population occurring over the past 8 years, suggest possible management directions, as well as, address the possible movement of the mountain lion with the movement of mule deer.

MATERIALS AND METHODS

The area studied encompassed the Open Space and Mountain Parks land west of Boulder extending from approximately Eldorado canyon on the south to the corporate boundary on the North, as well as, urban areas west of Broadway. Western boundaries of the study consisted roughly of the Flatirons, Flagstaff mountain and included the mesas that mark the transition from plains to foothills. The eastern boundary generally corresponded to Broadway. the total land area was approximately 17 square miles(City of Boulder, 1987).

The deer population was estimated using the modified Lincoln-Peterson formula. This was accomplished through mark and recapture beginning in 1983 until 1989 when marking ceased. The procedure entailed a known number of animals captured, marked and released back into the general population. At varying times after the final release, the population is counted; and the number of marked and unmarked animals is compared. The ratio of marked to unmarked animals is assumed to be the same in this sample census as in the total population, and a population estimate is therefore possible(Dale et. al. 1987). In our particular study, each spring, 4 interns walked each of four specific transect for approximately 10 hours/week , for 3 weeks, recording all sightings of tagged deer. Sightings made by city rangers and citizens reports were also included. These data were recorded on topographic maps to determine movements of individuals. From April 2-4, interns and park personnel walked each transect for four consecutive days and recorded sightings of all deer, marked and unmarked. This years data only consists of three consecutive days due to bad weather. The mean population estimate was then calculated using the average of the 3 or 4 individual daily sample estimates using this Lincoln-Peterson formula:

$$N = \frac{(n1 + 1)(n2+1)}{(m2 + 1)} - 1$$

where:
N= Estimated Population
n1= Total number of marked animals assumed to be alive, in the count area on count day.
n2= Total number of deer(both marked and unmarked) seen on count day.
m2= Total number of marked deer seen on count day.

Standard error and 95% confidence intervals were also calculated.

RESULTS

The animal population count was held on three consecutive days, April , 1990. From catalogs kept by the students it was estimated that there were approximately 56 tagged deer in the entailed study area. This was a marked decrease compared to the 83 assumed marked last year in 1989. But this decrease was to be expected considering the last deer marked was in the year of 1977/1988. For each day the total number of deer(marked and unmarked) seen was 609, 504 and 462, with the number marked at 22, 26 and 19 respectively. The resultant figures when placed in the Lincoln-Peterson formula, gave a current estimated population mean of 1319. With a standard error(SE) of 132.7 and a 95% confidence interval for this year at 1319 plus or minus 260 or 1059-1579(Figure 1). We are thus 95% confident that the true population mean lies between 1059 and 1579.

In comparing 1990's data to previous years the following was found:
1983- 783 plus or minus 43/ 740-826
1984- 888 plus or minus 146/ 742-1034
1985- no study done
1986- 1073 plus or minus 170/ 903-1243
1987- 1067 plus or minus 176/ 891-1243
1988- 1116 plus or minus 80/ 1036-1196
1989- 952 plus or minus 88/ 864-1040
(See Table 1 and Figure 2)

DISCUSSION

From 1983 to 1986 there was a general increase in population. These data indicate a 10% annual increase for this period and eventhough this is well below their biological potential of 25-30%, it shows that the existing population continues to rise(City of Boulder, 1987). In 1987 through 1989 there was a small decrease followed by an increase in 1988 and then another decrease in 1989. This could be attributed to the substantial increase in road kills, a bad winter, or the inaccuracy of the Lincoln-Peterson method. As shown from this years census, the population has made quite a substantial rise since 1989. This large increase is quite possible since we have had mild winters the past two years, but I believe our number of 1319 is an overestimation.

In an evaluation of the Lincoln-Peterson method Dale et. al. found that increasing the percent of the population marked did not improve accuracy. He suggested that the main difficulty with the Lincoln-Peterson estimate was the violation of the assumption of equal catchability and observability. In our study in order to try and cover biases of day, night or spatial location, we observed at all different times of the day and would stray from exact assigned locations. Contrary to Dale et. al.'s conclusions, the best known evaluation of the Lincoln-Peterson estimate done by

Strandgaard(1967), found that about 75% of a population needed to be marked before reasonable estimates were obtained. Bartmann et. al.(1987) reported that > 45% of a mule deer population needed to be marked to obtain reliable population estimates. Since the last deer marked was in 1989, we were using less than a 5% marked deer population. This leads me to believe our census is slightly innaccurate. But as Dale et. al. suggested the required accuracy of a population estimate varies with the intended purpose and since our goal is for population estimates and trends, exact numbers are not necessary. Also Boulder City Parks and Open Space is phasing in overlapping techniques based on aerial and pellet counts. These will provide population trend data from several sources allowing for a more accurate estimation.

Based on re-observations of marked deer over the years it looks as if most of the animals remained in the general vicinity in which they were trapped and marked. Deer at all trap locations tended to stay in the area of the trap site, moving .5 to .75 miles in any direction(City of Boulder, 1987). Eventhough, the trend has shown that the deer tend to stay in the same general vicinity, I believe the use of residential areas will increase. As the populations increase, along with the high quality of urban habitats, their tolerance for human prescence increases and since over several generations the deer have not been hunted, there will be an increase in residential use. This is not only a problem to homeowners as to the destruction of property, but also will cause an increase in injury or even death to the animal as well as the person from vehicle collisions. Furthermore, with this increase in population and residential use, I believe there is a great possibility that the mountain lion will begin to follow its prey.

The mountain lion(Felis concolor), had once ranged form northern Columbia to southern Chile and Argentina, and from coast to coast in North America. Hunting Pressure and changes in land management practices in western United States and Canada have restricted their home range mainly to mountainous, relatively unpopulated areas(Currier, 1983). In Colorado, the total number of mountain lions is estimated at approximately 1,100-1,500(Currier, 1976). Currently, from the most informed opinion, both within the Division of Wildlife and among guides and outfitters holds that the mountain lions are increasing(Allen et. al. 1988).

Between September 1988 and April 1989, over 80 human-lion encounters have been recorded in Boulder County, Colorado, with the majority of sightings occuring within just outside the city limits(Sanders, 1990). The growing deer population and prime lion habitat close to the city limits suggest that human lion encounters may continue to rise. Boulder county habitat consists of primarily ponderosa and lodgepole pine grading into spruce and fir at higher elevations(Sanders, 1990). This land

is covered with rocky outcroppings and steep rocks, which is an ideal area for the covering and hiding of prey common to the mountain lion(Shaw, 1979).

In North America, the mountain lion depends almost exclusively on deer for its food, although other species of big game and small mammals are eaten depending on local abundance(Dixon, 1982). Thus in Colorado the mountain lions are probably restricted largely to the habitat of its primary prey, the mule deer.

Through the research of Currier(1977), the estimated home range of the Colorado mountain lion is in the area of one lion per 5-21mi squared. This was calculated after successive field seasons on the basis of track data in Canon City, Colorado. Extrapolating from this study there could be as high as 40-45 mountain lions in Boulder County. This number may alarm many residents, but an increase over the years seems minimal. According to studies done by Currier et. al. (1977), Dixon(1982) and VanDyke et. al. (1986), mountain lions tend not to exceed certain densities. Home range boundaries are maintained through mutual avoidance as opposed to active defense and probably serves as a mechanism to limit population density and increase predation success rates(Hornocker, 1970). This suggests their is a point of social saturation for the species. As Currier suggested intraspecific relationships determine the maximum crowding tolerated by the mountain lions and a maximum density, home range of about 5-21mi squared. At or below this, the density is probable dependent upon prey density and stalking cover. This leads me to believe because of the high population of mule deer, the home ranges will decrease because of ample food sources and the mountain lion population will also increase.

The question is whether they will follow the deer down into the city limits. In much of western North America, mule deer migrate to lower elevation in the winter and higher elevations in the summer(Dixon, 1982). Dixon also suggests that these seasonal movements are also made by mountain lions as they follow their major source of prey. These elevational moves were recorded in the Kaiban region of Arizona, Idaho Primitive Area(Seidensticker et. al. 1973) and in California(Sitton and Weaver, 1977). Contrary to these findings, Shaw(unpublished report Arizona Game and Fish Department, Phoenix, 1981), noted that lions seemed reluctant to follow deer to the lowest elevations of deer range, even though this was where the greatest winter densities of deer occured. Mountain lions do not select areas on the basis of prey density alone(VanDyke et. al. 1986).

Eventhough, there have been increased reports of human-lion encounters, the possibility that this is due to increased public awareness cannot be forgotten. Nonetheless, it is my belief that due to the fact that the mountain lion is a highly adaptable animal, over time it will adjust, like

the deer, to the increased prescence of people, and human-lion encounters will continue to increase with possible catastrophic results.

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Figure 1 Population estimate

$$N = \frac{(n_1+1)(n_2+1)}{m_2+1} - 1$$

Day 1 $\frac{(57)(609)}{23} - 1 = 1,508$

Day 2 $\frac{(57)(504)}{27} - 1 = 1,063$

Day 3 $\frac{(57)(462)}{19} - 1 = 1,385$

$3,956 \div 3 = 1,319$

Standard Error

Day 1 $(1508 - 1319)^2 = 35,721$

Day 2 $(1063 - 1319)^2 = 65,536$

Day 3 $(1385 - 1319)^2 = 4,356$

$105,613$

$$SE(\hat{N}) = \sqrt{\frac{1}{k(k-1)} \sum_{i=1}^{k} (\hat{N}_i - \hat{N})^2}$$

roughly standardized $\sum_{i=1}^{k} (\hat{N}_i - \hat{N})^2$ means: the sum of the squared deviations from the mean

$$SE = \sqrt{\frac{1}{3(3-1)} 105,613} = \sqrt{17,602} = 132.7$$

95% Confidence Interval

$= \hat{N} \pm 1.96(SE)$

$= 1319 \pm 1.96(132.7)$

$= 1319 \pm 260.0$ $\quad 1,509 - 1,579$

Figure 2

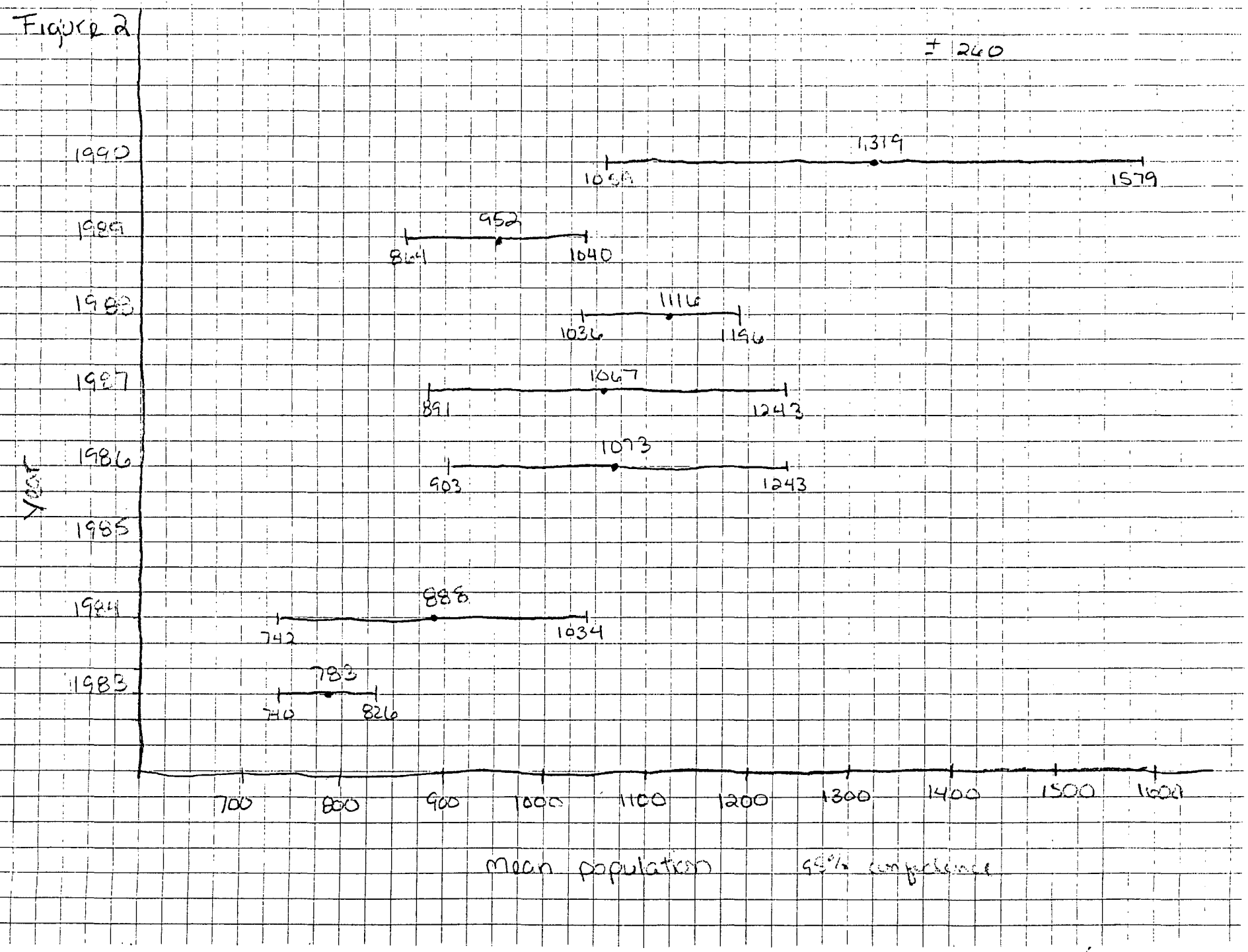
± 240
1990
1989
1988
1987
1986
1985
1984
1983
Year
1,319
1059
1579
952
864
1040
1116
1036
1196
1067
891
1243
1073
903
1243
886
742
1034
783
740
826
700
800
900
1000
1100
1200
1300
1400
1500
1600
Mean population
99% confidence

Table 1

Year	mean population estimate	standard error	95% confidence interval	average no. of deer seen	road kills
1983	783	21.9	740-826	296	119
1984	888	74.7	742-1034	312	133
1985	—	no	study	—	113
1986	1073	86.8	903-1243	439	116
1987	1067	89.8	891-1243	546	188
1988	1116	40.7	1036-1196	446	214
1989	952	44.7	864-1040	536	
1990	1,319	132.7	1509-1579	524	