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Dynamics of the Mule Deer Population in Boulder

and

Analysis of the Population Designs' Efficiency

(Deer, Deer, What can the Matter be?...)

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Abstract:

Deer population in Boulder, Co. and its western, northern and southern open space areas was done 1-27 to 4-11-90 using the Lincoln-Peterson estimation with approximately 5% of the population tagged. The mean estimate was 1319+133, 95% confidence intervals were 1058-1580. A linear regression of deer populations over the past decade showed population growth to be 66deer/year, and no correlation was found between deer population and deer roadkill/year.

A simple cost analysis of the current designs in use (pellet, aerial, and ground counts) showed the ground count to be the least effective use of money, and is thus in agreement with the city's decision to phase this design out. It is suggested that the other designs be kept simply to improve the accuracy of the population estimate.

Introduction:

The mule deer population in the city of Boulder, its parks, and surrounding open space, has become a heated issue in the past decade. There is concern that the deer population is increasing and thus outstripping its resources--petunias and tulips not withstanding--in addition to increasing the number of car/deer collisions. The other side of the issue is, of course, that it is the human population which is increasing and encroaching upon habitats. Either way, the deer/human conflict is in need of management, and the first step of management is determining the dynamics of the resource to be managed.

In this spirit, a joint venture between Boulder Parks and Boulder Open Space has occurred over the last seven years to calculate estimates of the mule deer population with the Lincoln-Peterson capture/recapture method, in addition to gathering data on movement and roadkill. To determine whether

or not the deer population has grown over the past decade, a simple linear regression was applied to the deer population from 1983-1990; and a simple linear correlation was applied to deer roadkill/yr and corresponding deer populations in order to determine if number of deer killed by cars/year is connected to the size of the deer population.

In addition, wildlife managers have begun using pellet counts and aerial counts to increase the accuracy of the population estimate while phasing out the ground count. An analysis of precision and cost of each design was calculated so as to better understand which design(s) proves to be the most effective for the money.

Study Area/Methods:

A continuation of the City of Boulder's deer population study was done from 1-27 to 4-11-90 in the city of Boulder and surrounding open space, bordered by Eldorado Springs on the South, Wonderland Lake on the North, and Broadway on the East. This area, previously divided into four sections, was covered by four University of Colorado students on foot and by car--students rotated sections every three weeks. When the group/individual had ear tags, the following observations were recorded: date, time, location, ratio of tagged to untagged, and tag numbers; an estimated 5% of the deer population was tagged during data collection. Similar data was collected by rangers and the general public during this period. A census count was taken on three consecutive days beginning at 7 a.m. during the first week of April, in which rangers and students walked predetermined routes (1-2 people/route) in the four sections.

Results:

The Lincoln-Peterson estimate showed the deer population to be 1319+133 deer, a 38% increase above 1989 levels and 18% increase over 1988 levels. The 95% confidence interval was 1058-1580.

Effect of Time(years) on Population

A Model 1 simple linear regression was calculated in attempts to provide a mathematical description of this relationship. The resulting least squares linear regression line was the following (p=.05) Y = (66.6+10.5)X + 745.8+42.4, and r2=.93, implying that 93% of the variability in the data set could be explained by this regression line(g.1).

Relation of Deer Population and Roadkill

Kendall's non-parametric correlation was run on the population/roadkill data and no correlation was evident at p=.05 (g.2).

Cost Analysis

Precision was calculated by averaging the standard errors available for each design, and cost was taken from a 1988 Boulder Parks memorandom. Efficiency of Design was defined as 1/(cost*SE) such that low cost and low standard error (SE) resulted in high efficiency, and high cost/SE resulted in a low efficiency. The average standard errors of Aerial, Pellet and Ground counts were 12, 68, and 79, respectively; while for cost, these values were $1346, $925, and $16,000. Respective efficiency of designs were 65, 16, and 8([illegible]). Expressing this alternately, aerial counts were 82% more precise than pellet counts with a 30% increase in cost, while they were 84% more precise than ground counts at only 8% of cost. Pellet counts were 14% more precise than ground counts, but at 6% of ground cost.

Discussion:

[illegible] of Time on Population

93% of the variability in the data set was explained by the relationship: Y= 66X + 745; reflecting that the deer population grows by 66(+10) each year. This conclusion has limitations, however. The Lincoln-Peterson design has recently come under fire as a terribly inaccurate estimate due to its unacheivable assumptions, thus biasing the regression line(McCollough and Hirth, 1988). However, assuming that the bias has been consistent over the seven years(which may or may not be the case due to variation in tagged deer from 1983-1990) the rate of population growth may be moderately reliable. Assuming that the population is growing, possible causes are a decrease in predation, and better habitat--resulting from fire prevention along the foothills and human landscaping--both of which are due to the impact humans have on the environment.

Relation of Deer Population and Roadkill

Kendall's test for correlation with nonparametric variables showed no correlation between the two occurrences(g.2), however, this result should be fortified with additional data analysis before accepting it as truth. For instance, the change in deer populations in areas of high density roadkill needs to be quantified in order to insure that a biasing did not occur by including areas in which roadkills could not possibly occur, i.e. the extreme North and South sections. An additional variable which may effect results is the ox reflector, which the Parks Dept. place on high density roadkill areas hopefully decrease collisions. Even if there was an increase of roadkill with increased deer population, the automobile could not be considered an effective predator, for as previously mentioned, the deer population has been steadily increasing apparently

unaffected by deaths due to automobiles, and it is hazardous to the citizens of Boulder.

Cost Analysis

Cost analysis of the three designs was approached in two ways: 1. determining the efficiency (effectiveness) of the design, and 2. comparing the amount of precision present to cost increase/decrease. The results of both showed the aerial count to be the most precise design for the money, with pellet count second and ground count trailing far behind(g.3). These results are in a general sense, pointing to the already accepted conclusion, to phase out the Lincoln-Peterson ground count. However, it must first be realized on what basis this conclusion is made.

First, due to availability of data, the standard errors of each count were not calculated from the the same years, nor from equal sample sizes. The pellet count was established from 1986-87, and 89; the aerial from 1988,1990; and the [illegible] from 1986-1990. There did not appear to be any consistency between [illegible] and standard error, however, perhaps implying that the standard [illegible] acceptable (although the 1987 pellet count is questionable)(t.5).

Secondly, in calculating effectiveness, standard error is figuratively equated to accuracy, under the assumption that precise measurements are more likely to reflect [illegible]. This is not the case with the ground count. McCollough [illegible]) state that there is no relationship between standard [illegible] accuracy--perhaps reflecting the huge discrepancies found in [illegible] counts (from -30 to +138%). Additionally, Bartman(1986) reports that helicopter (aerial) counts are at best 68% accurate, and the pellet counts recorded populations often lower than the average number of deer seen during the ground count censusing--implying

that these are not terribly accurate either. Thus, the effectiveness calculated may not in any way reflect accuracy, which brings to point the fact that comparing [illegible] by this method may not be appropriate. Yet, Kufeld (1980) stat[illegible] essentially impossible to reach a high degree of accuracy [illegible]ng wild populations in mountainous terrain. Hence, perhaps accuracy is too much to hope for in these designs due to the populations they [illegible] are, after all, estimates of the populations, NOT head counts. Thus precision maybe an appropriate measure of effectiveness on the basis that accuracy is impossible attain.

Accepting these assumptions--that the standard errors calculated reflect the true standard [illegible] designs, and that standard error is an effective measure of [illegible]'s accuracy/precision--the ground count can be eliminated as an effective design. The pellet and aerial counts should probably be both kept though the aerial count seems far more effective. This is because 1. the aerial count can only be done when snow cover allows for high [illegible]--though the more accurate counts are thought to be [illegible] armor months when the deer migrate to lower elevations(Kufeld, [illegible]. the count will undoubtably be more accurate with two estimates than just one.

Summary:

Resource [illegible] effective when the dynamics of the resource are understood, [illegible] studies which gather this information are feasible only if [illegible] recise information at a reasonable cost. In this light, [illegible] clusions can be made concerning the City of Boulder Parks/Open [illegible] study of mule deer populations--but it should be noted that they are [illegible] to error:

1. Mule deer popul[illegible] to be growing, however, this was determined using Lincoln-Peterson population estimates which may bias the results.
2. Mule deer populations do not seem to be related to the number of car-deer collisions[illegible] The data used in this analysis may not be complete enough--[illegible] geographic range that the analysis results in a type 2 error.
3. Under the assumption that precision is an effective measure of the pellet, ground and aerial counts' efficiency, the estimation of mule deer populations by the ground (Lincoln-Peterson capture/recapture) method is not efficient and should be discontinued. Though seemingly more effecient, the aerial count [illegible] used singly--for its estimated accuracy requires additional [illegible] from other sources.

Finally, in light of the fact that statistics showing that the deer population is growing may only serve to fuel citizen complaints about the deer encroahing upon man's habitat, it should be noted that the most likely causes of deer [illegible]--decrease in predators, increase in good habitat--are indirectly related to the effect humans have on the environment. The [illegible] those early stages needs to entail not only how to control the deer population, but how to control man's influence on its growth.

LITERATURE CITED

Bartman, R., L. Carpenter, R. Connett, D. Bowden. 1986. "Accuracy of Helicopter [illegible] Pinyon-Juniper Woodland," Wildl. Soc. Bull. 14:356-3[illegible]

Kufeld, R., J. Olterman, D. Bowden. 1980. "A Helicopter Quadrat Census for Mule Deer on Uncompahgre Plateau, Colorado," J. Wildl. Manage. 44:632-639.

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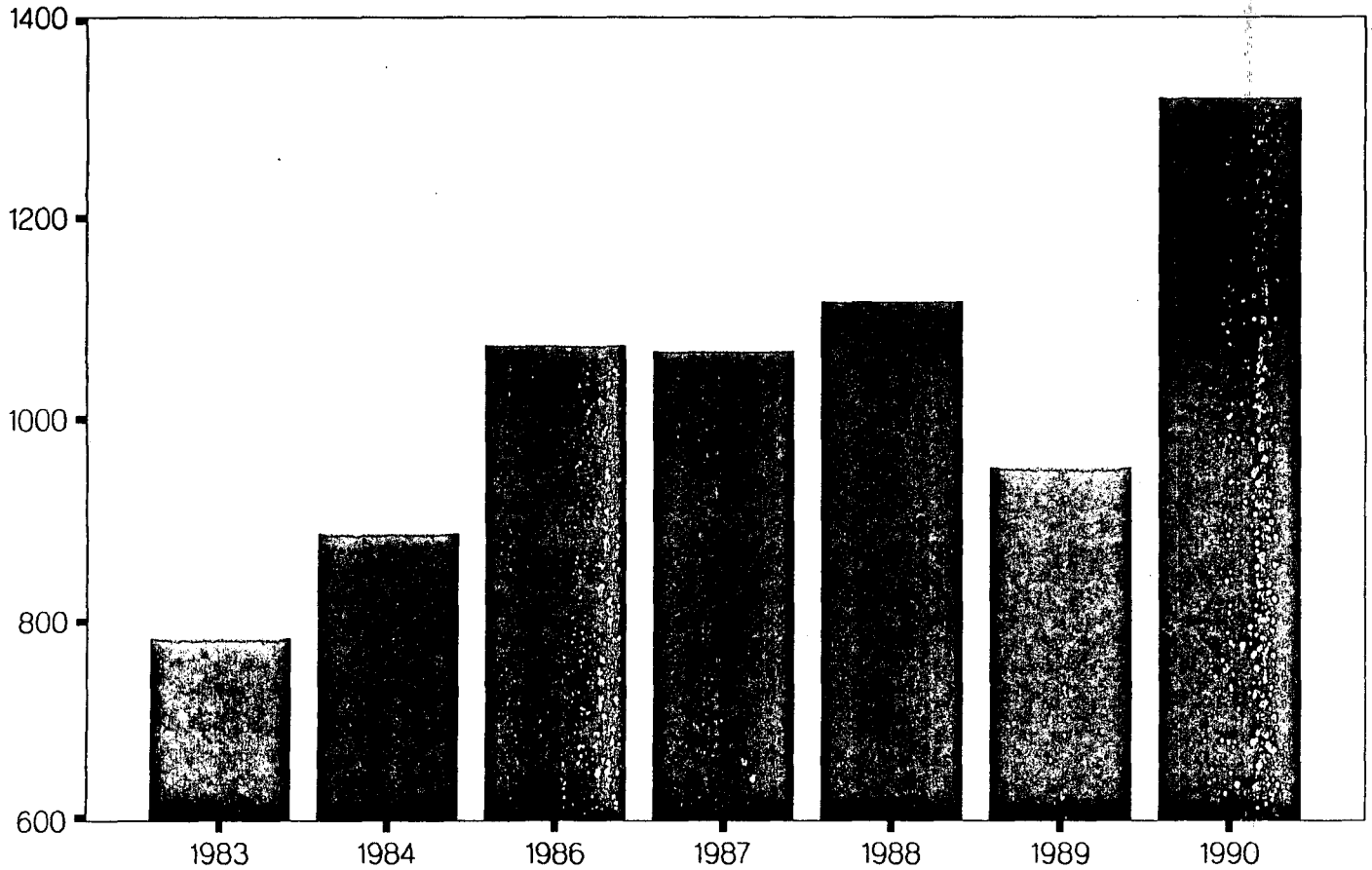
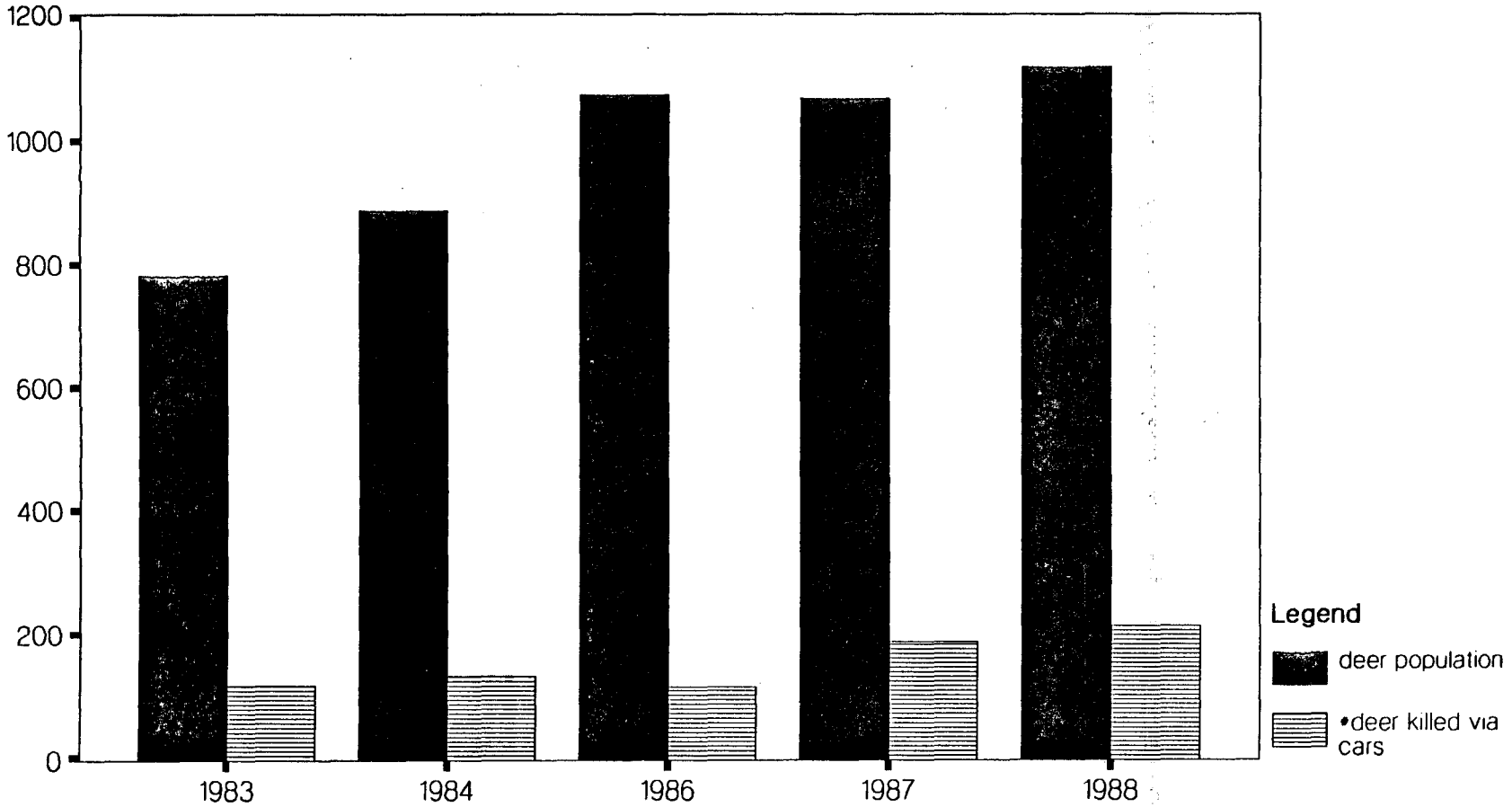
Lincoln-Peterson Estimate of Boulder Deer Population 1983-1990



note:1985 excluded due to lack of data

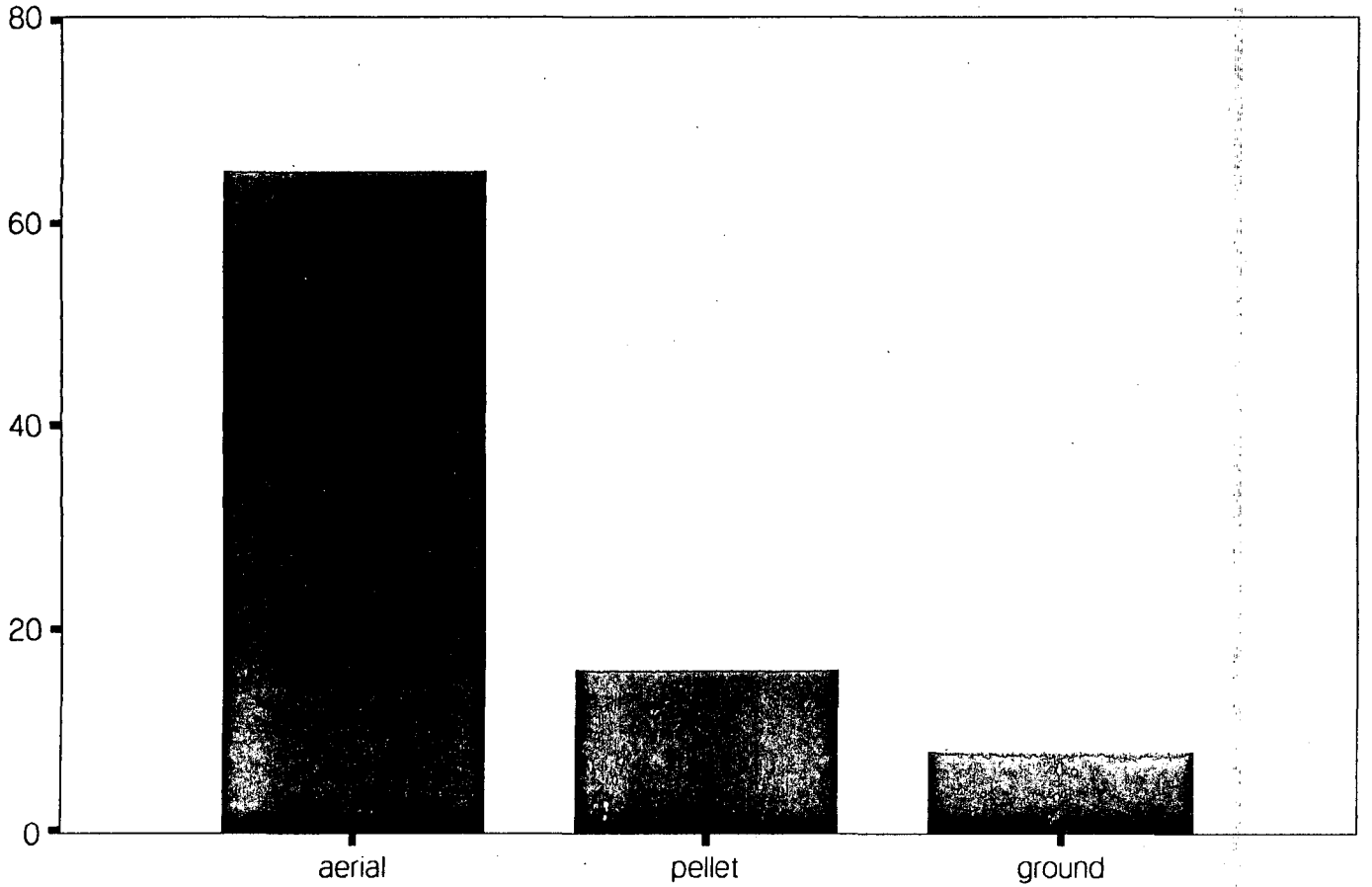
Yearly Deer Poulation and #Roadkill 1983-1988



year

population=lincoln-peterson estimate

Efficiency of Design: Aerial, Pellet and Ground Counts



Efficiency=1/(cost*SE) * 10^-6
cost = 1988 dollar value