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MOUNTAIN GOAT INVENTORY AND HARVEST STRATEGIES:

A RE-EVALUATION

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ABSTRACT

Growth of the Hoodoo Creek and Stanton Creek goat (Oreamnos americanus) herds were simulated based on field data. Unadjusted field values could not be used to simulate observed herd size trends. The implications of goat population growth responses to harvest are discussed.

INTRODUCTION

Mountain goat populations in many parts of North America and especially in British Columbia declined for a variety of reasons during the period from 1950 to 1970 (Hebert and Turnbull 1977). Inventory and monitoring were and continue to be inadequate for most goat populations in British Columbia.

Goat classification systems based on aerial surveys have been developed by Hebert (1978) and Nichols (1980); however, the population structure data have not been compared to estimates of population change and the relationship between survey results and subsequent management (harvest) strategies is unclear. These strategies should be based on the population characteristics of the ecotype or sub-ecotype (Hebert 1978). This paper examines the adequacy of present survey methods to provide needed harvest management information.

STUDY AREA

The study area encompassed the drainages of Hoodoo and Stanton Creeks both of which are part of the Knight Inlet watershed (Figure 1). These areas are characterized by precipitous slopes, recent and continuing glacial activity and open alpine habitats. They are part of the Coast Crystalline complex containing granitic, metamorphic and volcanic rock (Souther 1967). A more complete description is contained in Hebert and Turnbull (1977).

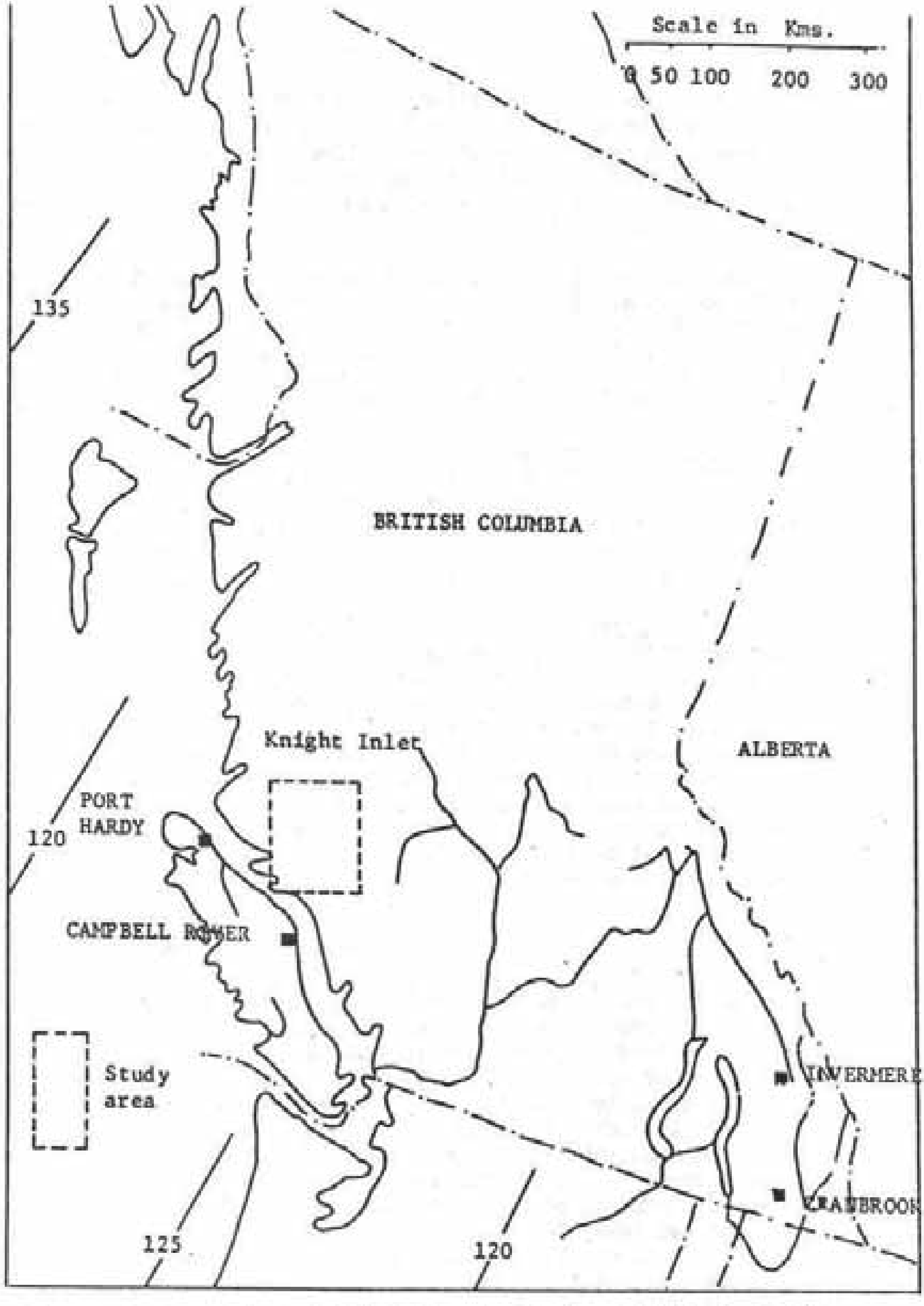

Figure 1 - Mountain Goat Study Area in Coastal British Columbia.

METHODS

The survey data were collected from helicopter transects flown at 150 m intervals from an elevation of 1200 m to the mountain tops (2800 m). Surveys were designed to produce estimates of sex and age ratios and population size and involved observing goats at close range (12-25 m) with 8x30 binoculars or a 200 mm telephoto lens. At least two observers were present for each survey.

All successful surveys were flown between July 18 and August 5 when goats were present on high elevation habitats. Surveys in September were unsuccessful in locating significant numbers of goats. Variability in the scheduling of the flights was caused by weather, helicopter availability and the work schedule of the participants. Attempts were made to fly the survey during clear weather, two to five days following inclement weather.

A population projection model was constructed which included productivity estimates (kids per 100 adult females), adult sex ratios and kid mortality estimates (based on ratios of yearlings per 100 adult females) derived from the survey data. Yearling and adult mortality were estimated (Youds et al. 1980). Harvest is not a factor for these populations and was not considered in the analysis.

For the purpose of analysis, values derived from the survey were considered to be an accurate estimate of the total population size. Survey data were tested for consistency by the model. Projections based on estimated productivity and mortality rates were compared to observed population trends. Parameters were altered based on literature and estimated values in an attempt to duplicate annual changes in the total goat population in order to compare simulated and observed population composition values for specific years. Subsequently, the underlying assumptions of goat harvest strategies were examined and the requirements for a revised inventory and harvest strategy for previously unhunted goat populations were examined.

RESULTS

During the period 1974-1980, fluctuations in weather produced population changes which allowed the dynamics of coastal goat populations to be examined. During a consecutive period of mild winters (1974-1977) the observed Hoodoo and Stanton Creek populations increased by 71.4 and 90.9 percent, respectively. These observed population changes were then compared to model predictions. Subsequently, a severe winter in 1978-1979 produced substantial decline of 82 and 92 percent in these respective populations. Although this was documented by a duplicate, systematic survey in Hoodoo Creek, a partial survey in Stanton Creek suggests that the decline was less than 92%. The resultant increase in the two populations, following the crash, allowed a wide range of dynamics to be compared, especially rates of increase.

Several years of data collection indicated that data quality varied among years. It was assumed that the data collected in 1977 by more experienced observers was of higher quality than that collected previously [compare identified animals in 1977 to those unidentified in 1974 (Table 1)]. Portions of the data were obviously incorrect and adjustments and assumptions had to be provided.

It was apparent from our data, and from the literature (Nichols 1980) that:

1. yearlings were underrepresented in the survey.
2. observed sex ratios could vary due to summer weather variability.

The survey results were examined through:

(a) a simulation of the original data

(b) a simulation which duplicated the observed change in population size and allowed a comparison of observed and simulated population structure for a specific year (1977).

(c) A simulation based on an adjusted set of data:
  i. selecting the year with the best quality data (most complete age and sex identification and greatest numbers counted)
  ii. adjusting data on yearling production and sex ratios.

Surveys conducted in July and August of 1974, 1976, 1977, 1979 and 1980 produced estimates of total population size and age and sex ratios (Table 1). Surveys conducted in September of 1975, 1978 and 1981 were unsuccessful in locating significant numbers of goats. It is believed that coastal goats migrate to lower elevations prior to the effects of early winter storms. The small numbers of goats recorded in these years were located below treeline (1200 m).

The model was used to simulate the observed trends in goat numbers for the Stanton Creek and Hoodoo Creek populations (Tables 2, 3) between 1974 and 1977. Mean values for productivity (kids per adult female) and kid mortality were used to define the model populations. Kid mortality was estimated from kid and yearling proportions in the populations. The initial population sizes were set at the number of goats recorded for the 1974 surveys.

Using these initial parameters, both simulations produced decreasing populations (simulation #1; Tables 2 and 3). The rate of decline (r) was -0.01 for the Stanton Creek population and -0.06 for Hoodoo Creek population.

In order to reproduce the recorded increase in numbers determined by the Stanton Creek surveys between 1974 and 1977, it was necessary to increase productivity (0.95 kids per adult female) and to decrease kid mortality (0.08) and yearling mortality (0.05) for the simulated Stanton Creek population (Simulation #2; Table 2). Similar adjustments were required for the Hoodoo Creek simulation in order to reproduce the observed increase in numbers (Simulation #2; Table 3). Rates of increase were 0.21 and 0.18 for the Stanton Creek and Hoodoo Creek simulations, respectively.

Table 1.

SUMMARY OF HOODOO AND STANTON CREEK

SURVEY RESULTS

Year	AD M	Males/100[1] Adult F's	AD F	UNID AD	Year-lings	Yearlings/[2] 100 AD F's	Kids	Kids/100[2] Adult F's	Total
				HOODOO CREEK					
1974	-	-	-	26	-	-	2	15.4	28
1976	2	18.2	11	15	1	5.4	6	32.4	35
1977	8	34.8	23	1	1	4.3	15	63.8	48
1979	2	200.0	2	3	1	40.0	1	40.0	8
1980	2	50.0	4	1	2	44.4	3	66.6	12
				STANTON CREEK					
1974	2	50.0	4	22	2	13.3	3	20.0	33
1976	17	121.4	14	5	2	12.1	5	30.3	43
1977	16	69.6	23	7	2	7.6	15	56.6	63
1979	4	-	-	1	-	-	-	-	5
1980	5	62.5	8	1	1	11.8	6	71.0	21

[1]Actual classification.

[2]Based on assumption that one-half of unidentified adults were females.

[3]Partial survey.

Table 2. Stanton Creek Simulation Results

Year	Estimated Mortality[1] AD M	AD F	YR	K	Productivity K/ADF	Sex and Age Composition AD M	AD F	YR	K	TOTAL	r
Simulation 1											
0	.05	.05	.20	.74	.42	13.0	13.0	1.4	5.5	33.0	
3						12.7	12.7	1.1	5.0	32.0	-0.01
Simulation 2											
0	.05	.05	.05	.08	.95	13.0	13.0	1.4	5.5	33.0	
3						19.2	19.2	10.8	13.2	62.6	0.21

Simulation 1 - Based on derived and estimated population parameters.
Simulation 2 - Based on observed population increase.

[1]See Youds et al. (1980)

Table 3. Hoodoo Creek Simulation Results

Year	Estimated Mortality[1] AD M	AD F	YR	K	Productivity K/ADF	Sex and Age Composition AD M	AD F	YR	K	TOTAL	r
Simulation 1											
0	.05	.05	.20	.91	.48	10.8	10.8	0.5	5.8	28.0	
3						9.8	9.8	0.4	4.6	23.9	-0.04
Simulation 2											
0	.05	.05	.10	.15	.90	10.8	10.8	0.5	5.8	28.0	
3						15.1	15.1	7.6	10.4	48.4	0.18
Simulation 3											
0	0	0	0	0	.79	4.8	11.3	3.0	8.9	28.0	
3						9.2	15.7	3.2	11.2	39.5	0.12

Simulation 1 - Based on derived and estimated population parameters.
Simulation 2 - Based on observed population increase.
Simulation 3 - Based on adjusted population parameters (see text).

[1]See Youds et al. (1980).

The Hoodoo Creek simulation was rerun using adjusted population parameters based on the assumption that the 1977 classification was more accurate than the 1974 classification. The classification was applied to the number of goats recorded in the 1974 survey (28). The number of yearlings was increased since it was likely that some were missed in 1977. It was also assumed that no mortality occurred between years for any age class. These adjustments produced an increasing population which totalled 39.5 animals in year 3 (Simulation #3; Table 3). The r value was 0.12, compared to 0.18 for the actual increase in goat numbers observed over the 1974 to 1977 period.

DISCUSSION

This exercise was not intended to estimate population parameters for the study area populations because a variety of productivity and mortality values would reproduce the observed increase in total numbers. In addition, the present survey counts do not provide good estimates of total population sizes. The results do, however, demonstrate that uncorrected productivity estimates and survival estimates for kids to yearling age (measured in July or August) were inconsistent with the apparent increase in herd size during the 1974 to 1977 period. Corrected classification data (Simulation #3; Table 2) fit the observed increase more closely for the Hoodoo Creek herd. Re-examination of inventory objectives and methodologies was undertaken on the basis of this analysis.

The study area populations are not subject to harvest at the present time due to their near inaccessibilty. In addition the entire area was closed to hunting in 1979 when the surveys showed a substantial decline in goat numbers. In the future, however, these and other coastal areas will become more accesible as logging progresses and road construction provides access for hunters. A means to inventory goat populations and effectively manage these previously unhunted populations is required.

Several models which simulate goat population growth (Kuck 1977, Hall and Bibaud 1978, Youds et al. 1980, Nichols 1980) have been described. These models represented goat populations as continually growing or declining, depending on the characteristics of the population (productivity and mortality). The chosen population variables produced increasing model populations from which a portion was available for harvest. Harvest slowed the rate of population increase but did not depress population numbers until the harvest rate exceeded the rate of increase. The need to estimate yearling and adult mortality rates introduces a major potential source of error to this method.

Additional complexity is introduced to goat management by their unknown density dependent response to harvest. At least two reports have indicated increased productivity did not occur when goat populations were harvested. Kuck (1977) monitored the harvest of an Idaho goat population and found that no increase in productivity (kids per adult female) occurred as the population size decreased. Hebert and Turnbull (1977) compared unhunted or lightly hunted and heavily hunted populations in a south-eastern British Columbia study area and found significantly lower kid proportions in the heavily hunted populations. This type of response may invalidate traditional harvest theory for some goat populations.

Rates of increase for harvested goat populations have not been adequately measured. Information on these rates is required if reasonably stable harvest regimes are to be established. Kuck (1977) describes a harvset experiment of the type necessary for calculation of the response of a population to harvest (see Caughley 1977). The harvest rate employed however, was greater than any goat poplation could reasonably be expected to sustain. Extension of this type of harvest experiment to other goat populations is required (Figure 2).

Careful monitoring of harvest and population size are required to establish the response of a goat population to harvest. The difficulties described in our study area in determining population variables make it unlikely that this method will provide sufficient sensitivity to adequately monitor any harvest of these populations. The need to establish total population estimates or at least population trends is evident. If we assume for example that the logistic growth model described by Caughley (1977) applies to goat populations then the allowable harvest is extremely low. Youds et al. (1980) calculated the maximum rate of increase for goats at 0.10. The expected response to harvest of a previously unhunted population which grows according to the logistic model at this maximum rate is shown in Figure 3. The maximum sustainable harvest is 2 - 3 animals per year; at this harvest level the population would be reduced to 50 animals.

The applicability of this model to the growth of goat populations is of course unknown. The value for $_m$ determined by Youds et al. (1980) is likely low since the theoretical maximum rate is .26 and this value was reached by one transplanted population (Thompson and Guenzel 1978). Conversely however, harvested goat populations may not show compensatory responses and therefore may not reach growth rates attained by unhunted transplanted populations.

Development of survey methods based on the establishment of population size estimates is required. Annual classification surveys in the study area produced inconsistent results which were of little value in establishing a harvest management program.

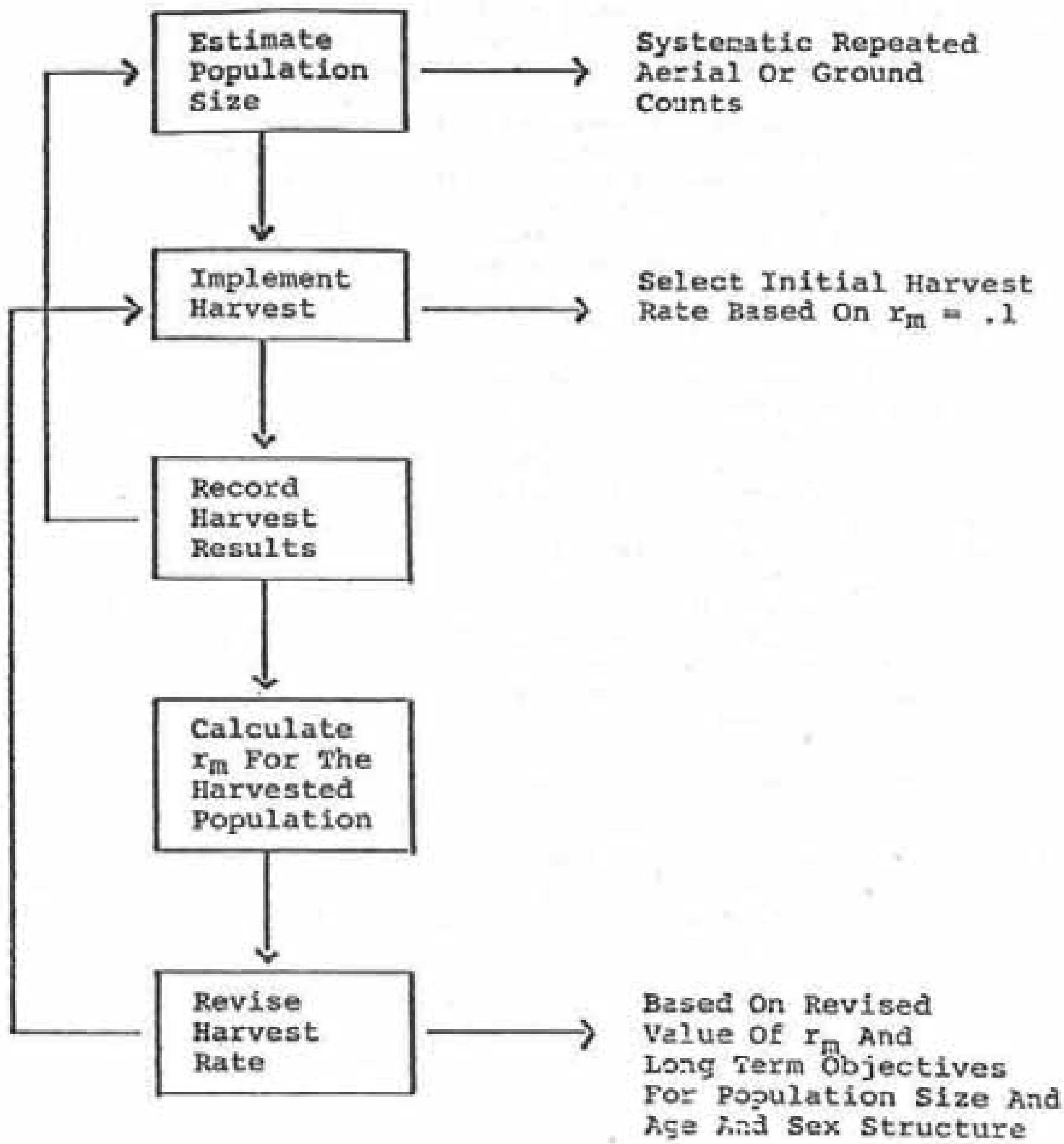

Figure 2. Flow diagram of a harvest management system for a previously unhunted goat population.

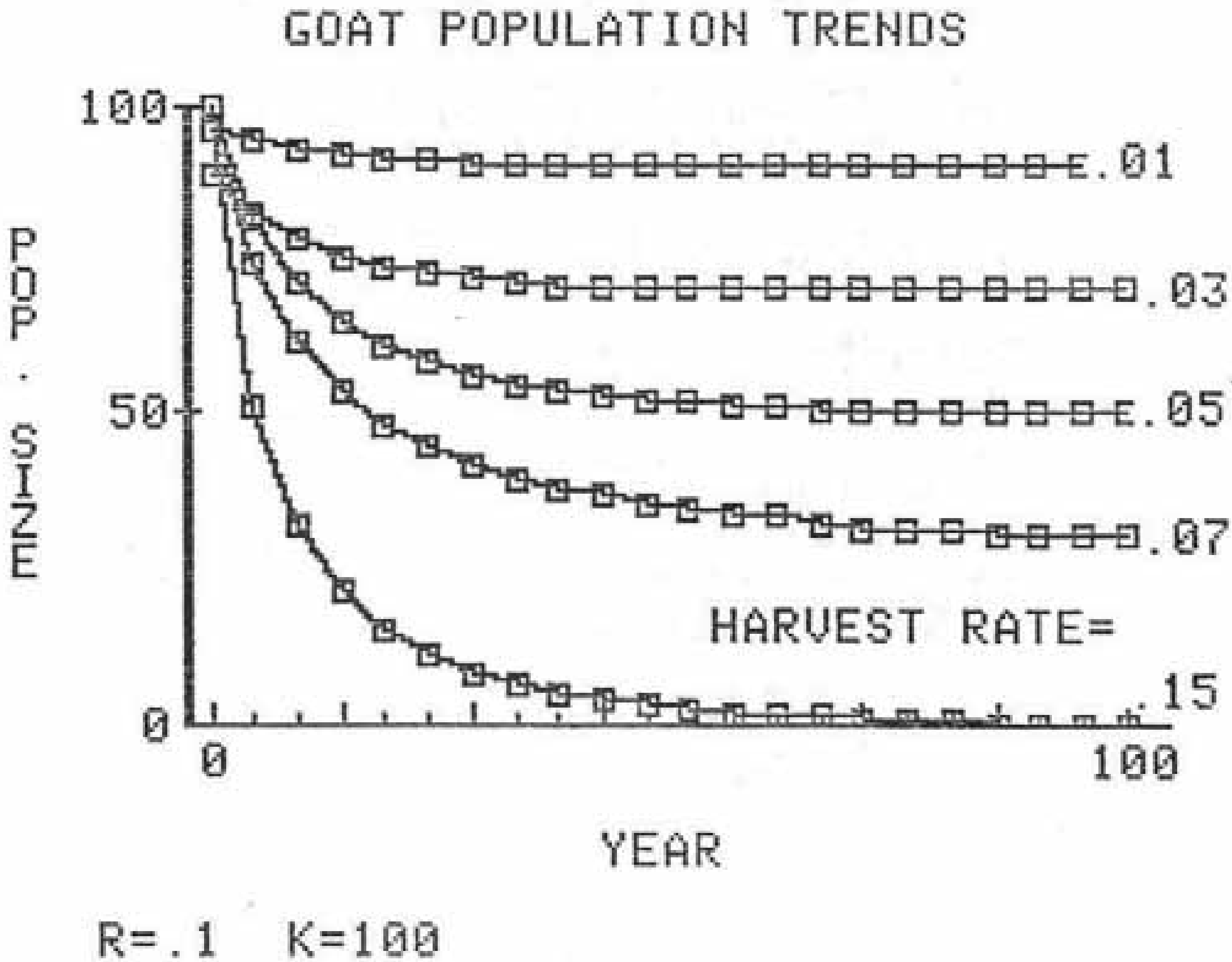

Figure 3. Hypothetical goat population under five harvest rates. The population is assumed to be at carrying capacity when harvest is imposed and to be showing a density dependent response according to the logistic model (after Caughley 1977).

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CONFERENCE DISCUSSION

Q At what age do coastal mountain goats reproduce?

Ans. We talked about that and as I said, I haven't really looked at the reproductive tracts of any of these animals. I just considered first reproduction at 2 1/2 years and considering the low productivity I get here, I think it could well be 3 1/2 before any nannies reproduce. But again, that's something that we haven't played with on the computer in terms of what effect the age of first reproduction might have on population growth.

Q. What are the effects of your helicopter surveys

Ans. All of our surveys were helicopter counts. They were done with a jet ranger. Those goats hadn't seen a human being before I got into there I'm sure. There had been a few helicopter passes over it. Its a totally remote part of coastal British Columbia. They were all done with systematic transects and they were all done with the same observers. When I first started flying in there, as Lyman showed, you could get to within a roter blade of those goats against the cliffs so all the sexing and aging was done from the helicopter. We did a bit of ground work but it wasn't really necessary. The goats are becoming a little harder to deal with now after 9 years of buzzing around but they have a year interval between each time we get there so they are still not that difficult to observe. Now I'm at the point where most of the sexing and aging is done with a camera with a 200 mm telephoto where I can zoom in on the animals and I'm still not having problems. I brought Tori Stevens up 2 years ago as an independent observer to do the age- and sex-classifying with me and we came up with almost identical results at the end of the survey. Every sort of check that I've tried to put on the system has worked very well. I really haven't hit any major stumbling blocks as yet.