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RH: MAXIMIZING RAM HARVESTS IN NORTH AMERICAN MOUNTAIN SHEEP

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Abstract: Relating survivorship curves for Dall (*Ovis dalli*) rams to maximal harvest rates determined in Alaska indicates maximum 3/4-ram harvests result in unnecessarily low harvest rates. Maximum harvest of 3/4-curl rams dramatically reduces the sustainable harvest rate by increasing mortality among the sublegal rams which remain at the end of hunting season. Maximum sustainable harvest rates for Dall rams in 4 Alaskan mountain ranges were determined by dividing the reported ram harvest by the population sizes which produced them. The mean sustainable harvest rate in these 4 study areas was found to be 2.4% of population size (excluding lambs). Application of this harvest rate to a model sheep population with ram survivorship equal to that in unhunted McKinley National Park showed the actual, sustainable harvest of 3/4-curl rams was only 42% of that predicted. Failure to sustain the harvest rate must result from increased mortality among rams at very young ages. Full participation in the rut is the most probable cause of early death among these sublegal rams. In an unhunted population participation in rut by these young rams is precluded by the presence of physically and behaviorally mature rams. Predictions of harvest rates sustainable at different age-at-harvest options are offered based on a linear model for ram survivorship. These analyses indicate sustainable harvest rate at full-curl age is greatly above that at 3/4-curl age. The natural mortality acting on age classes 2-7 years is insignificant when compared to mortality associated with rut in all species of North American sheep. Consequently, transfer of this mortality to very young rams which remain following maximal 3/4-curl harvest results in lowered harvest rates. Higher harvest rates will be sustainable at full-curl age than at 3/4- or even 7/8-curl ages. Supporting data are provided.

Key words: harvest rate, ram survivorship, sheep management.

INTRODUCTION

After the decline of North American mountain sheep which accompanied the settlement of the American west by white men (Buchner 1960), enlightened approaches to management of wild mountain sheep eventually brought many populations back to huntable numbers (Trefethen 1975). As sheep populations returned to viability, managers sought a balance between protection and use. This meant allowing for harvest, either hunting or by transplant, within the limits of biological safety and herd growth. The need to assure continued herd recovery and health was easily understood. Likewise, the advantages of maximal use by hunters were well known, though less apparent. These included revenues produced by license and tag fees, the development and maintenance of the guiding and outfitting industries, and a high public interest in the conservation and management which attends hunting.

A review of mountain sheep hunting regulations across North America (Demarchi 1978) shows the most common attempt to balance herd growth (either for recovery or transplant programs) with maximized hunter use was an attempt to limit harvest to surplus males (rams). Historically, rams which could be removed by hunters without compromising lamb production were defined as surplus. Sheep survivorship in unhunted populations shows a consistently low, but clearly identifiable mortality between 1 and 7 years of age (Deevey 1947). Still, the almost universal conclusion reached by sheep management biologists was that harvesting rams at the youngest acceptable age (before natural mortality removed any more of them than necessary from the shootable population) would give the greatest sustainable harvests.

Since ram horns grow throughout life and describe a full circle (full-curl) at maturity, the legal age of rams for harvest has been defined by the degree of horn growth, portion of a full-circle or curl, attained. The age/horn size limit commonly applied in North America in an effort to provide both biological safety and the maximum number of surplus rams was arbitrarily set at 3/4-curl. This defined rams above the ages of 4 to 6 years (depending on species and population growth characteristics) as surplus. The 1st 3/4-curl regulation was instituted in Wyoming in 1930. Next, Alaska instituted a 3/4-curl regulation in 1950; it persisted until 1979 when it was changed to 7/8 of a curl (Heimer 1980). The 3/4-curl regulation was established in 1930, 14 years before any real understanding of the biology of North American wild sheep. It persists as the dominant rule governing the harvest of mountain sheep throughout the western United States. Few such dicta have persisted purely on seemingly reasonable assumptions. The 3/4-curl rule is the most durable and perhaps the last of all such arbitrary management dogmas. Recently rams have been shown to reach this horn size well after they develop the capacity to sire offspring, usually at 18 months of age, (Wishart 1978 and Nichols 1978). Consequently, some western states have set regulations defining all rams above half-curl age as surplus. According to Demarchi (1978), Oregon has a half-curl rule; Wyoming and Colorado have had them in the past, and Colorado established a half-curl regulation again in 1983 (Shoenveld, pers. commun.).

Alaska's experience with different harvest regimes indicates the rationale behind the 3/4-curl regulation is probably spurious and, in all likelihood, results in lower sustainable harvest rates than harvesting rams at older ages. It is the purpose of this paper to present data on the Alaskan experience, and investigate alternate management possibilities. This will be done by reevaluating data on ram survivorship in unhunted populations and relating this survivorship and the harvest it predicts to observed maximal harvest rates.

MATERIALS AND METHODS

Maximum Sustainable Harvest Rates: Harvest rates were determined by compiling ram harvest records returned to the Alaska Department of Fish and Game. All sheep hunters in Alaska are required to report the date and location of their kill. These records were analyzed for specific areas of known population from 1973 through 1979. Four study areas were selected (Fig. 1). Surprise Mountain, Kenai Peninsula was the subject of an intensive research project by the Alaska Department of Fish and Game (Nichols 1978). During this study Nichols determined population size annually from 1973 through 1977. Population sizes in the 3 remaining study areas were determined with less rigor, but the aerial survey data area as accurate as is reasonably practical for large areas. These areas include the Pioneer Peak/Goat Creek area in the Chugach Mountains from 1976 through 1978, the Boulder Creek/Chickaloon River/Hicks Creek area in the Talkeetna Mountains from 1976 through 1978, and the Delta Management Area in the Alaska Range from 1975 through 1978. These areas were subject to quantitative if not complete cropping of legal rams (3/4-curl or greater) during years for which data were available. Horn size averaged 76.2 cm (30 in) throughout the period of data collection. This represents the lowest practical limit to which Dall ram horn length can be driven with a fall hunting season for 3/4-curl rams. Heimer and Smith (1975) showed the mean length for 3/4-curl horns from these populations was 68.6 cm (27 in). If all rams with horns greater than or equal to 3/4-curl were removed in each population during the fall hunting season, it is reasonable to expect that growth during the next year would push the mean horn size above the minimum theoretically possible.

One more study area was used to determine harvest rate at full-curl age/size. This area in the eastern Alaska Range was managed for high-quality trophy hunting beginning in 1974. The trophy management plan included setting the legal age/size at full-curl, limiting participation by lottery permit, and setting a harvest quota which was less than the annual increment of trophy, full-curl rams. Hunter reports from this area are required by the permit to hunt there, and population size has been established by repeated aerial survey.

Survivorship curve: The survivorship curve for unhunted Dall rams was plotted from a life table constructed using all known age ram skulls collected by Murie from 1937 to 1941. Previous analyses of Murie's skull collection data (Deevey 1947 and Bradley and Baker 1967) have been criticized because of uncertainty that they were based on skulls from populations satisfying the inherent assumptions of stable population size and stationary age structure (Murphy and Whitten 1976). Murie (1944) stated that the sheep population of McKinley Park reached maximum size in 1928. The spectacular die-off occurred 4 years later in 1932, and Murie began to collect skulls in 1937. Skulls which were deposited before the population peaked (1928) would have to have been on the ground for at least 11 years before Murie found them. The length of time a skull persists is unknown, but it is likely the skulls Murie collected were deposited between 1928 and 1937. Most of the skulls were probably deposited during the die-off of 1932. Consequently, it seems likely the population was stable during the time in which the skulls Murie collected during his 1st effort were deposited. Murie collected skulls again in 1941. His statement that, "Since 1932 the sheep population has not varied greatly," (Murie 1944 p 68) indicates population stability during the 2nd period of skull deposition. This reconstruction of the population history indicates there is little reason to criticize the use of these pooled data for construction of a life table on the basis of failure to satisfy the condition of population stability. Similarly, collection of a large number of skulls over a fairly long period of time should minimize difficulties resulting from time-specific perturbations in age structure.

Once the survivorship curve for ages 2 through 13 had been established, the slope for the best straight line for data points 2-6 years was determined. This slope was then used to estimate the number of yearlings required to produce the 2-year olds already in the sample. Bradley and Baker (1967), Geist (1971), and Hoefs (1983) have shown that for most species of North American wild sheep ram mortality between ages 1 and 2 years is identical in rate to that in the following years. These investigators as well as Murphy and Whitten (1976) have published data which substantiate the observation that lamb and yearling skulls were underrepresented in Murie's collections of ram skulls.

Bradley and Baker (1967) stressed the importance of survival from lamb to yearling age as well as magnitude of lamb production in relating generalized survivorship curves to specific populations. Since data required to relate the survivorship curve to production and survival in McKinley Park are not available, I shall assume the basic shape of the survivorship curve generated there is applicable to other Dall sheep populations of similar population quality. When generating a working model for specific, heavily hunted populations of similar quality the use of production and survival data from each study area where harvest rate data were gathered would be ideal. Unfortunately, these data are not available. As an alternative, I used data from a typical Interior sheep population located about 80 km (50 mi) east of McKinley Park, the Dry Creek population. This sheep population has been the subject of intensive study since 1968, and a continuum of data are available from it. The Dry Creek population has supported heavy ram exploitation for 10-12 years, and provides an opportunity to build into the model any possible latent effects of heavy ram exploitation on lamb production and subsequent survival.

For this approach to be above criticism, the Dry Creek population should exhibit population stability and a stationary age structure. This has not been the case over the years since 1968. However, the population has gone through a "cycle" during that time. The population was 1,470 sheep in 1972. It declined slowly to 1,250, and then recovered to a population of 1,450 in 1982. The mean lamb production and survival during this "cycle" should give rates necessary to maintain the population at in relating generalized survivorship curves to specific populations. Since data required to relate the survivorship curve to production and survival in McKinley Park are not available, I shall assume the basic shape of the survivorship curve generated there is applicable to other Dall sheep populations of similar population quality. When generating a working model for specific, heavily hunted populations of similar quality the use of production and survival data from each study area where harvest rate data were gathered would be ideal. Unfortunately, these data are not available. As an alternative, I used data from a typical Interior sheep population located about 80 km (50 mi) east of McKinley Park, the Dry Creek population. This sheep population has been the subject of intensive study since 1968, and a continuum of data are available from it. The Dry Creek population has supported heavy ram exploitation for 10-12 years, and provides an opportunity to build into the model any possible latent effects of heavy ram exploitation on lamb production and subsequent survival.

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Relating survivorship curve to harvest rate data: Typically a survivorship (l_x) curve begins with a synthetic "cohort" of 1,000 lambs. The number of sheep required to produce this many ram lambs is calculable. Since the sex ratio of mountain sheep is 50-50 at birth (Hoefs 1979, Simmons 1983), the production of 1,000 ram lambs would require the birth of 2,000 lambs of both sexes. Given the production rate required for stability in the Dry Creek population, 42 lambs per 100 ewes, the number of ewes required to produce 2,000 lambs would be 4,761 ewes. Population composition in Dry Creek averaged 54% ewes during the aerial surveys of 1970, 1975, and 1980. Applying this mean figure yields a calculated population size of 8,817 sheep (exclusive of lambs) to produce 1,000 ram lambs at stability under conditions of heavy but submaximal ram hunting for 3/4-curls and nominal predator abundance (Heimer and Stephenson 1982).

RESULTS

Harvest rates: Harvest rates for the 4 3/4-curl management areas and the full-curl management area are given in Table 1. These data show a mean maximal harvest rate of 2.4% was sustained by the 3/4-curl study populations across 4 different mountain ranges proceeding northward to mid-Alaska. These study areas include 2 with maritime influences, the Kenai and the Chugach, and 2, the Talkeetna Mountains and the eastern Alaska range, with continental climates. Table 1 also shows the sustained harvest rate in the trophy management area is 3.4%. This population is of significantly higher population quality than the other 4 study areas (Heimer and Smith 1975). Three of these, the Kenai, Chugach, and Talkeetna study areas are of similar, but below average quality. The Delta Management area is of average quality.

Survivorship curve: Data taken from Murie (1944) and applied to the Dry Creek population are presented in the life table (Table 2). The survivorship curve plotted from this life table is shown in Figure 2. The equation describing the "flat" portion of the curve from ages 1 through 7 years is, $y = -12X + 572$. Fitting a linear equation through the data points from ages 8 through 13 years given the equation, $y = -92X + 1228$. Also shown on Figure 2 are the ages at which Dall rams reach 3/4-curl, 7/8-curl, and full-curl horn development. The size/status classes for rams (Geist 1971) are plotted on the abscissa as well as age in years.

Relating harvest rate to survivorship curve: A sheep population under conditions comparable to the 4 areas which provided data on sustainable harvest rate at 3/4-curl management would have to be stable at 8,817 sheep exclusive of lambs. Multiplication of this population size by the rate of sustainable maximal harvest gives a realizable maximum annual harvest of 212 3/4-curl rams.

DISCUSSION

The most striking conclusion suggested by these data is that maximum sustainable harvest at 3/4-curl is considerably less in practice than predicted by the survivorship curve. The observed sustainable harvest level of 2.4% predicts a sustainable harvest of only 212 rams from the projected population of 8,817 sheep required to produce the lamb cohort of 1,000 rams. This is only 42% of the 510 rams which should reach 3/4-curl each year according to the survivorship curve. This immediately raises the question of whether the data are reliable and the analysis justifiable.

It is possible that the observed harvest rate could be in error. If there were many hunters killing but not reporting rams, 2.4% would be unrealistically low. While it is likely that harvest is somewhat underreported, it is not likely that a difference of this magnitude is caused by unreported harvest in the combined study populations. In the Kenai study area, the number of legal rams observed prior to hunting season during the aerial surveys usually matched the reported harvest (Nichols pers. commun.) There is little reason to suspect the magnitude of unreported kill even approaches a level which could give a doubling of the sustainable harvest rate in all 4 areas. Also, it should be emphasized that the population estimates in Table 1 are conservative. This tends to overestimate harvest rate. The number of sheep reported for each population in Table 1 is the number of sheep actually observed on the best aerial survey of each area. Work with marked animals in the Alaska Range (Heimer

1982) has shown that experienced pilots with experienced, highly-motivated observers probably miss at least 15% of the sheep present under survey conditions which include rugged terrain and fairly large population sizes (N = 1,000). I think the chance that harvest rate determined in the field is a gross underestimate is very remote.

Another possible source of error could lie with the survivorship curve. Errors may have been made in assembling the population history and age structure which misrepresented the generalized mortality for Dall rams. The curve does not differ greatly from other survivorship curves generated for Dall rams (Deevey 1947, Hoefs 1983, Murphy and Whitten 1976). It is also very similar to the survivorship curves for other species of North American sheep (Bradley and Baker 1967, Geist 1971, Woodgerd 1964, Sugden 1961). The most likely error lies in relating harvest rate and population size to the survivorship curve. I have mentally exhausted the possible errors in this analysis, and welcome the efforts of my colleagues in identifying serious mistakes in this area.

Given that data and analyses up to this point are acceptable, the question of why there is such a large difference in the theoretical and observable maximum harvests must be answered. I think the most fruitful approach lies with the hypothesis that removal of all Class III and Class IV (those above 3/4-curl) rams greatly increases mortality among the Class I and Class II rams which remain after hunting season.

Survivorship curves for all species of North American sheep have in common a greatly increased mortality at attainment of social dominance (Class IV). This social maturity generally occurs at 8 or 9 years of age and coincides with full-curl horn development in thinhorn species which do not broom horns as extensively as the bighorns. The mortality data in Table 2 show 2 noticeable increases in mortality between years. One is between 7 and 8 years, and may be thought of as the result of social dominance since it occurs coincident with Class IV status. The other occurs between ages 11 and 12 years and may be thought of as physical breakdown due to advanced age. If everything else were equal, it would be expected that the premature promotion of physically and behaviorally immature Class I and Class II rams to social dominance by removal of their inhibitory dominants through hunter harvest should cause a mortality rate equal to that of rams aged 8 years and older in an unhunted population.

For purposes of illustration and prediction, I fitted a straight line through the points of the survivorship curve from 8 through 13 years (Fig. 2). If this line is shifted along the abscissa to the point where it intersects the 3/4-curl age vertical at 2.4% of the model population (212 rams); it indicates the rut-associated mortality becomes operative on half of the Class I rams (Fig. 2 Line A). Rams in this group would be 2.5 years of age and in their 2nd rut. In an unhunted population, rams exposed to this mortality rate would be 7.5 years old and in their 7th rut. In the absence of Class III and

Class IV rams, the only rams not subject to rut-associated mortality would be those aged 1.5 years.

Nichols (1971) compared rutting behavior between the Surprise Mountain herd (Table 1) and an unhunted population located 16 km (10 mi) from Surprise Mountain on the Kenai Peninsula. He found that rams in the heavily hunted population actively participated in the rut at younger ages than in the unhunted group. Table III contains some of his findings.

These data show a shift toward greater involvement in the rut by young rams (beginning as early as 1.5 years); involvement was 6 times greater in the 2nd rut after inhibitory dominants were quantitatively removed. A 2nd striking increase in ewe-checking interactions was observed in the 1/2- to 3/4-curl (Class II according to Geist) group. This group showed a doubling in participation compared with a 41% increase in Class III rams.

These data indicate a linear representation of presumed rut-associated mortality is somewhat simplistic, and that full participation in the rut may not begin until a year later than projected using the linear model. Still, Nichols' 1971 data show a 6-fold increase in activity by rams in their 2nd rut. This may be important even though the absolute percentage of ewe-checking displays was fairly small (at 6%). Geist (1971) reported the young bighorn rams he studied had a markedly different rutting behavior and efficiency than mature rams. He observed immature rams courting anestrous ewes with an intensity that could only be described as harassment. Similarly, Nichols (1971) concluded

that young rams are less efficient than larger rams and that this inefficiency forces more energy expenditure by both ewes and rams. He stated that younger rams often harassed ewes repeatedly, nudging and
kicking at them and forcing them to move repeatedly. He speculated that inefficiency could well lead to unrecoverable energy losses in the young rams. If, as the coincidence of social maturity and increased mortality suggests, full participation in rut leads to accelerated mortality in Class IV rams, it is probably that the effect will be equal or greater on very young rams who are less efficient. Data collected in Dry Creek show the mean body weight of Class IV rams was 30% greater than the mean for Class II rams in spring (Heimer unpubl. data). Thus, in addition to rutting inefficiently, the young rams have lower total energy reserves and are metabolically disadvantaged because of their smaller body size. Still, whether the mortality is better described by a linear or higher order equation is an academic question; results are the same, a 2.4% harvest which was empirically observed, not derived from Figure II.

For simplicity in predicting the effects of transferring rut-associated mortality to young rams at different ages, I maintained the linear model for mortality. In order to predict the attainable harvest at 7/8-curl, note the legal definition for age at harvest is moved 1 entire ram status/size Class to the right. That is, maximal removal of legal rams will leave the entire Class III group in the population at rut rather than leaving the rutting to Classes I and II. Consequently, it may be

warranted to allow the linear model for mortality to become "operative" 1 full size/status Class later than the earlier model for 3/4-curl harvest. This would mean the accelerated mortality rate line should be moved to where it intersects the "flat" portion
of the survivorship curve at 4.5 years instead of 2.5 years (Fig. 2 line B). This predicts a slightly increased harvest of 250 (rather than 212) legal rams at maximum, an increase of almost 30% above what was observed at maximal 3/4-curl harvest. Thus, the sustainable harvest rate should rise to 2.8%. Similarly, moving the linear mortality rate line another complete size/status Class to the right predicts the sustainable maximum harvest at full-curl (Fig. 2 Line C). If rut-associated mortality becomes operative at half of size/status Class III or 6.5 years, the model predicts a sustainable harvest of 305 full-curl rams annually. This is an increase of 44% above that sustainable at the 3/4-curl level or a maximum sustainable harvest rate of 3.5%.

Since minimum distortion of the social structure appears to assure maximum survivorship and harvest rate, it should follow that ram harvests above 2.4% could also be sustainable by harvesting from all age classes of rams. However, management experience has shown that the hunting public is much more interested in full-curl rams than in half- or quarter- curl trophies. As a result, the practicality of enforcing a nonselective harvest regime spread across the entire ram segment of the population is highly questionable.

If minimal distortion of the social structure results in lowered mortality among the remaining rams, it may be that maximum cropping of full-curl rams will have a smaller increased mortality effect than total cropping of 7/8- or 3/4-curl rams simply because the social disturbance is smaller. This should cause an even greater increase in the harvest rate sustainable within a population managed for maximum full-curl production. If there were no mortality effect transferred to younger rams from total cropping at full-curl harvest sustainable harvest rate could rise as high as 5%.

In practice there are data which support the basics of this argument. In Table 1, the data collected from the trophy management area show the harvest rate for this group of sheep, which is managed for submaximal harvest at full-curl, is 3.4%. This harvest rate equals that predicted by line C on Figure 2. Hence, a maximum harvest of greater than 3.4% should be maintainable. Also, ram harvests in British Columbia have shown a steady upward trend since a full-curl regulation for thinhorn sheep and a 7/8-curl regulation for bighorn sheep were established (Demarch pers. commun.).

The similarity in survivorship curves for all species of North American mountain sheep coupled with similarities in their social structures argue that these results should be applicable to North American sheep in general. Specific work documenting increased mortality rates resulting from removal of most or all social dominants is yet to be done, but it appears to be within the realm of present technology. Still, the suggestions offered by integrating harvest rate data with survivorship indicate that understanding the mechanism may be less important to the sheep manager than experimentation with full-curl harvest regimes if maximum or increased potential harvest is desired.

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Table 1. Percent of observed populations harvested in areas of maximal 3/4-curl harvest in Alaska.

Area	Year	Harvest	Observed Population[a]	Harvest rate (%)	Horn size
Delta Management Area					
Alaska Range	1975	45	1513	3.0	30.6"
	1976	41	1513[b]	2.7	31.5"
	1977	42	1513[b]	2.8	31.2"
Pioneer Peak/Goat Creek					
Chugach Mountains	1976	4	300	1.3	30.1"
	1977	4	300[b]	1.3	30.5"
	1978	9	300[b]	3.0	31.1"
Surprise Mountain					
Kenai Peninsula	1973	2	213	0.9	30.0"
	1974	6	189	3.2	32.9"
	1975	5	154	3.3	28.8"
	1976	4	156	2.6	27.9"

Table 1. Continued.

Area	Year	Harvest	Observed Population[a]	Harvest rate (%)	Horn size
Boulder Creek/Chickaloon River/Hicks Creek Talkeetna Mountains	1976	24	750	3.2	29.7"
	1977	18	750[b]	2.4	29.5"
	1978	14	750[b]	1.8	30.7"
	Mean			2.4	30.7"
Trophy Area (full curl) Alaska Range	1976	37	1235	3.0	36.3"
	1977	44	1235[b]	3.6	35.5"
	1978	51	1235[b]	4.1	36.7"
	1979	35	1235[b]	2.8	36.0"
	1980	42	1235[b]	3.4	36.1"
	1981	52	1235[b]	4.2	37.5"
	1982	37	1235[b]	3.0	36.3"
	1983	38	--	3.1	36.8"
	Mean			3.4	36.4"

Table 1. Continued.

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[a] Population size observed in this year.

[b] Aerial survey not flown in area, population apparently stable from last count.

Table 2. Life table for Dall rams from McKinley Park and Dry Creek data.

Age	Frequency in sample (No. Skulls)	Cumulative frequency	% survival of 1,000	% mortality of 1,000	No. alive of 1,000
0	--	547[a]	--	--	1,000
1	--	312[b]	.570	.430	570
2	5	305	.978	.022	557
3	6	300	.984	.016	549
4	7	294	.980	.020	538
5	8	287	.976	.024	524
6	8	279	.972	.028	510
7	17	271	.971	.029	495
8	26	254	.937	.063	464
9	37	228	.898	.102	417
10	52	191	.838	.162	349
11	75	139	.727	.273	253
12	60	64	.460	.540	117
13	1	4	.063	.937	7
14	3	3	.750	.250	5

Table 2. Continued.

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[a] Calculated from mean survival in Dry Creek from 1972-1982.

[b] From findings of Murie, Bradley and Baker, Hoefs, Geist, etc. which show that survival between years 1 and 2 equals that between ages 2 and 7 yrs.

Table 3. Percent of ewe-checking interactions initiated by rams on Surprise Mountain and an unhunted, control population.

	Rams in 1st rut	Rams in 2nd rut	Class II rams (Geist)	Class III rams (Geist)
Surprise Mountain (heavy hunting for 3/4-curl rams)	2%	6%	51%	41%
Unhunted control population	0%	1%	22%	29%

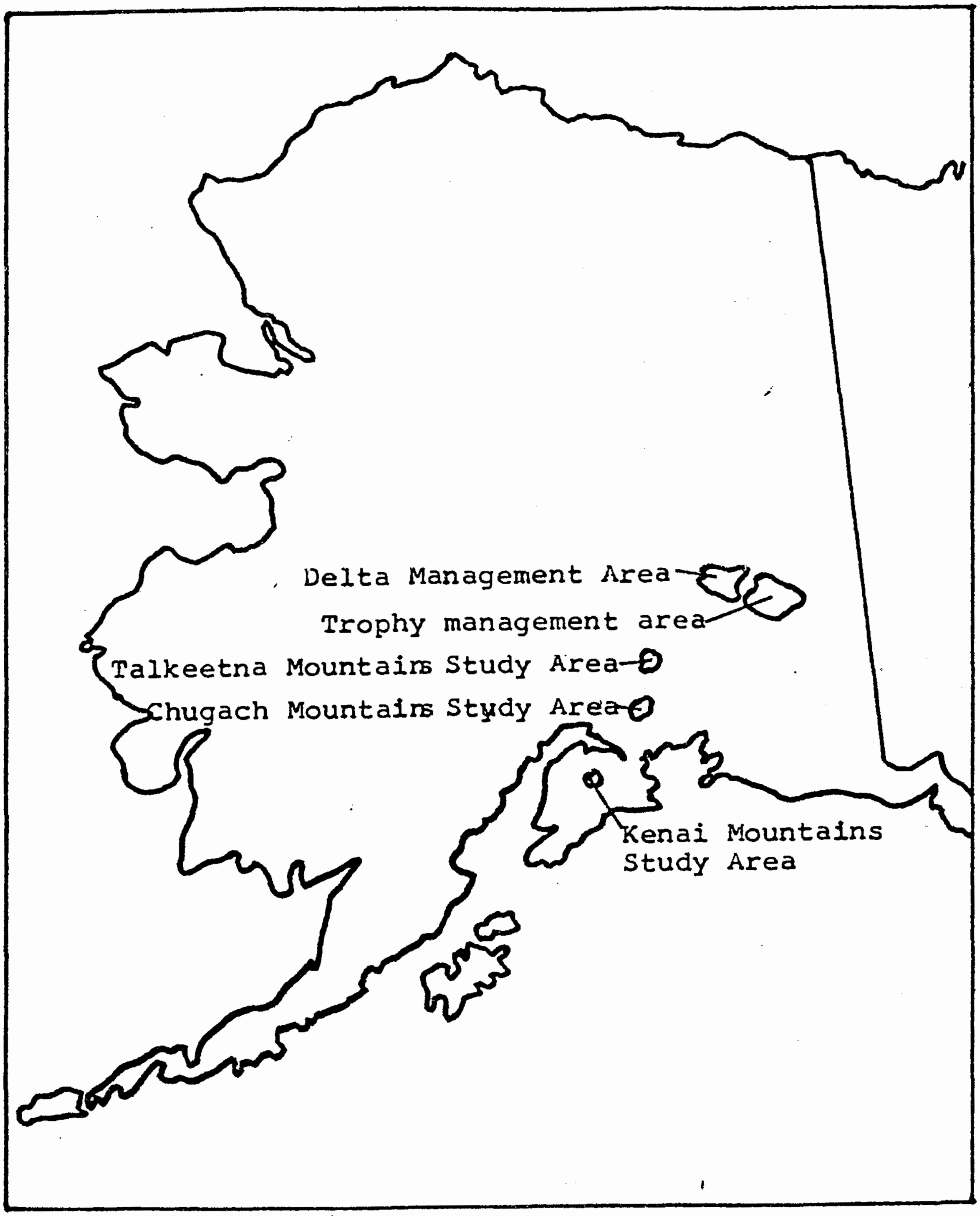

Figure 1. Areas in Alaska where sustainable harvest rates are known.

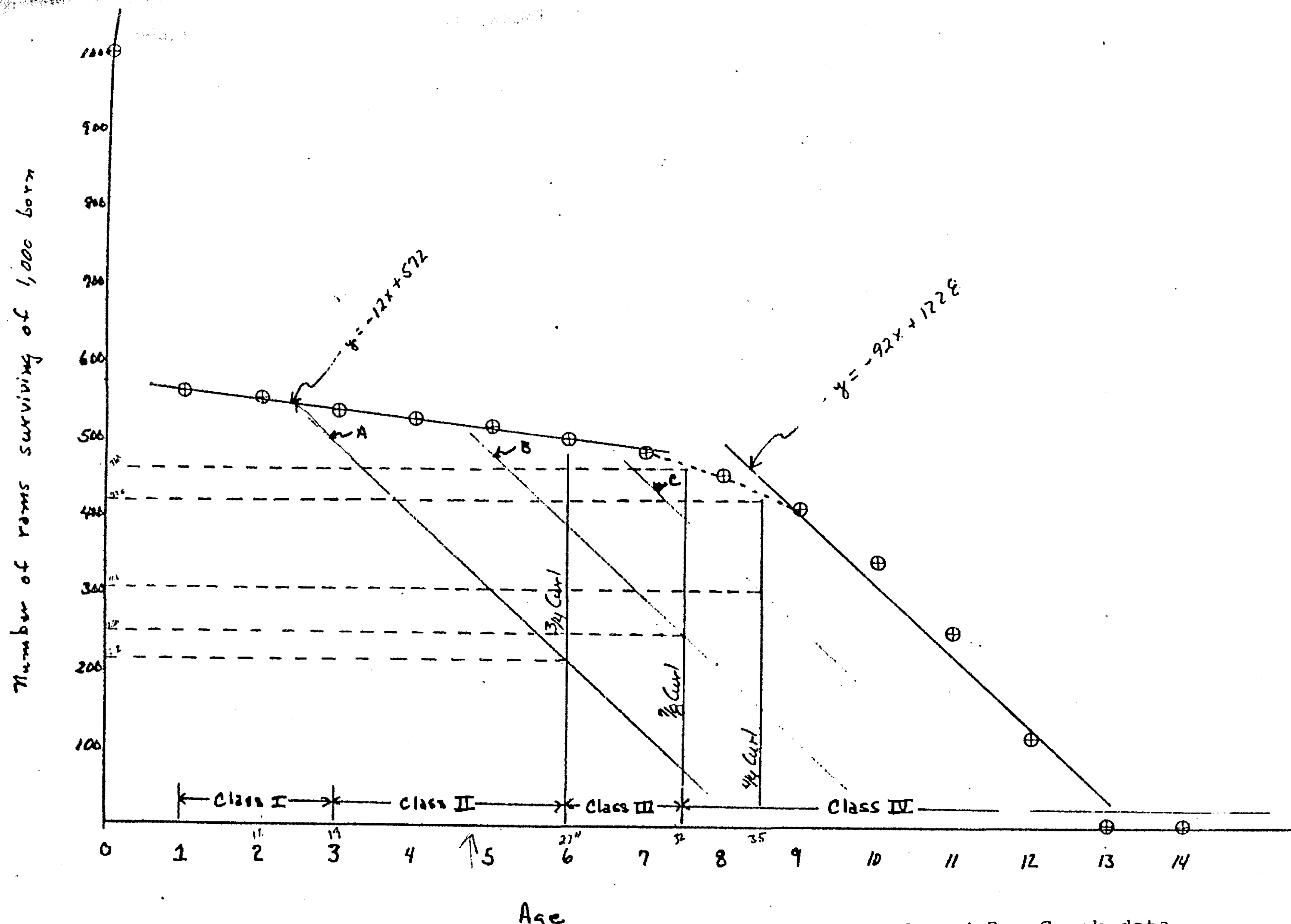

Figure 2. Survivorship curve for Dall rams from McKinley Park and Dry Creek data.