SOME EFFECTS OF A FULL-CURL LAW ON DALL'S SHEEP MANAGEMENT

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ABSTRACT

Measurements of Dall's sheep (Ovis dalli) ram's horns were converted from linear to cumulative degrees of arc per year. Average degrees of curl-growth were plotted by year for all horns that had reached full-curl; a growth curve was fitted to this data. All horns that had reached 3/4-curl but not full-curl before the ram's death were fitted to similar curves and plotted against age to estimate the number which would or would not reach full-curl had the ram lived to its full potential life span of 14 years. Of those examined, a minimum of 15% would not have reached 360° before death. This, plus loss in curl by natural wear and a natural mortality of 14-43% after 5 years of age, represents the loss in potential rams available for harvest between their average age at 3/4-curl and that at 4/4-curl, and would be the cost in lost hunting opportunity to hunters of a full-curl vs. a 3/4-curl law.

INTRODUCTION

Traditional management of Dall's sheep in Alaska has been by horn curl. For many years 3/4-curl was the legal minimum for rams. This was defined as a horn "...the tip of which has grown through three-quarters of a circle (270°) described by the outer surface of the horn, as viewed from the side." In 1979, this requirement was arbitrarily raised to 7/8-curl (315°) with no proven biological or management justification. The only biological justification postulated was that older rams are needed in a population to assure adequate breeding (Geist 1971). In fact, evidence to the contrary was found on the Kenai Peninsula, where 2 adjacent herds were compared (Nichols 1976). One had been hunted heavily and almost every 3/4 curl ram (and later every 7/8-curl ram) was removed annually, while a second herd was closed to all hunting and contained a nearly natural population of older rams. Over the 14-year period these herds were under observation, there was no statistical difference in ratios of lambs:100 ewes between herds. Stewart (1980), in a study of bighorn sheep, O. canadensis, found no increase in mortality of young rams due to breeding stress and could detect no relationship between dominance and mortality.

Another justification advanced for the 7/8-curl law was that it would produce more large trophies. This was proposed primarily by members of the guiding industry, who at the time were attempting to have a full-curl law passed. The Board of Game compromised upon a 7/8-curl regulation.

Once again a full-curl law is being proposed. Since such a law presently can be justified only on the grounds of producing larger trophies, sheep managers and hunters should be made aware of the cost of such a law in terms of potentially lost hunting opportunity. Not all sheep hunters would prefer to have a full-curl ram (Wishart 1974) especially if such a law would result in significantly fewer rams to hunt.

The natural mortality of rams between the average ages at 3/4-curl, 7/8-curl, and full-curl has been documented by several researchers (Buechner 1960, Murphy 1974, Heimer and Smith 1975, Hoefs and Cowan 1979), but largely ignored by managers. Their literature suggests that from 14-43% of all rams die of natural causes between the ages of 5 years (3/4-curl) and 9 years (4/4-curl). In other words, depending on a variety of factors such as winter weather, predation, herd density, etc., out of 1000 rams available to hunters as 3/4-curls, a range of 140 to 430 would not be available if hunters had to wait for all rams to reach full-curl.

Additionally, Hoefs and Nette (1982) found that loss from natural horn-tip wear, exclusive of brooming, was significant in older rams, and that little or no increase in length could be expected after age 8 in the Yukon. "Brooming" (breaking off of horn tips during clashing) further reduces horn length and curl by an additional and variable amount.

Another factor in loss of hunting opportunity caused by a full-curl law is that a proportion of rams never reach full-curl because of the growth form of their horns. Several studies have been concerned primarily with horn growth by length (Heimer and Smith 1974, Shackleton 1973, Wishart and Brochu 1983). However, management here is by curl, not length. This study re-examines earlier horn measurements and determines the percentage of rams that reached 3/4-curl but would not have been expected to reach full-curl within their lifespan.

METHODS

Measurements of 570 sets of ram horns were made at taxidermy shops in the early 1970's by Erickson (1970), Heimer and Smith (1975), and others. Their data included: total horn curl in degrees, diameter of curl based on horn axis, and annual growth by length. Methods of measurement were described by Heimer and Smith (1974). I converted cumulative annual length measurements from their data on 355 horns into degrees of arc and averaged them by year for all horns which reached or exceeded 360°. A relatively smooth curve was produced by graphing these averages against age, and a curvilinear equation was derived by trial and error using a number of possible formats. A curve of the form $Y=Ae^{B/X}$ (where Y is an estimated point on the curve representing degrees of horn curl, A and B are calculated constants, e is the natural logarithm, and X is a selected age) produced a consistently good fit ($r=0.99+$) for most horns. The constants for this curve were then calculated (Hewlett-Packard HP-67 program #03193D) for each horn which had not yet reached

360° by the time of the ram's death. A curve, using this formula but with constants as calculated for each individual horn, was then generated by computer for each of these horns and plotted against horn-curl and age to estimate whether or not the horn would have reached full-curl within the animal's maximum expected lifespan.

Curves and points were plotted for means of a sample of full-curl-or-better horns from each of the mountain ranges represented in the original data: Alaska Range East of Denali National Park, Brooks Range, Chugach Range, Kenai Mountains, Talkeetna Mountains, and Wrangell Mountains. Each average annual growth in cumulative degrees from age 2 through age 8 was compared between ranges by analysis of variance. There was insufficient data to compare above age 8.

RESULTS

Average cumulative horn-growth in degrees by age was graphed for horns having reached 360° before death, and was plotted against a fitted curve (Figure 1). It can be seen that the curve fits the means for each year's growth very well. Also indicated are the ages at which the curve and the actual data reach 3/4, 7/8, and 4/4-curl. These ages are about 5, 6-7, and 9 years, respectively. Minor differences in growth rate (but not form) were found between the mountain ranges. Although differences existed on an annual basis, the only consistently significant difference ($P < .05$) in horn curl was between the Wrangell Mountains and the Brooks Range, with the latter population exhibiting less cumulative horn growth as rams got older (Figures 2 and 3).

In all of the over 500 original measurements, only 2 horns were found from rams which had lived 13 years. It appears that very few rams reach age 13, and almost none reach 14. Therefore, age 14 was selected as the maximum to which any ram would grow. This is a liberal estimate, but for purposes of this study, I assume that if a ram's horns could not be expected to reach 360° by age 14, they would never do so. Therefore, graphs were generated on a computer with maximum ordinates of 360° for horn-curl (the minimum we are interested in under a full-curl law), and 14 years of age. Any horn-curl growth curve projection reaching 360° before age 14 was considered to have the potential for reaching full-curl. Any not reaching that size by age 14 was assumed not to have that potential.

Curves generated for each of the horns which had not yet reached full-curl by the time of the ram's death showed considerable variation (Figures 4-6) but most reached full-curl within the maximum assumed lifespan. In some cases, the fitted curves forecast that the horns would reach full-curl, but the observed data suggested this would not be so. In all cases, if the forecast growth reached 360°, the horn was considered as having full-curl potential. This assumption produces a conservative estimate of horns unable to reach full-curl within a ram's lifespan (Table 1).

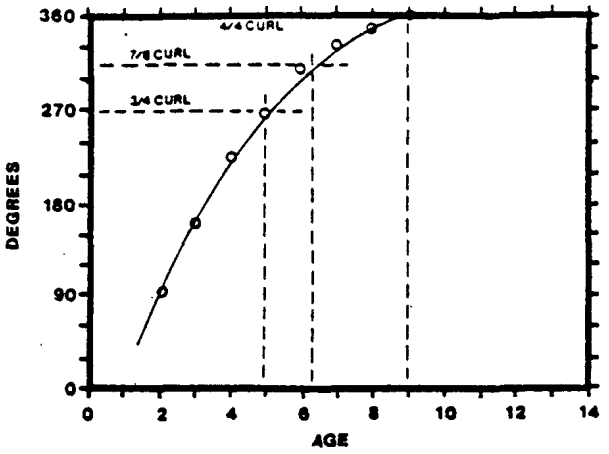
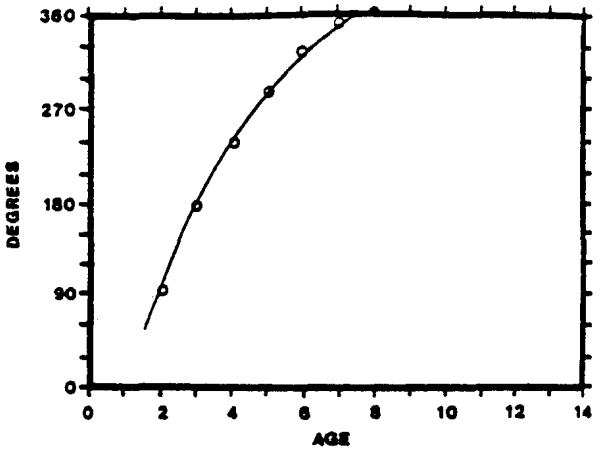


FIGURE 1



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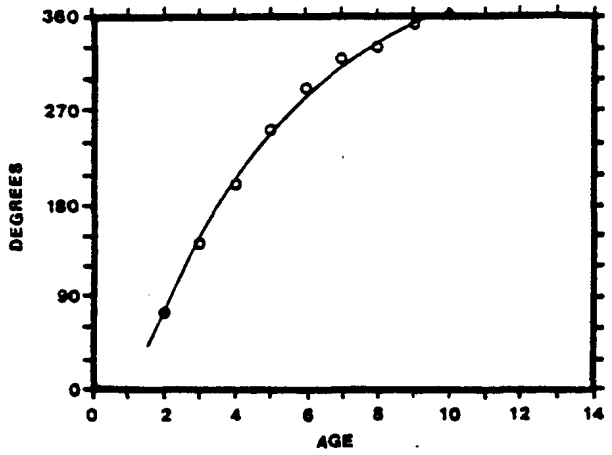

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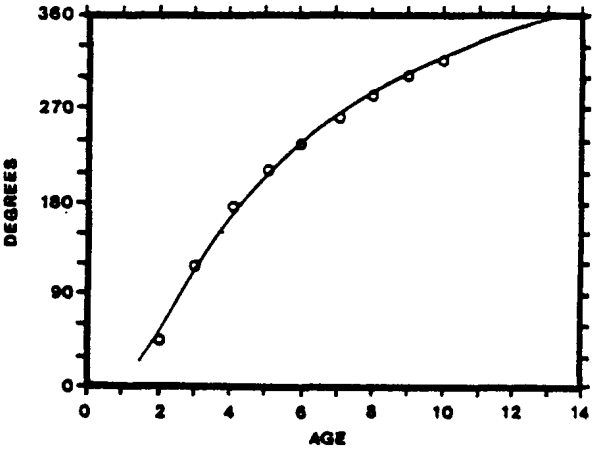

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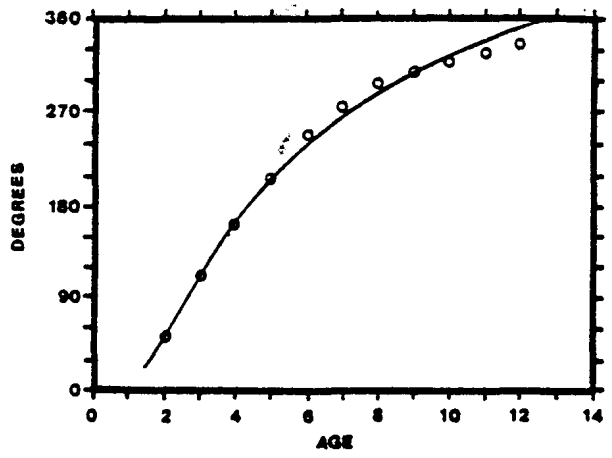

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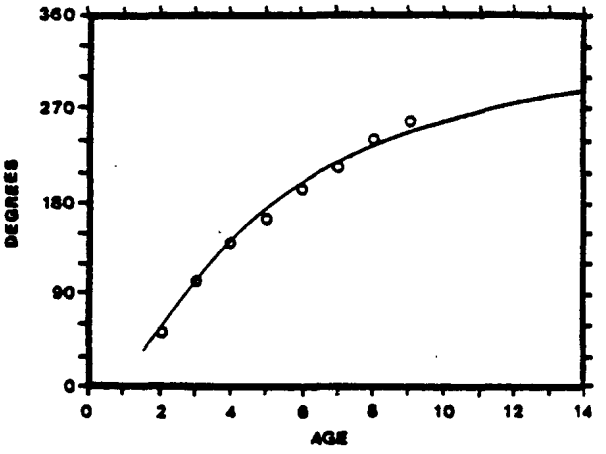

FIGURE 6

Dall's sheep horns by age and degrees of curl.
(Solid lines represent mathematically fitted curves;
circles represent original data points.)

Figure 1. Means of full-curl horns from all areas sampled, with probable ages indicated at specific sizes.
Figure 2. Means of full-curl horns from Wrangell Mountains.
Figure 3. Means of full-curl horns from Brooks Range.
Figure 4. Example of projected horn growth reaching 360^0 before age 14.
Figure 5. Example of projected horn growth reaching 360^0 before age 14, while actual data points suggest growth will not reach 360^0.
Figure 6. Example of projected horn growth not reaching 360^0 before age 14.

Table 1. Potential of sub-full-curl Dall's sheep rams' horns to reach full-curl during rams' life span.

Area	Would reach 360° Percent	N	Would not reach 360° Percent	N
All Alaska	85	165	15	28
Alaska Range E.	80	37	20	9
Brooks Range	63	20	38	12
Chugach Range	92	24	8	2
Kenai Mountains	100	17	0	0
Talkeetna Mountains	87	20	13	3
Wrangell Mountains	96	47	4	2

DISCUSSION

Based on these analyses, I estimate that at least 15% of all rams which have reached 3/4-curl will not reach full-curl even if the ram lived to be 14 years old. This is a conservative estimate for the following reasons: few or no rams actually live to age 14 and those dying earlier would reduce the potential of some horns reaching full-curl before death. The hypothetical growth curves tend to overestimate the potential of horns to reach 360° before age 14. Thus, the actual percentage of sub-full-curl ram horns without the potential to reach full-curl is probably higher than 15%.

Examination of Table 1 shows that the estimated percentage of rams unable to reach full-curl status varies by mountain range. A full-curl law would appear to have less effect on hunting opportunity in some areas, such as the Wrangell and Kenai Mountains (although the small sample size may have biased the estimate for the latter area), than in the Alaska Range or, especially, the Brooks Range, where almost 40% of 3/4-curl rams may not reach full-curl within their lifetime.

On average, of every 1000 3/4-curl rams available to hunters under a 3/4-curl law, a maximum of only 850 would be available under a full-curl law because of horn growth characteristics. This loss in opportunity is in addition to that caused by natural mortality, horn wear, and brooming during the intervening years. While they may not be directly additive (some rams without the potential to reach full-curl would be among those dying of natural causes), these potential losses represent a substantial decrease in hunting opportunity to the public should a full-curl law be implemented.

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