LESSONS LEARNED FROM RATES OF INCREASE IN BIGHORN HERDS

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Abstract: Bighorn herds have the potential to double their numbers in approximately three years. Theoretical and actual cases are provided in this paper. For 100 bighorns it was found the optimum ratio for herd maintenance at a 1:1 sex ratio was approximately 20 lambs: 40 ewes (1+ yrs) of which no more than 30 ewes (2+ yrs) were required to optimize production. The implications of these ratios for managing nursery herds are discussed.

DISCUSSION

Rocky Mountain Bighorns are a density dependent species relegated by predators and deep snow to islands of unique habitats of rocky escarpments adjacent to grassy pastures, which in winter are exposed to wind and/or sun. These"islands" are quickly overpopulated by a species that has the potential to double approximately every three years (Buechner 1960). Bighorns throughout their ranges have at one time or another followed most of the suites of population curves and age pyramids found in most ecology texts, e.g.,Odum (1971).Wildlife managers should be able to recognize where their bighorn herds fit in these population configurations and as managers should take appropriate measures in regulating herd numbers.

The capability of bighorns to increase at a rapid rate was demonstrated by Beuchner (1960) using Leopold's (1933) life tables and examples from bighorn populations from Wildhorse Island, Tarryall and Fort Peck. For example, the annual rate of increase at Wildhorse from 1947 to 1954 was 30% and is almost identical to the "no mortality" table from Leopold.

Recently, we observed a similar rapid increase (26% per annum) in a bighorn nursery herd that was colonizing a coal mine site that was undergoing reclamation at Minalta Coal Ltd. Gregg River Mine (GRM) near Hinton, Alberta (Table 1). The mine site is immediately adjacent to a largely reclaimed mine site leased by Cardinal River Coals Ltd.(CRC) that presently harbors a large bighorn herd that has stabilized around 400 animals. Aside from the rapid increase in the GRM herd, there were two other notable events. The first observation was that the GRM herd had a high lamb : ewe ratio (53:100) compared to the CRC herd (23:100) immediately to the south during the same year, 1996, indicating significant differences in density dependent responses by the two adjoining herds. The second observation was that the age structure of the GRM ewe and lamb herd corresponded closely to the Leopold "no mortality" table of 100 animals (Table 2), i.e., approximately 20 lambs:40 ewes (1+ yrs) and 30 ewes (2+ yrs).

Table 1. Rate of increase in a bighorn nursery herd during colonization of a reclaimed coal mine site at Gregg River Mines (GRM), Alberta 1993-1996.

YEAR	Lambs	Yearlings	Ewes	Total	
1993	12	11	17	40	annual rate of increase 26%
1996	23	15	35	73	

At this point, it is appropriate to note that the above age ratios of ewes to lambs was maintained in a population of bighorns that were kept at 100 animals at a 1:1 sex ratio through ewe harvests, transplants and ram hunts for six years (1975-1980) at Ram Mountain in west central Alberta (Jorgenson and Wishart 1986) see (Table 2). In other words, during that period the population was kept at the inflection point of its sigmoid curve, that is, young and productive and near its maximum potential rate of increase and with minimal losses to natural mortality such as old age. Thereafter, the herd was left to expand without ewe harvests and although the population doubled during the next ten years, the rate of increase (7% /annum) was far below the annual potential of 30% suggesting that indeed we had been managing the herd at or near its inflection point at 100 animals.

Table 2. Age composition of ewes with lambs in populations of 100 bighorns.

HERD	Lambs	Yrlgs	2 Yrs	Ad	Total	
Model	23	9	7	23 =	39 ewes (30 2+ewes)	Leopold (1933)
Wildhorse (1954)	18	7	5	27 =	39 ewes (32 2+ewes)	Woodgerd (1964)
Ram Mtn. (1975-80)	21	9	8	24 =	41 ewes (32 2+ewes)	Jorgenson and Wishart (1980)
GRM	23	8	(35)	=	43 ewes (35 2+ewes)	This study

In order to maintain the 20:40:40 ratio at Ram Mountain during the 1970's, it was necessary to remove approximately 18% of the ewes each year. Two notable events took place within the ewe herd under this harvest regimen. Firstly, some of the yearlings began to breed and, secondly, when adult ewes(2+yrs) exceeded 28 animals there was an abrupt decline in breeding by yearling ewes. In either case, lamb production and survival within the frame of 40 ewes was equally successful. Hence the conclusion, that a herd of 100 bighorns with a 1:1 sex ratio could be maintained by approximately 20 lambs:40 ewes (1+ yrs) and with no more than 30 ewes (2+yrs). In fact, this optimum age ratio of ewes and lambs on nursery ranges is basically independent of ram numbers, since the young rams leave the nursery ranges after a few years and remain segregated from the ewes except during the rut. By viewing a nursery herd that appears to support only 20 lambs implies that it requires no more than 40 ewes one year and older to maintain that production; the rams are simply a by-product (Jorgenson et al. 1993).

At the CRC mine during a bighorn nursery herd population rise of approximately 9% per year from 1985 to 1993, the population was being subjected to a ewe removal program that averaged 11% per year. In other words, the ewe removals were insufficient to prevent a population increase. This was due partly to new ranges being created by reclamation, however, by 1995 the nursery herd had peaked at 184 ewes (1+yrs) with 98 lambs followed by a drop to 51 lambs and 186 ewes the following year. As stated earlier , the adjoining herd that was expanding at the GRM site enjoyed a healthy lamb:ewe ratio of 53:100. Since the population peak at CRC, it has been recommended that the total ewe herd size be reduced and stabilized at 144 females and maintained at or near the inflection of the population curve. This will require an annual removal of 26 ewes or 18% of the ewe herd. A rancher would liken this approach to a cow/calf operation, except he would remove the annual calf increment. In either case, both management systems are dealing with "fenced" or "island" populations.

Once the Ram Mountain herd was allowed to expand with the cessation of ewe removals, a significant series of population self regulation events took place (Festa-Bianchet et al. 1995). Body mass of young ewes decreased (Figure 1) and corresponded to increased age at primiparity and decreased lamb production. Primarily, the young ewes stopped breeding; first the yearling ewes, followed by the 2 yr-olds, then the 3 yr-olds. The reduced contribution of lambs from young ewes was reflected in the declining percentage of lambs to adult ewes (3+ yrs) (Table 3 and Figure 2). In other words, the bottom of the age pyramid began to shrink. Although there were ewe and lamb age ratios approaching Leopold's "no mortality" table in some years during rise, the percentage of lambs/adult ewes (3+ yrs) was approximately 20% below Leopold and approximately 10% below the years of optimum production on Ram Mountain (Table 4).

Fig. 1. Ave. wt. gain of yrlg ewes

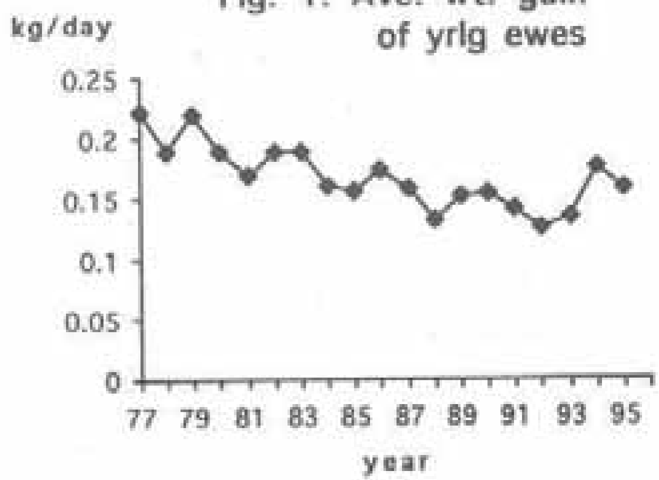


Table 3. Adult ewe (3+ yrs) : lamb ratios at Ram Mountain from 1975 to 1997 in response to ewe removals, followed by the rise and fall of the population during five year intervals without ewe removals.

YEARS	Adult Ewes (3+ yrs)	Lambs	Percent Lambs	Ave. Age of all Ewes
1975-82 (population control)	24	22	92	3.8
1983-87 (population rising)	43	35	81	4.4
1988-92 (population peaking)	70	47	67	5.1
1992-97 (population falling)	77	43	56	6.4

Figure 2. Diverging ewe/lamb numbers on Ram Mtn. 1975-1997.

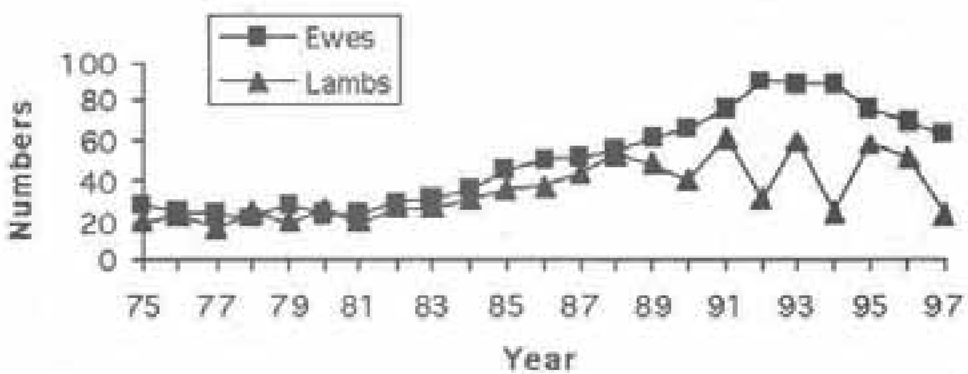


Table 4. Ewe and lamb age ratios at Ram Mountain (RM) in 1983 and in 1989 during a population rise that were approximately comparable to Leopold's (1933) "no mortality" life table.

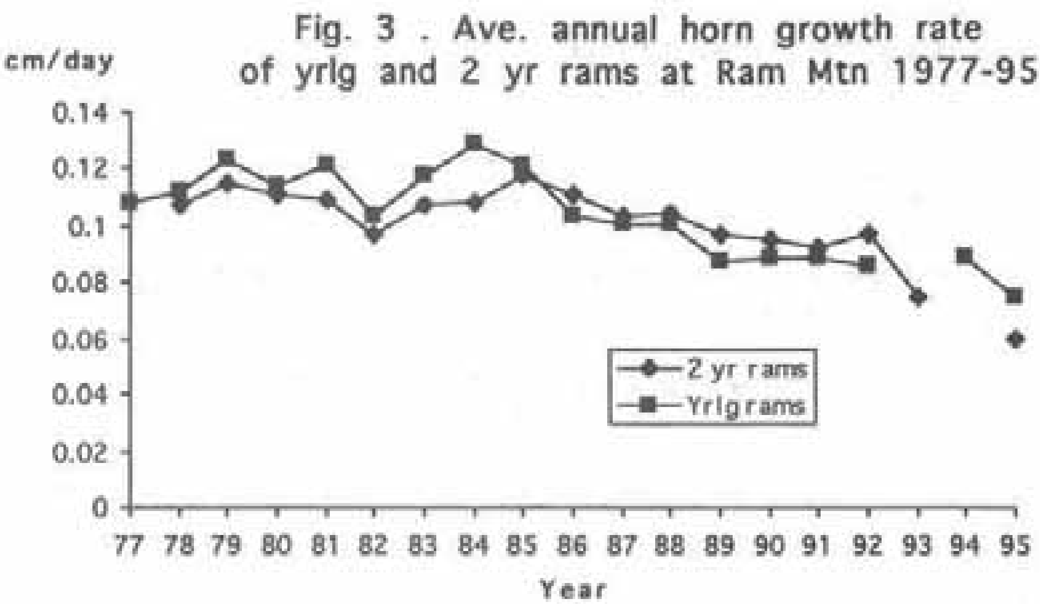
YEAR	Adult Ewes (3+ yrs)	Lambs	Percent Lambs	Yearling Ewes	2 yr Ewes	Total Ewes and Lambs
RM 1983	31	26	84	13	7	77
Leopold	30	30	100	12	9	81
RM 1989	61	48	79	24	11	144
Leopold	61	61	100	23	18	163

The early stages of overpopulation are not easily perceived in bighorn populations from lamb:ewe ratios without accurate knowledge of the age structure of the ewes to at least age three. In a field situation without ground counts and a lot of marked animals this precision of assessment is not attainable (Jorgenson 1992, Festa-Bianchet 1992). However, the later stages of overpopulation are quite apparent when ewe and lamb numbers begin to diverge as we observed at Ram Mountain and as we often see in our mountain Parks. In the late 1970's in southwestern Alberta we failed to perceive the consequences of this ewe/lamb divergence in our bighorn herds from aerial surveys until after a pneumonia die-off (Table 5). Although the die-off may not have been prevented, the losses may have been less severe (Onderka and Wishart 1984).

Table 5. Numbers of bighorns observed from winter aerial surveys north of Waterton Park to Crowsnest Pass, Alberta before and after a pneumonia die-off (1975-1984). *Note diverging ewe/lamb numbers from 1975 to 1979 before die-off, followed by continued low lamb production.

YEAR	Ewes	Lambs	Rams>1/2 curl	Rams >4/5curl	Total
1975	187	81	50	35	353
1979	248	77	44	29	389
1981/82			die-off		
1983	86	20	4	5	123
1984	108	19	21	3	159

One of the more conspicuous symptoms of overpopulation, aside from reduced body mass in young ewes, is reflected in reduced horn growth of young rams on the nursery ranges (Jorgenson et al. 1998). At Ram Mountain, horn size in yearling and 2 year-old rams decreased significantly as the nursery herd increased (Figure 3). This observation of poor initial horn growth in rams on an overstocked range in Banff National Park (BNP) was also noted by Shackleton (1973). He compared ram horn increments from BNP and a herd recovering from a die-off in Kootenay National Park (KNP). Rams from KNP had significantly greater horn lengths and diameters during their first four years of growth compared to BNP.



Horn increment measurements can be relatively easily obtained from rams harvested from various ranges and can provide a useful measure of population quality as predicted by Geist (1971). It is interesting to note that many record book rams are a result of nursery herds having accessed new or renewed ranges following die-offs, transplants, fires or reclamation. This has been particularly true in Alberta and Montana (Gilchrist 1992).

In summary, Rocky Mountain bighorns have a very high reproductive potential, possibly in response to short-term density fluctuations during their evolution (Festa- Bianchet and Jorgenson 1998). Certainly this capability has served the species well when they have invaded and heavily utilized newly formed food sources from fires or avalanches, thereby suppressing forest succession in their favor. In recent times the natural sources for range expansion have been largely replaced by introductions of sheep to new or former ranges or by sheep invading reclaimed mine sites. Bighorn managers should keep in mind that with this high reproductive potential, mountain sheep should be managed as though they are about to overpopulate an island. This can be achieved by removing the ewes, keeping in mind that a nursery herd requires no more than 30 ewes (2+ yrs) to produce 20 lambs. Overpopulation clues can be reflected in poor lamb crops, poor growth rates in young ewes and poor early incremental growth in ram horns.

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