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SUSTAINABLE BROWN BEAR HARVEST IN SWEDEN ESTIMATED FROM HUNTER–PROVIDED INFORMATION

JON E. SWENSON
Norwegian Institute for Nature Research, Tungasletta 2, N–7005 Trondheim, Norway
FINN SANDEGREN
Swedish Hunters Association, Research Unit, Box 7002, S–75007 Uppsala, Sweden

Abstract: We compared a hunter-provided index of the annual population trend of brown bears (*Ursus arctos*) in Sweden during 1963–91 with harvest rates with time lags of 0–20 years. We conclude that this trend index probably reflected at least the major trends of the population. Harvest rates 6, 8, and 14 years earlier explained 83% of the variation in the population trend, as perceived by the hunters. From these data, we estimated a sustainable legal harvest of 44.5 bears in 1991. This estimate is very close to that of 43–50 bears, which we have estimated using independent methods. In addition, estimates of the harvest level to maintain the present rate of increase calculated by both mehtods were also similar. Although many hunters have been unhappy with the present quota system, this analysis of hunter-provided data gave support to the present quota levels.

Key words: brown bears, harvest-quotas hunting, Sweden, *Ursus arctos*.

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INTRODUCTION

Recently we estimated the size of the Swedish brown bear (*Ursus arctos*) population to be about 620 in spring 1991 and that the sustainable legal harvest was about 7% annually, or about 43 bears (Swenson et al. 1994). The population estimate was based on marked-unmarked ratios of breeding females observed with radio-marked adult males during the breeding season in two study areas and an extrapolation to the rest of the country using the distribution of females and hunter statistics. Two other methods yielded similar population estimates. The estimate of sustainable legal harvest was based on a 1.5% mean population growth over the past 50 years, from four population estimates, and a mean harvest rate of 5.5% during this period. After gaining additional information on the distribution of females and performing a new population estimate in the southern study area, we revised the population estimate to about 670 in Sweden (Swenson et al. 1995). Assuming a sustainable legal harvest rate of 7%, the sustainable annual harvest would be 50 bears.

During 1981–91, when bears were hunted on a quota system, the harvest increased at an average rate of 9.6% annually; doubling every 7.2 years (Swenson et al. 1994). By 1987–1991, the annual legal harvest averaged 43.8 bears. This equaled the sustainable harvest we calculated in 1991. Because the official policy in Sweden is to allow the brown bear population to continue to increase and expand (Frisén and Eriksson 1992), we proposed a new hunting system that included female subquotas, limiting the harvest of females to maximum 5% (Swenson et al. 1994). This system was implemented by the Swedish Environmental Protection Agency (SEPA) in 1992, and the 1992–94 harvest fell to an annual average of 32.3, a drop of 26% from the 1987–91 period. This should allow a population increase of about 2% annually.

Bear hunting in Sweden is open to all hunters who own or lease hunting rights in areas open to bear hunting and have a rifle allowed for big game. Most bear hunting occurs incidentally during moose (*Alces alces*) hunting and is popular, because the possibility of shooting a bear adds to the big-game hunting experience, but bear hunting itself also is growing in popularity. The new regulations implemented in 1992 came rather abruptly and without prior notification. Most hunters reacted negatively, both to the female subquotas, which reduced the harvest, and to the way in which they were implemented. Many hunters claimed that there were many more bears than we estimated. They also said that want higher quotas and were unhappy that we did not use their collective knowledge when making estimates.

In a sense, the hunters had a point. It is notoriously difficult to estimate the size, trend, and effect of hunting on bear populations (Eberhardt et al. 1986, Harris 1986, Harris and Metzgar 1987a, b, Miller et al. 1987, Garshelis 1990, Miller 1990a, b). Therefore, we decided to analyze the hunters' impressions of population trends, as recorded during 1963–91, to see if this information could be useful for bear management in Sweden.

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METHODS

The perceived trend of the bear population was reported

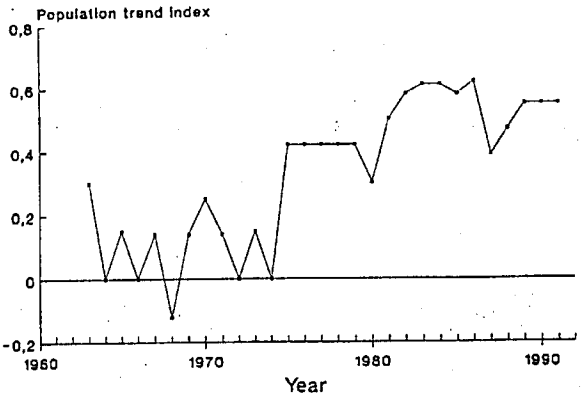

Fig. 1. The status of brown bears in Sweden as perceived by hunters during 1963–91. The population trend index is a mean of the annual reported status for each province, where increase = 1, stable = 0, and decrease = −1.

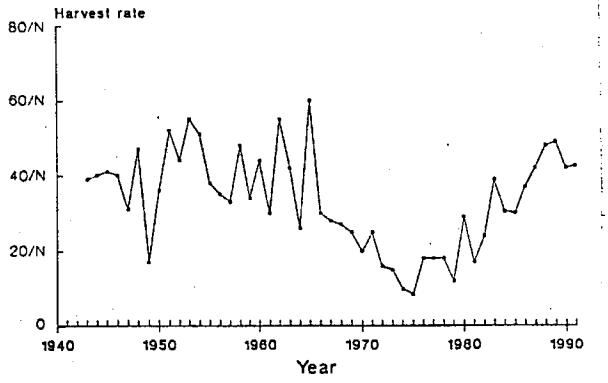

Fig. 2. Legal harvest in relation to the calculated brown bear population in Sweden annually 1943–91 (N = population size in 1991).

annually by representatives of the organized hunters as increasing, stable, or decreasing for each province with bears during 1963–91 in the annual reports of the SHA. We gave a report of increase the value of 1, stable a 0, and decrease a −1 for each province and calculated an average index for the entire country for each year (Swenson et al. 1995). This type of index has been used commonly in Scandinavian wildlife research (Myrberget 1982, Steen et al. 1988, Lindström et al. 1994).

Of course, such an index should not be accepted uncritically. As a test of its potential reliability, we made two predictions: (1) the index would vary inversely with the harvest rate, because all evidence indicates that the earlier decline in brown bear numbers in Scandinavia was caused primarily by overharvest (Myrberget 1969, Lönnberg 1929, Elgmork 1994, Swenson et al. 1995), and (2) this relationship should occur with a time lag because age structure can take 10–15 years to stabilize following a change in harvest rate (Harris and Metzgar 1987b) and because bears reproduce slowly (Bunnell and Tait 1981, Miller 1990a).

The sustainable harvest is more important to hunters than the number of bears, which is a controversial subject. We could avoid estimating bear numbers by designating the number of bears in 1991 as N. Numbers before then were estimated using the equation in Swenson et al. (1994a), assuming a stable population increase of 1.5% annually. Thus, the population increased from 0.48N in 1943 to N in 1991. Harvest rate was also estimated relative to N by dividing the number killed legally each year from 1943 to 1991 by the population estimate for that year (e.g. 18 bears shot in 1943 divided by the population estimate, 0.48N, equals 37.5/N). Population trend index for each year was entered as a dependent variable into a stepwise multiple regression with annual harvest rates delayed 0 to 20 years as independent variables. Harvest data are from the annual reports of the SHA (1943–80) and files of the SEPA (1981–91).

Table 1. Results of a stepwise multiple regression between the population trend of brown bears in Sweden as perceived by hunters (y) and annual legal harvest as a proportion of the estimated population using time delays of 0 to 20 years (x) during 1963–91. Only significant relationships ($p<0.05$) are reported here.

Time delay (years)	Regression results			
	R	R^2	F	p
8	−0.713	0.509	27.96	<0.0001
6	−0.827	0.686	28.24	<0.0001
14	−0.909	0.826	39.61	<0.0001

RESULTS

The population trend index showed that hunters considered the bear population to be generally stable or slowly increasing during 1963–75. After 1975, the population was considered to be increasing more generally over the country (Fig. 1). Harvest rates have also varied during the period hunting has been allowed, with a lower level in the 1970's and the early 1980's (Fig. 2). When population trend was regressed against harvest rate with time delays, significant relationships were found for each time delay from 5 to 15 years, with the highest relationships in the range of 6 to 14 years (Fig. 3). In the stepwise multiple regression, three significant relationships were found, using delays of 8, 6, and 14-years (Table 1, Fig. 4). Together, these three harvest rates explained 83% of the variation in the population trend experienced by the hunters (Table 1).

We calculated the harvest rate that would cause population stability from the multiple regression formula using these three independent variables. We set the population index (y) at 0 (stable) and the three harvest rates (x) to be equal and solved the equation for x. The result was 44.5/N. Using the 1991 population estimate of N bears, this would be a harvest of 44.5

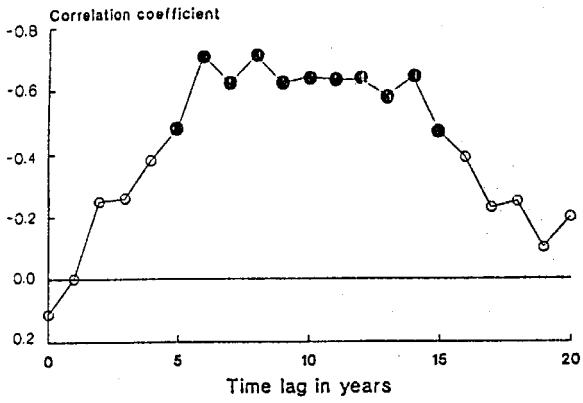

Fig. 3. Correlation coefficients from simple regressions of the population trend index on harvest rate using time lags of 0 to 20 years. Significant relationships ($p<0.05$) are indicated by closed circles.

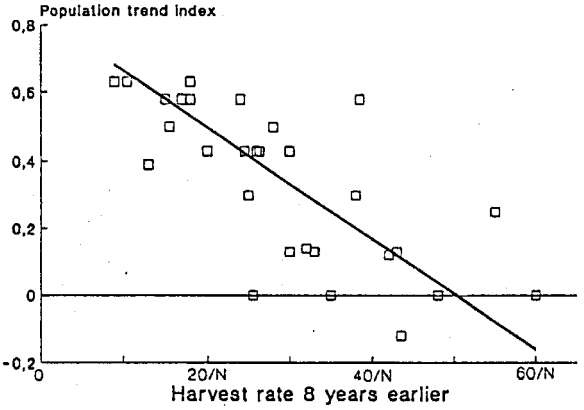

Fig. 4. Perceived trend in the brown bear population in Sweden (Fig. 1) in relation to the harvest rate 8 years earlier (Fig. 2).

bears. For 1943, it was 21.4 bears (44.5/N times 0.48N). The mean harvest rate from 1943–91 was 33.6/N (*SE*=1.8), or 33.6 in 1991. At this level of harvest, the bear population should continue to increase at 1.5% annually.

DISCUSSION

The hunter-provided population trend index apparently reflected major trends in the population, although we could not determine its absolute accuracy. Both predictions were upheld; hunting pressure was a major factor affecting the perceived population trend, and there was a time lag of about 5–15 years between changes in hunting pressure and detection of changes in population trend. We would not have based harvest recommendations on these hunter-provided data alone. However, there was close agreement between the sustainable annual legal harvest determined from the hunter information, 44.5 per year, and that obtained from our independent data, 43–50, and the annual legal harvest to maintain the present rate of increase, 33.6 from hunter information and ca. 31 from our data (Swenson et al. 1994). This increases our confidence in our recommendations.

Several aspects of the trend index made it suitable for this type of analysis. First, there was a wide variation in the trend index and the harvest rate over a relatively long period (18 years). Second, the dominant trend was one of increase. The increase resulted in an expansion of bears into areas that had not had permanent bear populations for many decades. It would certainly be easier for hunters to notice the appearance and increase of bears numbers in new areas than to accurately detect a decline. However, there was a widespread impression of population decline, or at least stability, during the late 1960's and early 1970's. In 1969, the hunter representatives from Norbotten requested that the bear be protected in this northernmost province. Third, the trend information was not used in setting the quotas, which perhaps allowed the hunters representatives to be more objective than they might otherwise have been. Fourth, most hunters in Sweden hunt in the same area each year and know the area well.

The hunters provided reliable information that, when analyzed, supported the present quota levels. Yet, there is a widespread feeling among hunters that todays quotas are too low. Several conditions specific to bears make it difficult for hunters to accurately evaluate quota levels. First, the relatively long time delay for a population change to be noticed by hunters after a change in harvest rate makes it difficult to associate harvest rate with population trend. Second, bear populations are very sensitive to overharvest, requiring more conservative harvest strategies than the other big game species found in Sweden (Bunnell and Tait 1981, Knight and Eberhardt 1985, Miller 1990a). Third, bear home ranges are very much larger than hunting lease areas (Wabakken et al. 1992).

We in the bear research project have been somewhat skeptical to use observations of bears and bear sign from the public because of a documented high error rate (Elgmork et al. 1976) and because previous population estimates based on such observations were grossly overestimates (Swenson et al. 1995). The results of this study show that hunter observations, perhaps as opposed to those from the general public, can gave valuable information. We hope that these results will lead to a closer cooperation between hunters and researchers, with us using more of the hunters' information in our research program, and the hunters showing a greater acceptance of our research findings.

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