Sustainable management of the saiga antelope

E. J. Milner-Gulland

The saiga antelope is exploited principally for its horn. Two major factors will influence the manager's decision about the best sustainable hunting strategy for the saiga: the climatic unpredictability of the region in which it lives and the effects of highly selective hunting for males on the population dynamics of the species. This paper discusses these factors and assesses the prospects for sustainable management of the saiga.

Introduction

The saiga antelope *Saiga tatarica* is found in the semiarid steppes of Kazakhstan and Kalmykia, in the former Soviet Union, with a remnant population of subspecies *S. tatarica mongolica* in Mongolia. The males bear horns, which are highly valued in Chinese traditional medicine and so fetch a high price on international markets (Luxmoore, 1989). In the nineteenth century the saiga was heavily hunted for its meat and horns, and its numbers reached low levels (Zhirnov, 1982a). During the Soviet period the saiga was effectively managed and the population recovered over the period 1921–50. From 1950 to 1990 it was hunted in a regulated way, predominately for meat (Zhirnov, 1982a). Since 1990 severe poaching has been reported and the saiga again seems to be in danger of population decline (V. Neronov, pers. comm.). Thus, historically, saiga have been shown to be both vulnerable to overhunting and capable of sustaining regulated hunting pressure.

Two major factors influence the ability of the saiga to sustain hunting pressure. The first is the unpredictable climate of the area in which it lives. The population size has undergone major fluctuations over time, which can be linked to climatic conditions (Sludsky, 1963; Fadeev and Sludsky, 1982; Zhirnov, 1982b). Second is the effect of highly selective hunting for males on the population dynamics. The saiga is very susceptible to selective hunting pressure because only males bear horns. The Soviet managers were scrupulous in their avoidance of selective hunting (Tikhonov, 1979) but the current unregulated hunting seems to be targeting males (V. Neronov, pers. comm.).

Recently, a proposal has been put forward by the IUCN Sustainable Use of Wildlife Programme, together with the Russian Academy of Sciences, to institute a sustainable rangeland management programme for the Kalmykian semiarid steppe, with the saiga as the linchpin revenue-earning species. Thus, an examination of the necessary conditions for sustainable saiga hunting is particularly timely. This paper describes the influence of the two major factors, climate and selectivity for males, on the dynamics of hunted populations of saiga, and then discusses the other pressures on the species and its prospects for sustainable management.

Climatic factors

Saiga are affected both by drought and by harsh winters. Droughts reportedly occur about once every 3 years, severe winters once every 10 years (L. Zhirnov, pers. comm.). Analysis of climatic data suggests that the timing of droughts and harsh winters is unpredictable and that annual climatic variation in the area is not significantly autocorrelated (Milner-Gulland, 1991). Mass mortality occurs

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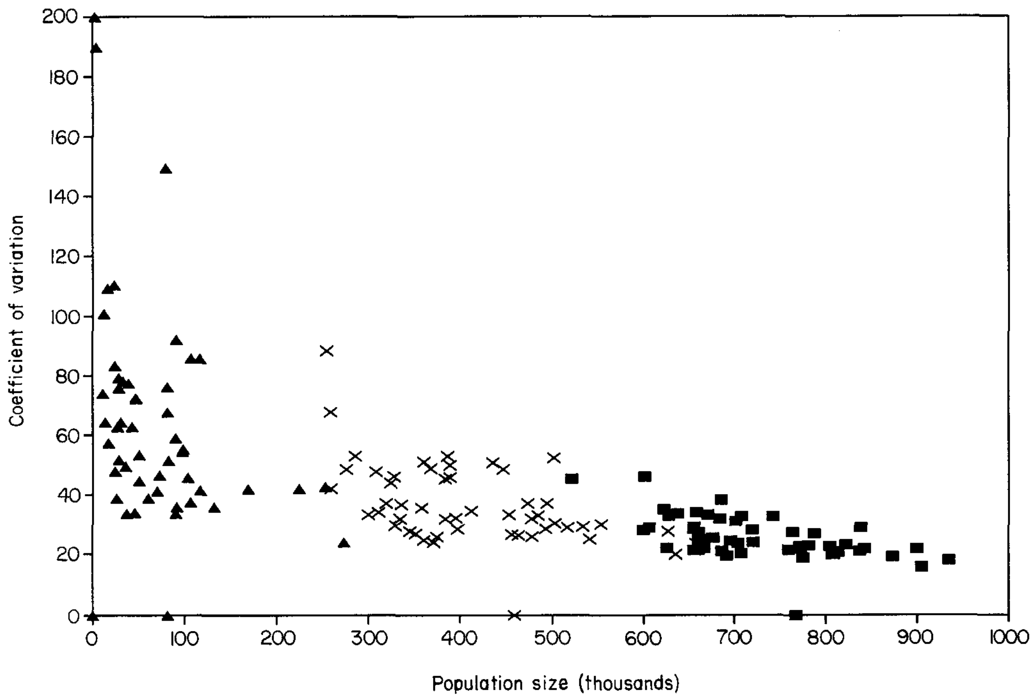

Figure 1. The mean population size and coefficient of variation over 100 years for each of 50 runs of the Leslie matrix model, with three hunting mortalities [5 per cent (■), 10 per cent (×) and 15 per cent (▲) of the population hunted per year] and 30 per cent of the harvest being made up of adult males (the unhunted population is approximately 25 per cent adult males). As the hunting mortality increases, the mean population size tends to decrease and the variance in coefficient of variation tends to increase. Also shown are the mean population sizes in a deterministic climate at the three hunting mortalities, which are above the overall mean population sizes under stochastic climatic conditions. The deterministic population sizes are the symbols on the x-axis of the graph for each hunting mortality. The carrying capacity is 1 million individuals.

in *dzhut* winters, when a layer of ice forms on the vegetation and is eaten by the saiga. Males are particularly susceptible to harsh winters because they are weakened by the rut, while females and juveniles are more susceptible to drought (Zhirnov, 1982b). The species is well adapted to the harsh climate of the Central Asian steppe in several ways. For an ungulate, it has unusually high fecundity in good years, because it routinely produces twins, the females are able to give birth in the first year of life and they continue to produce young for up to 10 years (Bannikov *et al.*, 1961). This high fecundity allows populations to recover rapidly after bad years. The species's nomadic lifestyle also allows groups to move away rapidly from areas affected by heavy snow or drought.

In order to model the effects of climate on a hunted saiga population, a Leslie matrix model was developed in which the population is divided by age and sex (Milner-Gulland, 1994). Mortality and reproductive rates vary by age and sex, and hunting can be applied differentially to age and sex classes. Four sets of demographic parameters are used, corresponding to the type of climate experienced: a good or bad summer, and a good or bad winter. Climatic states are assigned randomly to years according to the likelihood of occurrence and the model is run for a series of years. The stochastic Leslie matrix model is run many times in order to produce a distribution of population sizes and yields from harvesting saiga, depending on the climate, hunting mortality, and the hunter's selectivity for males.

As expected, the model predicts that the higher the proportion of the population killed by hunters, the smaller the average population size is, and the higher the variance around that average is. Figure 1 shows the effect of three hunting rates on the mean and variance of population size over 50 simulation runs. The mean population sizes if the climate is assumed to be constant are also shown. Although in a deterministic climate, the saiga's high fecundity would allow high sustainable offtake rates, taking climatic stochasticity into account lowers the sustainable hunting mortality substantially. The model also shows that if hunting is climatically determined, for example if it occurs only in the autumn of years with a good summer following a year with both a good summer and a good winter (44 per cent of years fit this description), variance between runs is substantially reduced and average population size is increased (for details see Milner-Gulland, 1994).

Selectivity for males

In general, the wildlife-management literature has seen hunter selectivity for males as a positive factor for the sustainable use of a hunted population (for example Fairall, 1985). A more female-biased population can have a higher per-capita growth rate than one in which females are heavily hunted, and the removal of 'surplus' males by hunters can have little or no effect on the population. Some authors have addressed the issue of scarcity of breeding males (Beddington, 1974; Caughley, 1977), but the complexity of the possible effects of sex-biased harvesting on population dynamics has not been widely appreciated (Ginsberg and Milner-Gulland, 1994).

In a polygynous species, such as the saiga, harvesting a higher proportion of adult males than is found in the population may indeed have little deleterious effect on the population, up to a point. On the other hand, biasing the harvest towards females will have a strong deleterious effect on a population's reproductive rate. However, if too many males are removed, serious reductions in the fecundity of the saiga population could ensue. The possible effects vary in subtlety, ranging from not enough males being available to mate all the females, to younger, incompetent males failing to mate efficiently if older males are removed. Any hunting that continues into the rutting season can reduce fecundity by disrupting mating, thereby leaving females unmated or producing a spread in parturition dates. This could lead to higher juvenile mortality in a species, such as the saiga, in which birth dates are highly synchronized (Bannikov *et al.*, 1961).

There is some evidence for each of these effects having a role in reducing fecundity in various ungulate species (Ginsberg and Milner-Gulland, 1994). However, there is little evidence about which effects are important for the saiga. Substantially reduced conception rates were observed in saiga in a season in which hunting was extended into the rutting season (Bannikov *et al.*, 1961), but no other observations are available. The model described above was, therefore, used to analyse the effects of hunting on the saiga, under three assumptions about the effects of selectivity of males on saiga fecundity (Figure 2). As the assumed effect of selectivity for males on fecundity becomes stronger, on average the mean population size drops and the variance about the mean increases. Clearly, the assumption made about the effect of hunting for males on the population dynamics of the species is key to the sustainable hunting strategy chosen by a manager and, in the absence of data to the contrary, a conservative assumption about the effects of hunting should be made.

Other pressures on the saiga

The saiga is under pressure from humans in other ways apart from unregulated hunting. Irrigation canals built in the 1970s cut across saiga migration routes in the west of its range,

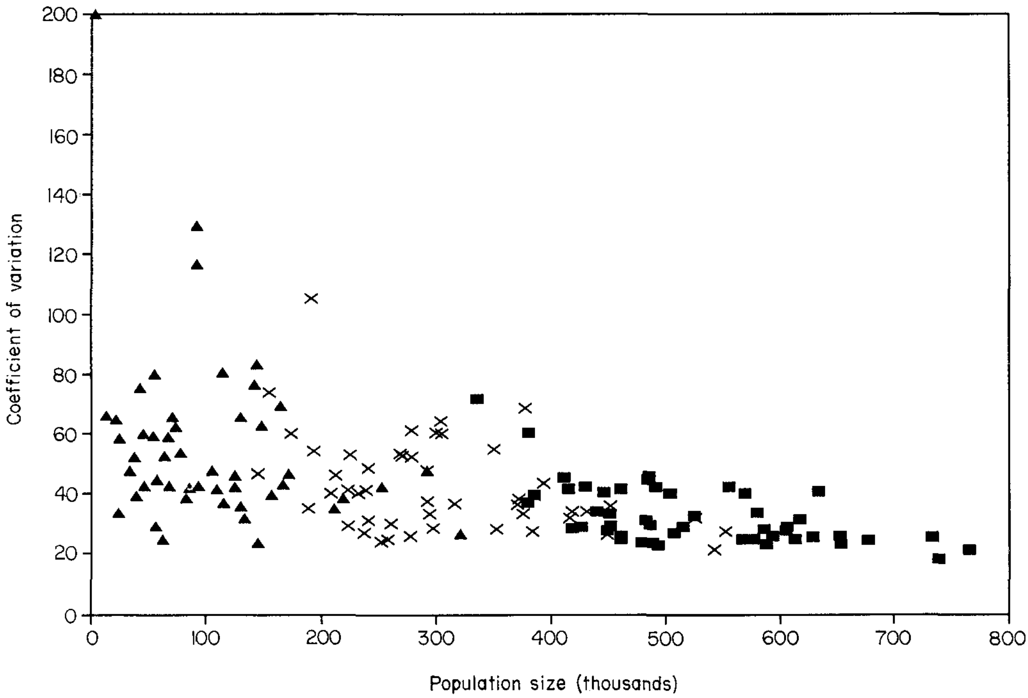

Figure 2. An illustration of the effect of a lack of breeding males on population size in a stochastic climate. In all simulated populations a hunting mortality of 10 per cent is modelled; 40 per cent of the harvest is adult males. Each of the three assumptions is run 50 times for a period of 100 years per simulation. For each simulation the coefficient of variation is plotted against the mean population size. As the assumption about the effect of males on population fecundity becomes more severe, population size declines and variance in the coefficient of variation increases. The assumptions shown are: (■) that a lack of males is limiting only at a sex ratio of less than 1 male to 12 females; at this fairly low hunting mortality this is equivalent to assuming no dependence of fecundity on males; (×) that fecundity declines linearly with sex ratio at ratios of less than two adult males to five adult females (the average ratio in an unhunted population); (▲) that both fecundity and infant survivorship decline linearly with sex ratio at ratios of less than two males to five females.

isolating the Kalmykian population. The saiga continued to migrate for some time and died in large numbers in the canals. In Kalmykia in particular, there have been large increases in livestock numbers over the last few decades, causing rangeland degradation and desertification (Vinogradov *et al.*, 1985). This has probably led to a decline in the area that can support saiga and to an increased likelihood of the transmission of epidemic disease between livestock and saiga.

Saiga are very wary of areas affected by humans. Their parturition grounds are usually found in areas of minimal disturbance. Particularly in Kalmykia, there is less and less suitable undisturbed habitat. Feral dogs are now the major predators of saiga in Kalmykia. Substantial reductions in fecundity have been observed in Kalmykia, together with alterations in migration patterns (V. I. Petrishev, pers. comm.). The causes of these changes are not clearly known as yet. In Kazakhstan, and also in Kalmykia, agriculture has spread into the more temperate northerly edges of the saiga's range. This does not affect them in normal years, but in severe droughts the saiga formerly used these areas. This buffer against mass mortality in exceptionally bad years is now likely to be unavailable.

The dependence of the saiga on a particular area of former Soviet Central Asia is dangerous for the species in a time of political instability. The Kalmykian population is under growing human-induced pressure, and is declining (Kuzyakin, 1985). Thus the species is principally dependent on a single large population in Kazakhstan. The saiga's need for large areas of undisturbed steppe to roam is one that will become increasingly hard to meet as the Central Asian steppe becomes more populated and developed.

Prospects for sustainable management

In many ways the saiga is an ideal candidate for a successful sustainable management scheme: it can sustain high hunting mortality rates, produces a high-value product, and has a well-defined end market. It is unusual in having been managed effectively for several decades in the recent past. Thus, there is some existing utilization infrastructure, and there is considerable management expertise available. Some of the drawbacks are the political instability of the region, the vulnerability of the species to episodes of mass mortality and, paradoxically, the fact that the product is of high value and is internationally traded, giving the prospect of illegal trade and a requirement for high levels of law enforcement for the legal trade to remain viable.

This paper has concentrated on the implications of the climate and saiga biology for the development of sustainable hunting strategies. Although the saiga has such high potential reproductive rates, it is vulnerable to extra human-induced mortality because of its high population variance, caused by climatic stochasticity. A species with high variance in population size should be maintained at a higher mean population size than would otherwise be necessary, to guard against it reaching dangerously low numbers in some years. Anything that increases population variance further, such as hunting in bad years, is also likely to cause problems. The fact that males have so much more economic value than females means that extra attention must be paid to the effects of sex-biased hunting on population fecundity.

In order to institute a sustainable hunting programme, the species must first be protected from unregulated hunting and other human-induced pressures. The Sustainable Use of Wildlife Programme of the World Conservation Union (IUCN) has proposed a 5-year conservation and sustainable use programme for the Kalmykian population, in collaboration with the Russian Academy of Sciences. The objectives are to conserve the saiga antelope in Kalmykia, to maintain its natural steppe habitat, to assist with the economic development of rural communities and farmers, and to provide a case study and framework for similar projects that could be instituted in the region in future. If this programme receives funding, the saiga's prospects will brighten considerably.

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