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Abstract: Serengeti cheetahs are well protected from poaching inside Serengeti National Park, but 70% of cheetah cubs are killed by other predators, mainly lions. Within the National Park it is likely that adult survival will remain high while juvenile survival will fluctuate depending on predation pressure. At low lion density, the cheetah population has a very low risk of extinction. Recently, lions did suffer an extreme population decline on the plains by canine distemper. Currently, however, the lion population is rebounding dramatically. What do you do when one endangered species is killing off another in your very large reserve?

Serengeti Cheetah Viability and the Lion Factor

*by Marcella Kelly**

Serengeti cheetahs are well protected from poaching inside Serengeti National Park. But is their population viable in the long-term, especially considering that 70% of cheetah cubs are killed by other predators, mainly lions, within the National Park? In combination with other factors that kill cubs (e.g. abandonment, floods, fires), a cheetah cub born within the Serengeti National Park has only a 5% chance of making it to one year old. For these reasons I became very interested in conducting a population viability analysis on Serengeti cheetahs. I had already compiled data from a 25-year photographic index of Serengeti cheetahs (from 1969-1994), and from this, was able to determine basic demographic parameters: longevity, reproductive success, recruitment, adult mortality, adolescent mortality, litter size at independence, etc. Then, in collaboration with Dr. Sarah Durant, we modeled the cheetah population using Sarah's population model Popgen.

We first found the population growth rate is nearly equal to one (l = 0.997), meaning that the population, on average, is self-replacing and hence is not in imminent danger of crashing to extinction. This is good news. But the population size itself fluctuates substantially and hence is subject to stochasticity, or vagaries of individual vital rates or of the environment (i.e. good and bad years). Therefore we included stochasticity in our model, allowing the computer to randomly choose vital rates for good and bad years within a reasonable range dictated by the variance we estimated in our model parameters. This showed that despite having a growth rate of nearly one, the cheetah population is still subject to extinction under environmental stochasticity (extinction risk was 30% for the next 50 years).

We also found that the extinction risk is most sensitive to changes in adult survival, such that small increases or decreases in adult survival cause big changes in extinction risk. However, because adults are well protected from poaching in the Serengeti, adult survival is already very high (87%). The probability of increasing adult survival is very low. Juvenile survival (0-1 year olds) proved to have the next strongest affect on cheetah population growth. Therefore, we went on to model the effect of different numbers of lions on juvenile survival and recruitment and to calculate extinction risk (see figure). At low lion density (72 female lions), the cheetah population has a very low risk of extinction. At average and at high lion density (98 and 120 respectively), however, cheetah extinction risk is very high. That is a bit disconcerting. Recently, lions did suffer an extreme population decline on the plains as one-third of the population was killed by canine distemper beginning in late 1993. Currently, however, the lion population is rebounding dramatically.

All of this presents a very interesting conundrum for conservation and reserve management. What do you do when one endangered species is killing off another in your very large reserve? Culling lions to protect cheetahs is not an option. Most people go to the Serengeti to see the king, and that king is the lion. Hence lion culling would be extremely unpopular. Alternatively, it is very unlikely that cheetahs would use any type of artificially constructed den designed to protect cheetah cubs from lions. Increasing juvenile survival is also unlikely. Within the national park it is likely that adult survival will remain high while juvenile survival will fluctuate depending on predation pressure. Therefore, for Serengeti Plains

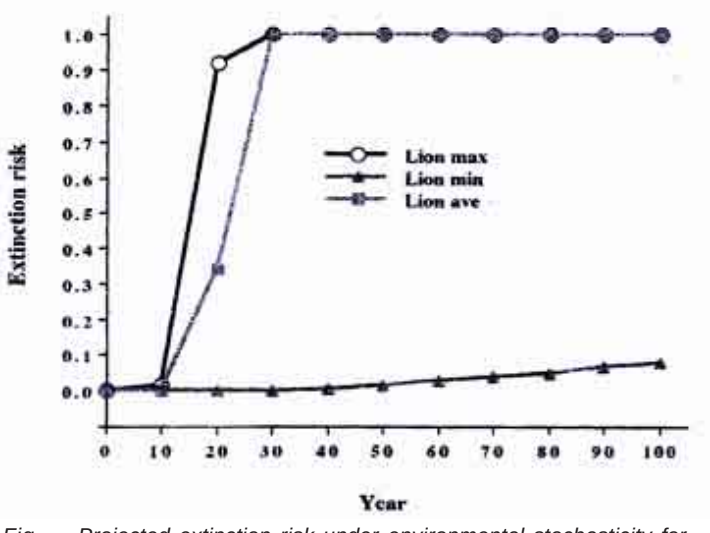

Fig. Projected extinction risk under environmental stochasticity for cheetah populations subjected to different lion densities. Low lion density, 72 adult female lions, corresponds to the minimum recorded over 20 years of lion study; while high density, 120 adult female lions, corresponds to the maximum recorded, and average lion density is 98.

cheetah conservation, it will be extremely important to continually monitor lion numbers and their effect on cheetah cubs.

There is, however, another possibility. Cheetahs are highly mobile in the Serengeti and they are capable of moving from the center of the park out into surrounding game reserves in a matter of days. In Namibia it has been suggested that cheetahs emigrate out of protected reserves because these reserves have high densities of other predators which are themselves likely to be seeking refuge from hunting pressure in surrounding reserves. Additionally, litter size at 10 months old in Namibia has been reported as 4.0, twice that of the Serengeti indicating that cheetahs exhibit signs of predator release and hence can potentially rear large litters in the absence of predation.

Cheetahs perhaps provide a good example of a fugitive species. They are excellent dispersers but poor competitors in comparison to other large predators, always losing in direct competition for food and suffering high mortality from predation. Sarah Durant has shown that cheetahs do actively avoid lions, however, and that they appear to seek out "competition refuges" with low densities of lions and hyenas. Their mobility is likely the key to their continued co-existence with other predators.

Conservation of cheetahs may rely on their protection outside protected areas as well as within core areas of national parks. The secretive and elusive nature of cheetahs may allow them to exploit edges of parks where other large, aggressive, and gregarious predators are exterminated by human hunters. In game reserve areas surrounding the Serengeti National Park, hunters and pastoralists preferentially hunt other predators but rarely hunt cheetahs. Such buffer zones would require minimal management effort and may then support high numbers of cheetahs. Aside from this possibility, we are forced to conclude that cheetahs will remain at low density and at risk of extinction even in protected areas where adult survival is high if these areas support high numbers of other large predators.

Sarah has now begun radio collaring cheetahs in the woodland areas surrounding the Serengeti Plains in order to determine the basic demographic rates of these cheetahs. If reproductive success is higher in the woodland areas than in the Plains, then perhaps the woodlands are actually a source of cheetahs while the Plains, once thought of as a cheetah stronghold, are actually a sink for cheetahs, relying on supplementation from other areas to remain viable. Hopefully, Sarah will have results of her interesting work soon.

For further information on the population viability analysis conducted on Serengeti cheetahs, see the June 2000 issue of *Conservation Biology* or contact Marcella Kelly via email.

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