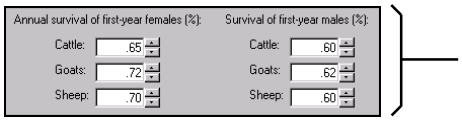
Experiments - Higher First-year Survival

Annual losses of first-year livestock in Ngorongoro Conservation Area can be extreme. Newborn mortality and the loss of animals to disease during their first year can exceed 50%. Efforts are underway by donor agencies to improve veterinary practices and reduce deaths of first-year animals. Savanna can be used to suggest how great the benefit will be to Maasai herders, relative to the costs of the programs, and other ecosystem effects.

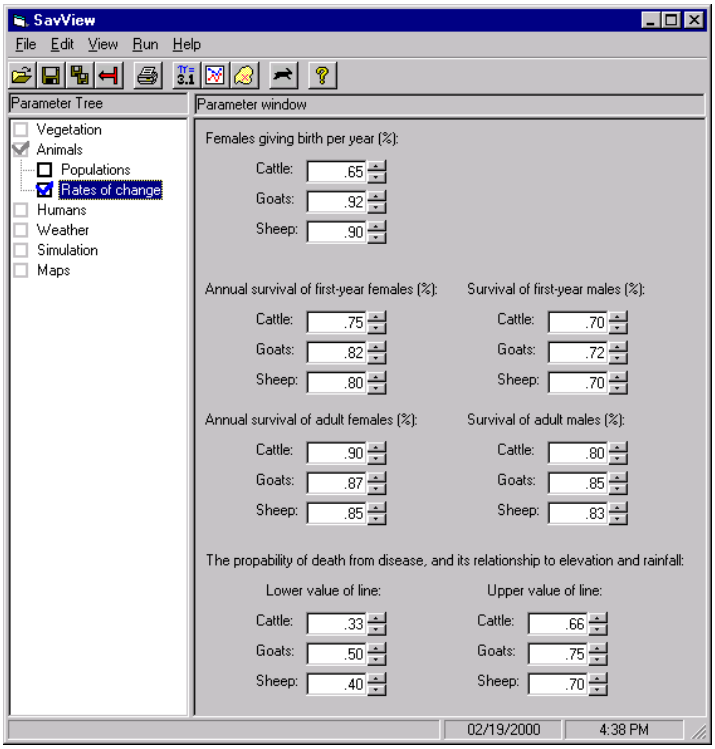
We can use SavView to adjust the first-year survival of livestock, exploring the effects of improved veterinary practices upon survival. These settings are within the "Rates of change" window under "Animals". In the example shown below, survival for both female and male cattle, goats, and sheep were increased by 10%.

Population rates of change are only used if animal populations are actually being modeled. If you find that some of the entries in the

Modified first-year survival rates



Default first-year survival rates



window shown are grayed-out, populations are not being modeled for that species. Return to the “Populations” window and enable population modeling by selecting the animal group of interest, and changing population modeling from “No” to “Yes”.

In the example we’ll review as a group, populations were culled, to prevent them from collapsing. When populations exceeded a given value (125,000 for cattle), animals were culled to a lower population (120,000 for cattle).

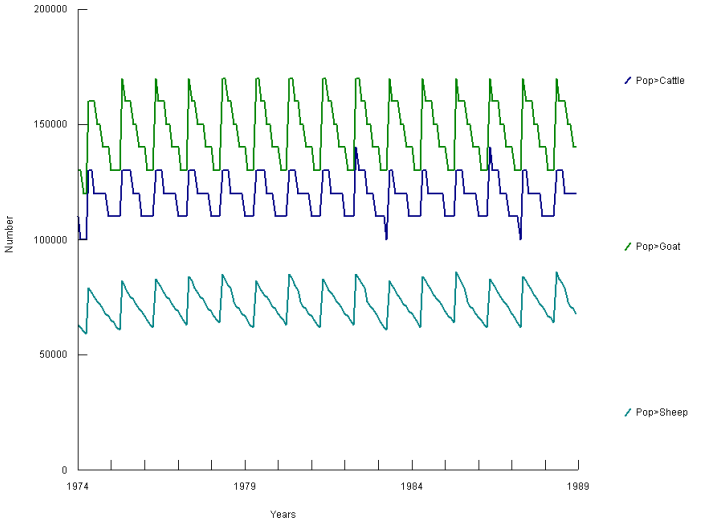
Exercise: As a group, we will review the effects of setting livestock first-year survival 10% higher than in the control model. We will look at the number of animals culled, and changes to plants and animals within the ecosystem.

Notes: Note that the control model was still be adjusted when this volume was produced, so the numbers shown as default may not be current.

Experiments - Higher First-year Survival (continued)

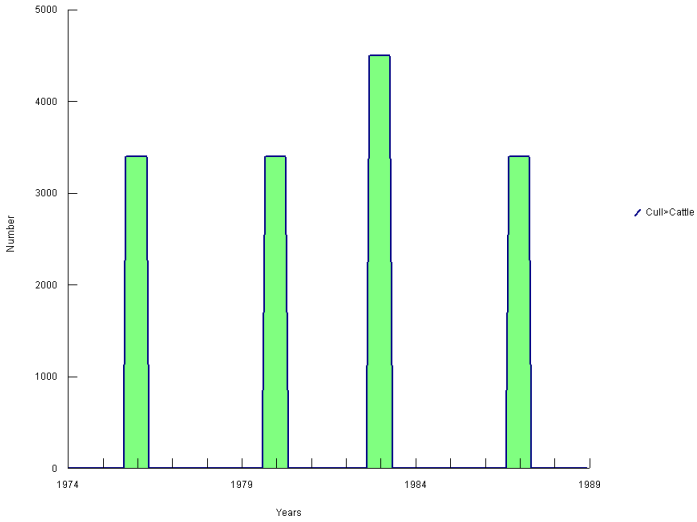
Livestock populations

Livestock populations are culled when they reach a given limit. For example, here if the number of cattle exceeds 125,000 animals, the population is reset to 120,000 animals, and the culled animals are summed.

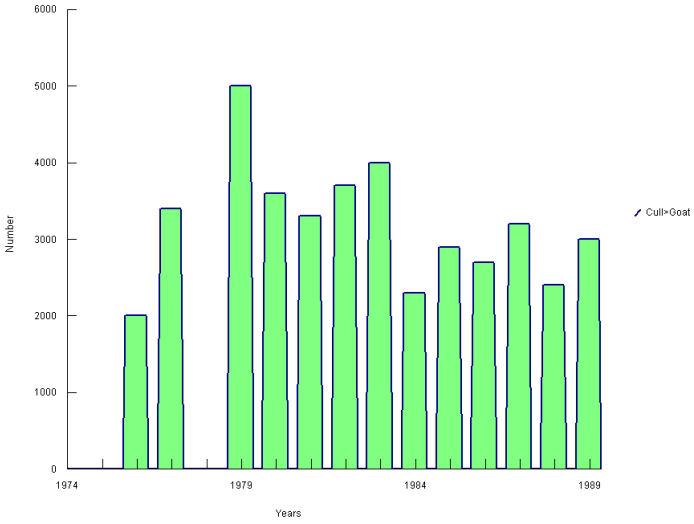


Numbers of cattle culled

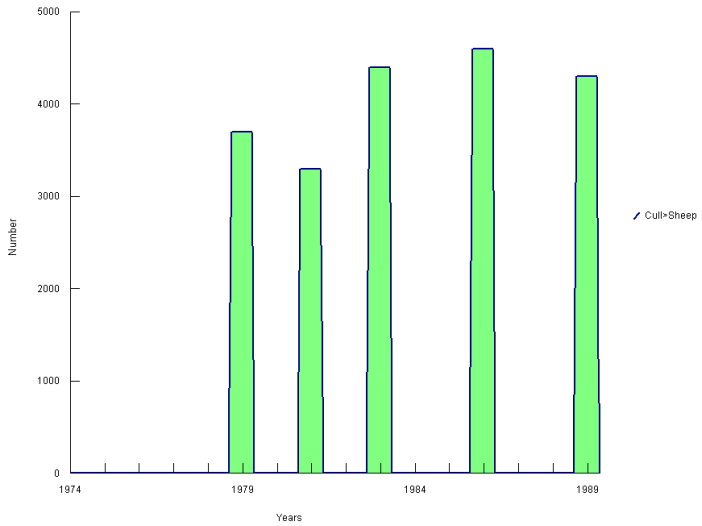
The population growth rate of cattle is increased when first-year survival is increased. From the results, it appears that three or four years pass before enough animals are added to warrant culling.



Numbers of goats culled



Numbers of sheep culled.



Every year but the driest year produces enough goats to allow herders to cull a few thousand. That said, fewer animals are culled in the drier years. Notice that for sheep, more time passes between culling events during the drier portion of the simulation.

The animals culled represent *extra* production to the Maasai. Built-into the NCA-Savanna model are sources of mortality like disease and predation. These animals where culled after the other sources of mortality had been considered.

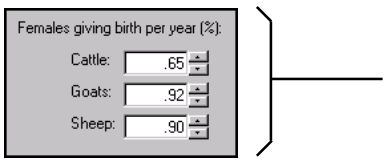
Experiments - Increased Livestock Birth Rates

To a large degree, birth rates amongst both livestock and wildlife are determined by the gestation period of the species in question, and are not likely to change greatly. However, in Savanna, the annual birth rate is entered as a percentage that incorporates both the lag in birthing due to gestation, etc., *and* the number of females that may not be fertile or may abort due to reduced animal condition. Improved nutrition and veterinary care can reduce numbers of females in this second group, thereby increasing the birth rate.

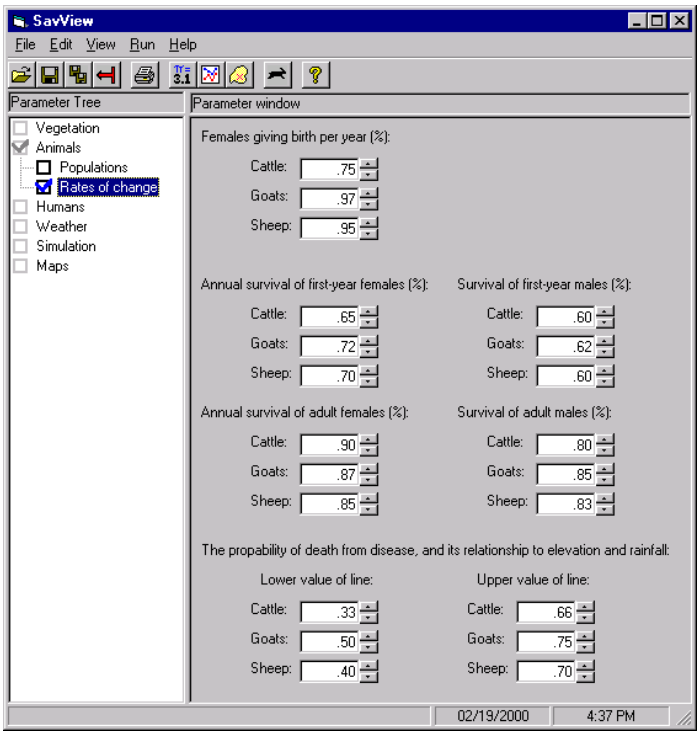
We can use SavView to adjust the birth rate of livestock and run Savanna, weighing the costs of improved veterinary care and nutrition and ecosystem effects against the benefits of higher livestock production. These settings are within the "Rates of change" window under "Animals". In the example shown, birth rates for each of the livestock groups has been increased by 5%.

Population rates of change are only used if animal populations are actually being modeled. If you find that some of the entries in the window shown are grayed-out, populations are not being modeled

Modified livestock birth rates



Default livestock birth rates



for that species. Return to the “Populations” window and enable population modeling by selecting the animal group of interest, and changing population modeling from “No” to “Yes”.

In the example we’ll review as a group, populations were culled, to prevent them from collapsing. When populations exceeded a given value (125,000 for cattle), animals were culled to a lower population (120,000 for cattle).

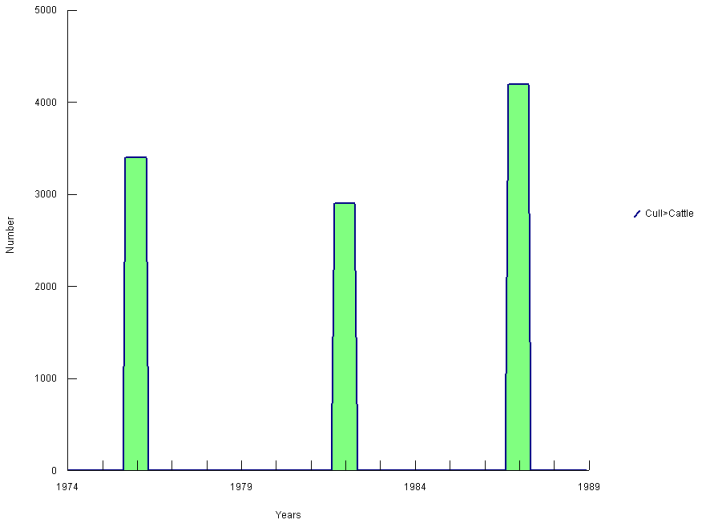
Exercise: As a group, we will review the effects of setting birth rates 5% higher than the control model. We will look at the number of animals culled, and changes to plants and animals within the ecosystem.

Notes: Note that the control model was still be adjusted when this volume was produced, so the numbers shown as default may not be current.

Experiments - Increased Livestock Births (continued)

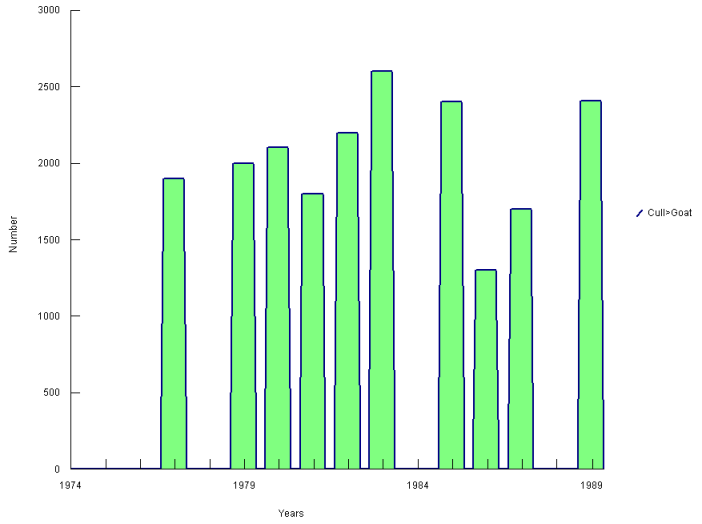
Numbers of cattle culled

Increasing the birth rate in cattle by 5% allowed a few thousand additional cattle to be culled.



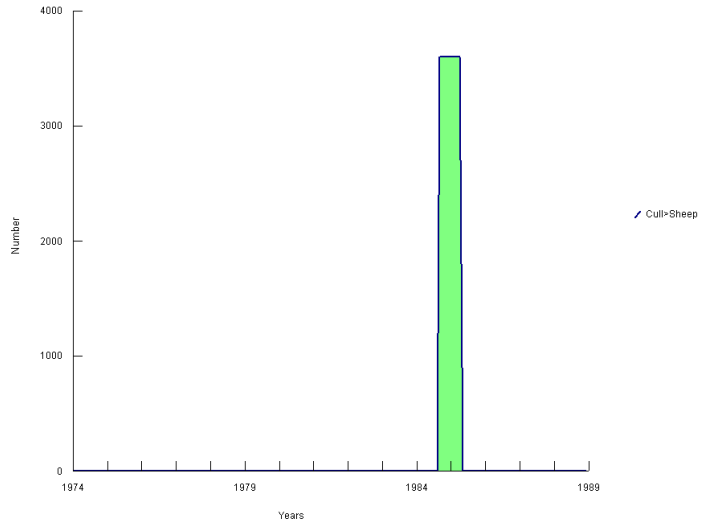
Numbers of goats culled

Some number of goats are available to be culled in all but the driest years.

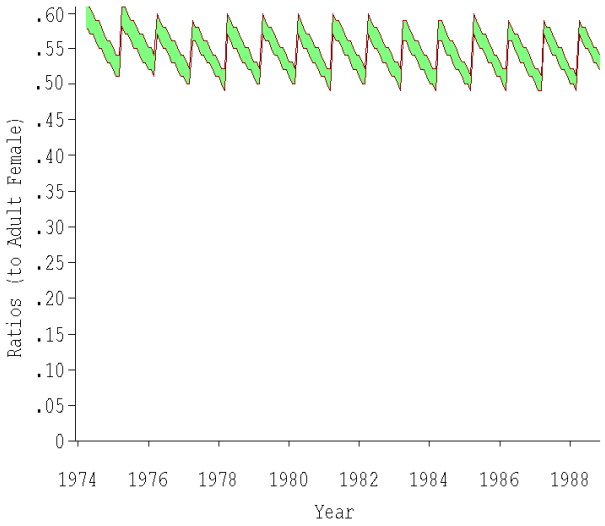


Numbers of sheep culled

The sheep population increased very slowly with an increase in juvenile survival, with more than 10 years passing before a culling event.



The ratio of calves to adult females in the control model (bottom line) and with birth rates increased (top line)



Culling of animals essentially increases the rate that the population is cycling, and reduces the average age of the herd. As shown, with culling the number of juvenile animals increases compared to the control model.

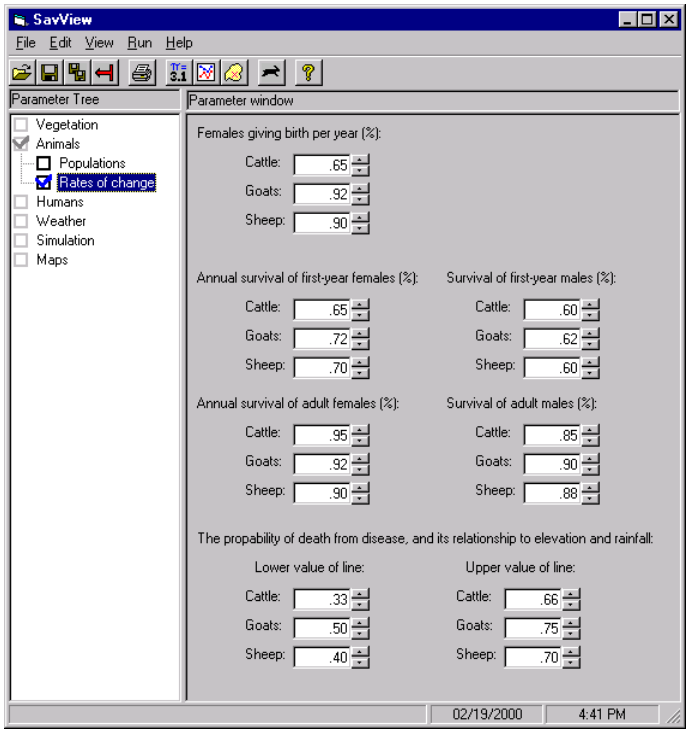
Note that none of the graphs shown illustrate changes in the vegetation of Ngorongoro Conservation Area. The vegetation of NCA remains essentially unchanged in these scenarios. Although the age ratios in livestock change with culling, the population remains stable. With that, forage use remains relatively constant.

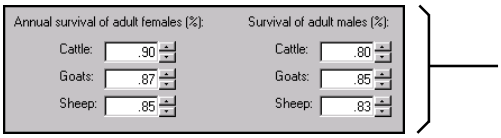
Experiments - Improved Adult Livestock Survival

Similar to the previous examples, improved veterinary practices can increase the probability that adult livestock will survive from one year to the next. East Coast fever is a critical source of losses in Ngorongoro Conservation Area, for example, but treatment with acaricides can lessen losses. The economic benefit from such treatments should be weighed against the economic and ecosystem costs prior to beginning such a program. Savanna provides the means to suggest what some of those costs would be. In addition, a more complete picture of economic costs will be painted when the economic submodel currently in development is joined with Savanna.

Adjusting adult livestock is similar to adjusting the other values we have experimented with. The settings are within the "Rates of change" window under "Animals". In the example shown, adult survival rates for each of the livestock groups has been increased by 5%.

Modified adult livestock survival rates





Default adult livestock survival rates

In the example we'll review as a group, populations were culled, to prevent them from collapsing. When populations exceeded a given value (125,000 for cattle), animals were culled to a lower population (120,000 for cattle).

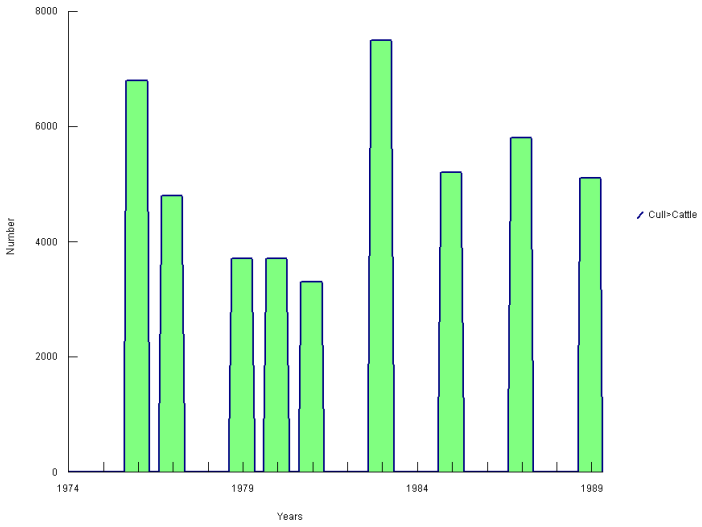
Exercise: As a group, we will review the effects of setting adult livestock survival 5% higher than the control model. We will look at the number of animals culled, and changes to plants and animals within the ecosystem.

Notes: Note that the control model was still be adjusted when this volume was produced, so the numbers shown as default may not be current.

Experiments - Improved Livestock Survival (continued)

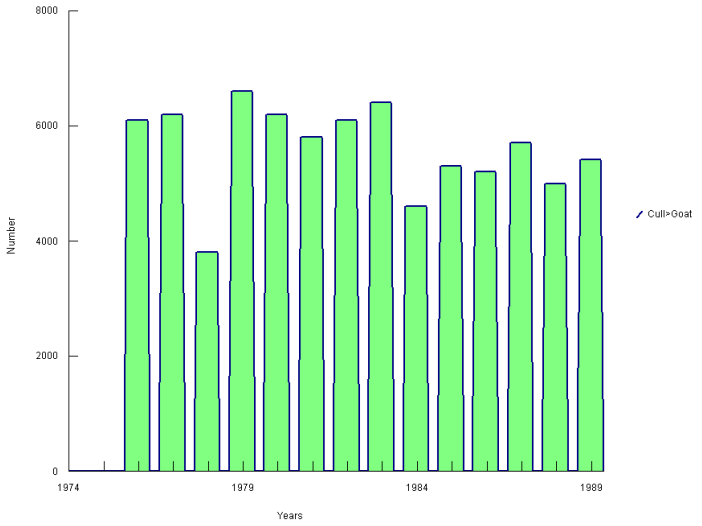
Numbers of cattle culled

Increasing adult survival in livestock by 5% annually had a dramatic effect upon the number of animals that could be culled. In wet periods, from 4 to 7 thousand cattle could be culled. In drier periods, 5 to 8 thousand cattle could be culled every other year.



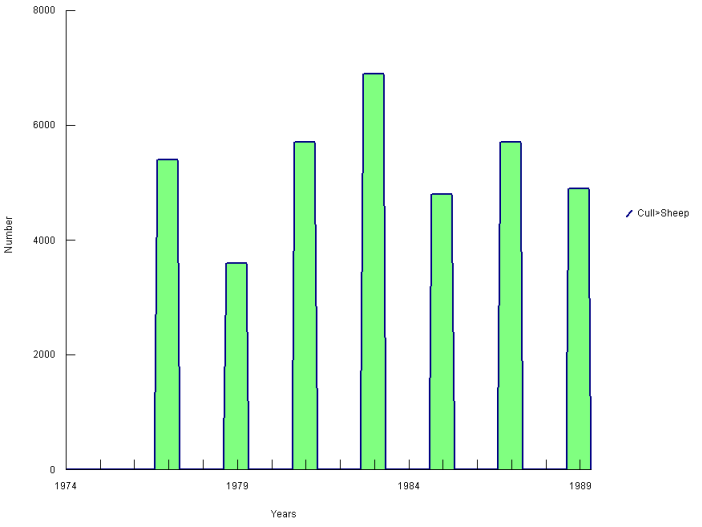
Numbers of goats culled

Some number of goats are available to be culled in each year, with adult survival set higher.

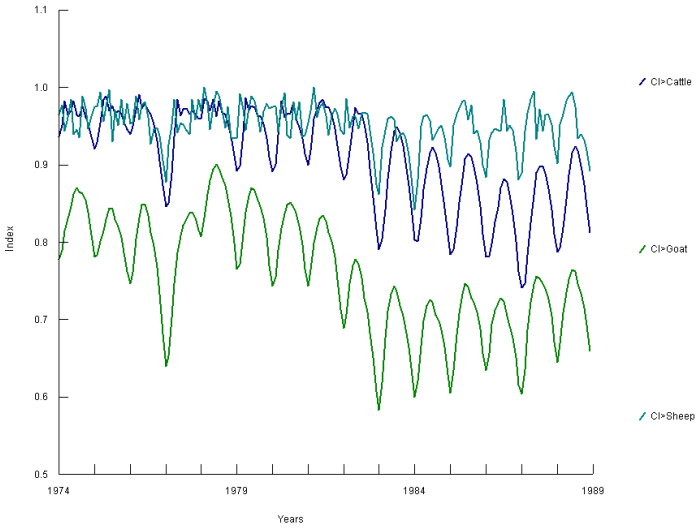


Numbers of sheep culled

In NCA-Savanna, with adult survival set 5% higher than the control, culling of several thousand sheep occurred every two years.



The condition indices of livestock



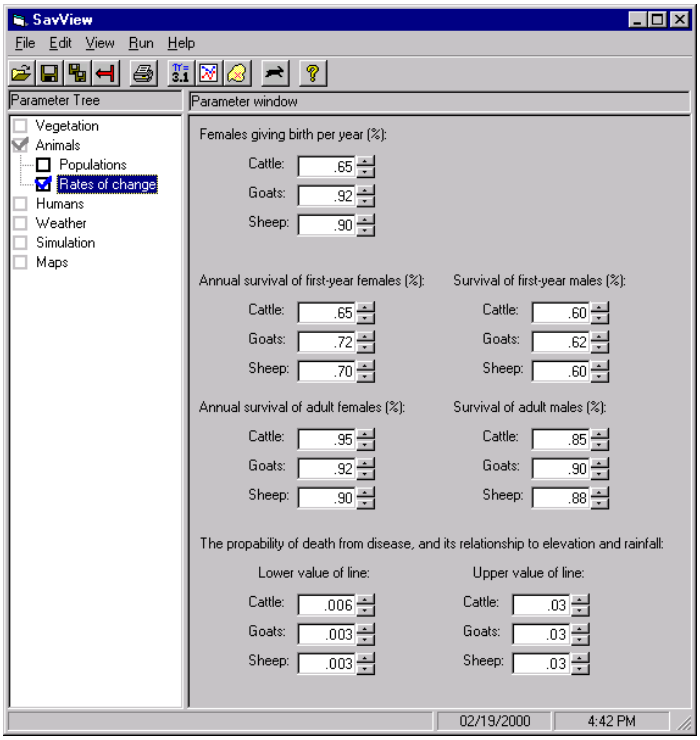
Although, as mentioned, the changes to forage availability are small with the addition of livestock waiting to be culled, it is present. For example, the condition index of livestock (and other animal groups) decreased when adult survival was set 5% higher. The change is minor when compared to the control model, however, because livestock are removed from the system when population exceed the set threshold.

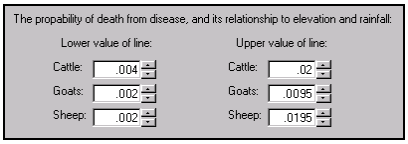
Experiments - Reducing Effects of Disease

It is thought that cattle populations have been at levels below the carrying capacity of Ngorongoro Conservation Area because of diseases, such as East Coast fever. To capture this relationship in Savanna, a modification was made. A portion of livestock are now infected with a generic disease each year, and die. The proportion is set in the DISEASE.PRM file. This reduced livestock populations to below the carrying capacity of NCA. To avoid having wildlife population increase in response to the excess forage available, wildlife were made to avoid areas where livestock were grazing, thus incorporating avoidance of herders by wildlife.

The strength of this relationship with disease, which is in turn related to elevation and rainfall, can be adjusted in SavView. If livestock tend to inhabit wet areas or if rainfall is heavy for a given year, larger numbers of animals will die than if they inhabit dry areas. Increasing the value of what is labeled the upper value will make this relationship with elevation and rainfall more extreme.

Modified livestock disease rates





Default livestock disease rates

Increasing both by an equal amount will cause the relationship to be the same, but overall disease rates will increase. A similar change occurs if the values are decreased.

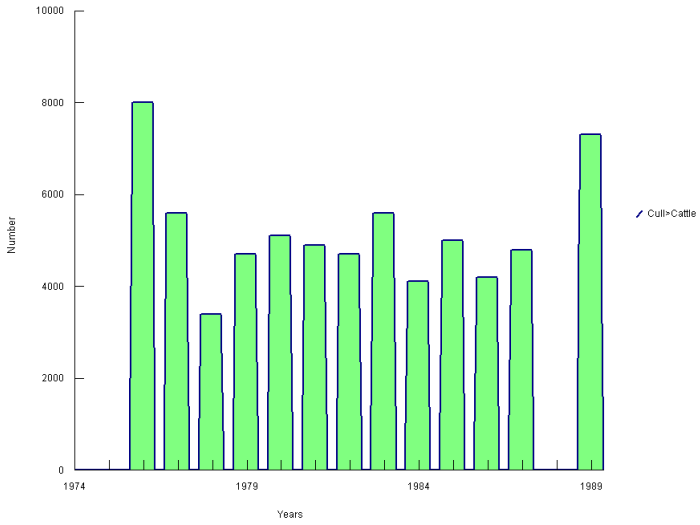
Exercise: As a group, we will review the effects of decreasing death rates due to disease, simulating improved veterinary practices perhaps. Again we will use culling of animals, and will look at the number of animals culled, and changes to plants and animals within the ecosystem.

Notes: Note that the control model was still be adjusted when this volume was produced, so the numbers shown as default may not be current.

Experiments - Reducing Effects of Disease (continued)

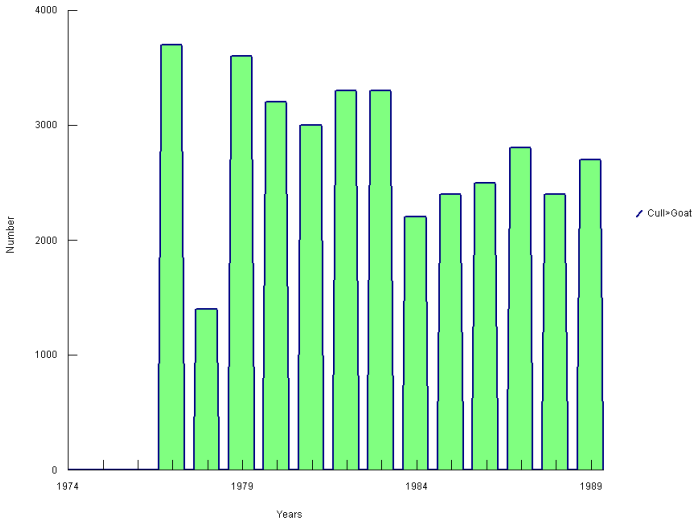
Numbers of cattle culled

Reducing the effect of disease, perhaps representing improved veterinary practices, increased the number of animals available for culling significantly. For cattle, between about 4 and 8 thousand animals may be removed annually, when the rate of death from disease is halved.



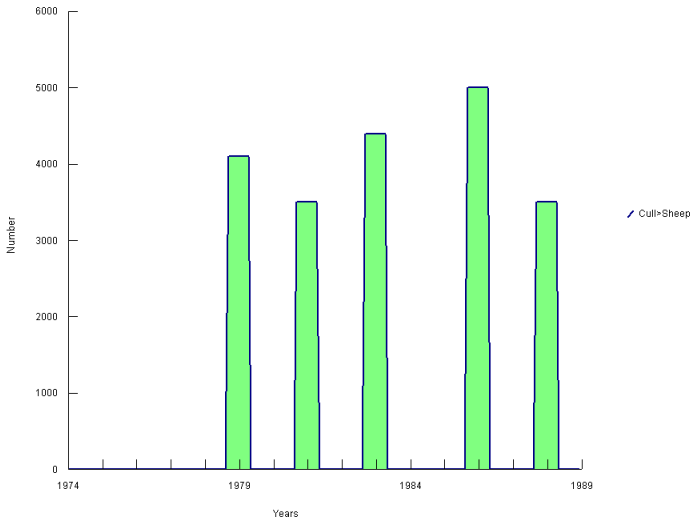
Numbers of goats culled

Between 2 and 4 thousand goats were culled annually when disease risk was reduced.

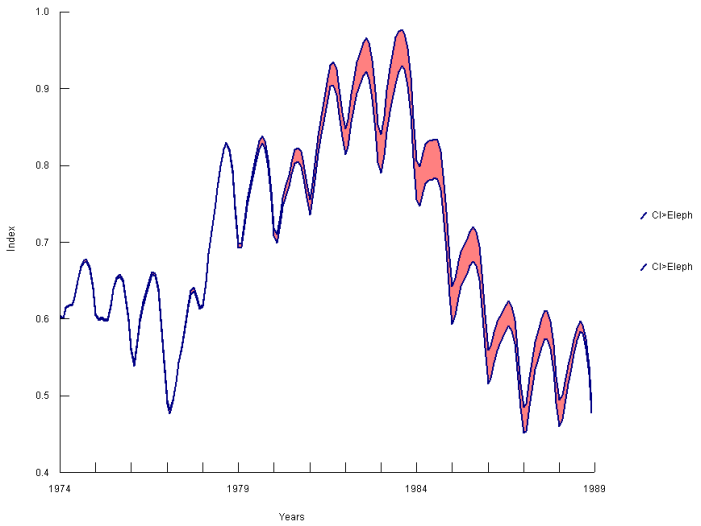


Numbers of sheep culled

Sheep built-up their population more slowly, with culling every few years.



The condition index of elephants in the control model (top line) and with livestock disease reduced (bottom line)



The changes are small, but there is a reduction of forage available to both livestock and wildlife when disease in wildlife is reduced and culling is increase (without culling, the effects would be far larger). The illustration shows the condition index of elephants in the control model and with disease in livestock reduced. The red areas represent a decrease in condition under the experimental setting.