# **Experiments - Allowing Livestock in the Craters**

One of the most useful things about the nature of Savanna is its ability to include spatial relationships in its modeling. Examples are GIS maps that describe topography, vegetation, water availability, and things affecting the distribution of animals. Once the control model is created, these spatial data may be adjusted to simulate the effects of proposed management decisions. The breadth of questions that may be addressed is diverse.

Force maps incorporated into Savanna describe restrictions upon species that are not directly tied to ecological relationships. In Ngorongoro Conservation Area, for example, Maasai herders may move their livestock into the craters to reach water, but they may not stay to graze. We may judge the relative importance of this restriction using Savanna.



G

SavView is constructed to allow you to set force maps for use in Savanna. A different force-map may be used each season, or a given one may be assigned to all the seasons.

To select a map to use, select the animal group of interest from the list, then select the force map you would like to use from the second list. Force maps modified for experiments begin with an "Exp." in their description. After looking at the map to ensure it is what you want, and confirming the appropriate season is highlighted, select "Apply" to use the map.

**Exercise**: Using SavView, set the parameters so that cattle, goats, and sheep are allowed to graze in the craters during all seasons, and run Savanna. After the model completes, compare the changes in plants and animals with the control model.

**Notes**: This simulation may take as much as an hour to complete, depending upon the speed of the computer. A completed analysis is stored upon the accompanying CD disc.

179



Ì

The condition index of cattle in the control model (bottom line) and when allowed to use the craters (top line)

There are subtle changes in the condition of livestock, however, as shown for cattle.

Rhinoceros population

The animals that inhabit Ngorongoro Crater exclusively, such as rhinos, generally show strong declines when livestock graze the site.



# **Experiments - Removing the Threat of Livestock Theft**

- In Ngorongoro Conservation Area, Maasai herders tend to avoid using the southern part of the area, south of Kakesio, because of a high likelihood of animals being rustled. This was incorporated in Savanna by modifying the force maps used for livestock. In force maps, values between 0 and 100 may be used to represent how likely animals are to occur in a grid cell (0 being absent, 100 being no restrictions). Because herders may use the southern part of the area, but are just not as likely to, in the force maps we assigned low values to these southern areas, between 25 and 40.
- Using Savanna and SavView, we can estimate the relative benefits of allowing livestock to graze in the southern part of the area, and balance that with the costs of improved security. In SavView, we



182

would go to the "Parameters" window, select "Maps" and "Force", then for each of the livestock types, change the force map to one that allows the animals to use the southern areas.

**Exercise**: As a group, we will review the effects of allowing livestock to use the southern portion of Ngorongoro Conservation Area. We will look at the number of additional livestock that can be supported, and changes to plants and animals within the ecosystem.

**Notes**: To conduct analyses using your own version of a force map, modify an existing force map using GIS software, such as IDRISI. Then edit the MAPPRM.PRM file within the Savanna "parms" directory, and run "savanna.exe" within the "bin" directory. Using SavView to run the model will overwrite MAPPRM.PRM, but you may still use SavView to look at the results of the simulation. In that case, a note is shown in SavView reminding you that the settings in whatever file you may open do not match those being graphed or mapped.

183



G



*Elephant distributions for a typical April to July, with the* **Control model** on the left and threat of livestock theft removed on the right

The additional animals in the southern portion of the study area excluded wildlife to varying degrees. Elephants were particularly effected, as shown in the above maps. They compare the distribution of elephants in the control and experimental models. Elephant populations declines as well (not shown).

# **Experiments - Removed Threat of MCF**

- Wildebeest move into Ngorongoro in the early wet season and begin to calve. Infected wildebeest calves secrete in their mucus the pathogen that causes malignant catarrhal fever (MCF) in adult cattle. When infected with MCF, almost all cattle will die. Maasai herders are well aware of the risks posed by grazing their cattle in areas used by migratory wildebeest, and avoid the areas during the wildebeest calving season. The importance of this restriction upon their grazing has changed in recent decades as well, with a large increase in the numbers of wildebeest.
- What would be the effects of allowing herders to use those areas now avoided because of MCF? Savanna can suggest answers to such questions. In SavView, go to the "Parameters" window and to "Maps" and "Force", then select cattle from the list. Ensuring that



Ø

the wet season is highlighted, and select from the second list the map that allows cattle to use areas now avoided due to MCF. After running Savanna, the output reflects potential changes to the ecosystem.

Of course, we would expect greater losses due to MCF if the restrictions upon access were ignored. Using the disease submodel of Savanna, we can predict how many additional cattle will become infected with MCF by using the additional grazing areas.

**Exercise**: As a group, we will review the effects of allowing cattle to graze in the plains during the wet season. We will look at the number of additional livestock that can be supported, changes to plants and animals within the ecosystem, and judge how many additional cattle may die.

**Notes**: Some of the output we will review as a group was generated using the disease submodel. This was done outside of Savanna, using Savanna output. When the disease submodel is merged with Savanna, numbers of animals dying from MCF, for example, will simply be another set of charts and maps to be viewed.

### **Experiments - Removed Threat of MCF (continued)**

Cattle distributions under the control model (left) and without risk of MCF (right)

Cattle are distributed across Ngorongoro Conservation Area during the wet season, if the restriction due to MCF is removed.

#### Livestock populations

The increased grazing area allows the cattle population to expand in spite of the population being limited somewhat by other diseases such as ECF.

Goat and sheep condition indices under the control and experiment.

Small stock populations remain stable, but their condition indices do 188 decline slightly.







The number of cattle infected with MCF during a typical April in the control model (left) and with the avoidance of wildebeest calves removed (right). Each yellow square represents an infection.

Increasing cattle production comes at a cost, demonstrated by the MCFMap disease modeling programs developed under IMAS. As shown above, several more cattle are infected with MCF when grazing in the short grass plains during the wet season.

## **Experiments - Adding or Restoring Water Sources**

As a semi-arid area, water availability in Ngorongoro Conservation Area is important in determining the distribution of wildlife and livestock. Areas where water is limited or controlled may have forage that can support livestock but will go uneaten. Efforts to improve range in semi-arid areas often entail adding water sources, increasing the areas where grazing may occur or reducing travel times to reach water.

Savanna uses distance to water maps in its modeling of livestock and wildlife distributions. The cells in these maps simply contain the distance, in meters from the cell to the nearest water source. We can address management questions about water sources simply by modifying the distance to water maps.



Ì

We will examine the effects of adding several water sources. To add sources in places that were reasonable, we actually restored water sources that were in place previously, but had failed. In general, the average distance to water was reduced throughout Ngorongoro. These sites were marked as additional water sources for all animals - we did not differentiate which sources would be usable only by livestock, such as wells.

**Exercise**: To conduct the simulation, in SavView, go to the "Water" selection in "Maps" under "Parameters". Highlight each of the seasons in-turn, and select from the list the water map with additional sources for that season. Then run the Savanna model. After the model completes, compare the changes in plants and animals in response additional water source.

**Notes**: This simulation may take as much as an hour to complete, depending upon the speed of the computer. A completed analysis is stored upon the accompanying CD disc. Note that in Savanna, different water maps could be used for livestock and wildlife, with somewhat increased complexity..



Cattle distributions in May through August for the Control model (left) and with water added (right)

Accumulated offtake for the Control model (left) and with water sources added (right)

In general, added water sources distributed foraging more evenly across the landscape. Note the increased offtake in the center of the map on the right, for example.

Warthog condition indices in the Control (lower lines) and with water added (upper lines)



Elephant condition indices for the Control model (upper lines) and with water added (lower lines)

The effect of adding water sources varied across animal groups. All population changes were small, but small changes in condition



indices were seen. For warthogs, for example, added water sources improved their condition, with more forage close to water becoming available. In contrast, additional water sources caused a decline in the condition of elephants, as they competed with other animal groups that in the control model were excluded from sites by the distance to the nearest water.



# **Experiments - Dedicating Water Sources to Lodges**

- As mentioned, water is important to Maasai and their livestock, as well as wildlife. A contentious issue in Ngorongoro Conservation Area is the use of water to support tourist visits, at the lodges that sit atop Ngorongoro Crater rim. A tool is needed that allows land managers to investigate potential changes to the ecosystem when new lodges are planned, and water diverted.
- With its use of distance to water maps, Savanna serves as a tool to address these questions. Distance to water maps may be modified to show reduced water availability. In the experiment, we removed water sources that were within 1 km of lodges. This reduced the number of water sources relatively little, only affecting the area around Ngorongoro Crater.



If you wish to repeat the analysis or make other changes, in SavView, go to the "Water" selection in "Maps" under "Parameters". Highlight each of the seasons in-turn, and select from the list the water map with additional sources for that season. Make any other changes you wish, and then run the Savanna model.

**Exercise**: As a group, we will review the effects of dedicated some water sources to lodges We will look at changes to plants and animals within the ecosystem, and judge how important the changes are.

**Notes**: The mapped water sources may be made more representative by noting for each source whether it is available to each animal group. In the current model, all water sources are available to all groups.



### **Experiments - Dedicating Water to Lodges (continued)**

Crater browsing antelope population

In general, changes in response to dedicating water sources within 1 km of lodges to those lodges had very small effects upon wildlife, livestock, or vegetation. This might be predicted from the small change in the distance to water, from 10.2 km to 10.5 km, when averaging across all the non-water cells.

Animals restricted to the crater did show decreases in their populations, as shown for crater browsing and resident grazing antelope.

Resident grazing antelope population



196

Integrated Management and Assessment System. These materials are from April 2000 and pertain to Savanna 4E.2. A newer model and volume may be available. See the 'About' boxes in SavView for contacts.

1979

Year

1984

1989

5000 L

