ODD protocol
Game of Thrones model Step 2

OVERVIEW

Purpose

This model explores the demographic dynamics between sheep, wolves, and humans. This is the second step towards creating a model of Westeros. It is based on the Wolf Sheep Predation model (Wilenski 1997).

Entities, state variables, and scales

This model uses the environment, and the wolves and sheep agents of the Wolf Sheep Predation model. To those, it adds a breed of human agents who can feed on grass or sheep, and who domesticate some of the wolves they encounter.

Table 1. Global variables used in this model.

Global variables	**Explanation**
Max-sheep	To stop the simulation if there are too many sheep
Model-version	Identifies if there are humans or only animals
Initial-number-sheep	Determines the number of sheep at setup
Initial-number-wolves	Determines the number of wolves at setup
Initial-number-humans	Determines the number of humans at setup
Grass-regrowth-time	After how many ticks grass regrows (resource)
Sheep-gain-from-food	How much energy sheep get from grass
Wolf-gain-from-food	How much energy wolves get from eating a sheep
Rate-sheep-eating	How often humans eat an encountered sheep
Sheep-reproduce	Each sheep's probabilities of reproducing if they have energy
Wolf-reproduce	Each wolf's probabilities of reproducing if they have energy
Humans-reproduce	Each human's probabilities of reproducing if they have energy
Show-energy?	Switch, determines if we see sheep's energy on the window

Table 2. Turtle variables

turtle variables	**Explanation**
Energy	Counter that gets updated when an agent moves and eats. At 0, the agent dies.
Wolves variables	
Domesticated?	True/False. Record if a wolf has been domesticated.

Table 3. Patch variables

Patch variables	**Explanation**
countdown	Counter used to regrow grass.

Process overview and scheduling

This model is pretty simple. At every tick, all agents move, which depletes their energy, and they look for food. If their energy is depleted, they die, if not, they consider reproducing.

Ticks do not represent any specific unit of time.

DESIGN CONCEPT

Basic principles

This model added one component to the Wolf Sheep Predation model, which aimed to show the predator-prey equilibrium that can arise between two species.

Objectives

This modification of the Wolf Sheep Predation model is simply to add humans, which complicates the equilibrium between the two animals.

Interaction

Wolves and humans interact with sheep by eating them. Humans interact with wolves by either domesticating them or getting eaten by them.

Stochasticity

Only the energy level of the agents is set randomly at the beginning of a simulation (with a maximum value set by a slider). Which patches are depleted at setup is also random, as well as the regrowth countdown of depleted patches.

Observation

There is one plot that follows the population sizes of sheep, wolves, and grass.

DETAILS

Initialization

At setup, about half the patches become green, which means that they have resources. The rest get a countdown value that determines when their grass with grow back. The number of sheep and wolves is determined by sliders. They are placed randomly on the landscape, with a

random energy value with max based on a slider. If the user chose to add humans (model-version), a certain number of humans are added at random on the landscape. They also have a random energy level with max from the Interface slider.

Input data

There are no external data.

Submodels

Move:
This is called by all turtles. The turtles wiggle a bit and move forward by 1.

Eat-grass:
This is called by sheep. The patch becomes brown and the sheep adds a certain value (based on slider) to its energy level.

Eat-sheep:
This is called by wolves. If there is a sheep on the same patch as the wolf, the sheep dies and the wolf adds a certain value (based on slider to its energy level).

Death:
Called by all agents. If energy reaches 0, the agent dies.

Grow-grass:
Called by all patches. If the patch is brown, it checks its counter. If the counter is at 0, the patch becomes green. If not, the counter is updated to its value -1.

Display-labels:
Called only if the switch is ON. It shows the energy level of wolves and sheep.

Add-humans:
Called during setup. Creates a certain number of humans, colored blue.

Reproduce:
Called by all agents. They roll a die. If it is successful, they create a new agent and give them half of their energy.

Humans-eat:
Called by humans. A certain percentage of the time, they will look for a sheep to eat. If there is one on the same patch, that sheep dies and the human adds a certain value (based on the wolf-gain-from-food slider) to its energy level.

When the human does not look for a sheep, it looks at the grass. If there is grass on the patch it is on, the patch becomes brown and the human adds a certain value (a quarter of what sheep gain from grass, as humans cannot convert plants to energy as well as animals) to its energy level.

Domesticate-wolves:
Called by humans. If there is a wolf on the same patch, and that wolf is still wild, the human rolls the dice. About 50% of the time, it will domesticate the wolf. The remaining times, it will get eaten by the wolf (who gets 1.5 times energy as it would from a sheep, arbitrary decision).

Humans-feed-animals:
If there is a domesticated wolf on the same patch (aka, a dog), it will ask the dog to feed on a sheep if there is one around, but the human will take some of that energy (they share the sheep).

REFERENCES CITED

Wilensky, U. (1997). NetLogo Wolf Sheep Predation model. http://ccl.northwestern.edu/netlogo/models/WolfSheepPredation. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.