FROTEMBO
ODD description

The description is based on the updated version (Grimm et al. 2010) of the ODD protocol that was originally proposed by Grimm and his colleagues in 2006.

Overview

Purpose

The *FROTEMBO* agent-based model represents snare trapping of blue duikers (Cephalophus monticola) in Cameroon. It was co-designed and used with local populations to raise their awareness about the sustainability of bushmeat hunting activities in the region of the Korup National Park (South-West Cameroon).

Entities, state variables, and scales

The *FROTEMBO* model is based on two main entities: the hunter and the hunted species. Two classes of agent have been created to represent these two entities in the ABM: *Household* and *BlueDuiker*. A *Household* is characterized by the village it belongs to and the number of snare traps it uses and sets along a trap line. A *BlueDuiker* is characterized by an age (in weeks, which is the unit of time used for all temporal parameters), a sex (male or female) and a stage (newborn; juvenile; subadult and adult). The behaviour and the mortality rate of a *BlueDuiker* depends on its stage and for the subadult and aduld stages, it also depends on its sex. A convenient way to code the *BlueDuiker* agent was therefore to create a hierarchy of specific *Stages* from an abstract class (see UML class diagram on figure 1). The lifehistory parameters are listed in table 1.

Parameter	Stage	Value	Unit	Source
Home range	Adult	3	ha	Dubost (1980)
Perception range	Adult	37	ha	
Weaning	Female	21	week	Wilson (2005)
Subadult	Juvenile	40	week	Wilson (2005)
Sexual maturity	Subadult Male	95	week	Chardonnet (1995)
	Subadult Female	72	week	Chardonnet (1995)
Lifespan	Adult	400	week	Bousquet et al. (2001)
Survival rate	Young (0- 40 weeks)	60	%	Dubost (1980)
	Sub-adult and Adult (40 – 300 weeks)	90	%	Chardonnet (1995)
	Old (> 300 weeks)	1	%	
Impregnation	Female with partner	0.15	weekly prob.	
Gestation period	Female	30	week	Chardonnet (1995)
Number of offspring	Female	1	individual	Mouté (2010)

Table 1: Model parameters for blue duiker

The elementary spatial entity in the model is a Cell representing 1 ha. There are 6 land covers: village, road, farm, secondary forest, primary forest and water, set at initialisation and remaining unchanged during a simulation. Three different spatial extents based on the same spatial resolution (1 ha) have been used:

1. a 15*15 grid with one village to introduce the various land covers and the BlueDuiker population module,
2. a 50*50 grid with two villages to interactively introduce hunting with snare traps,
3. a 160*180 grid to introduce a realistic representation of the study zone with seven villages (Abat, Bajoh, Basu, Mgbegati, Bayip-ossing, Bakut and Osselle) located at the North-eastern border of Korup National Park.

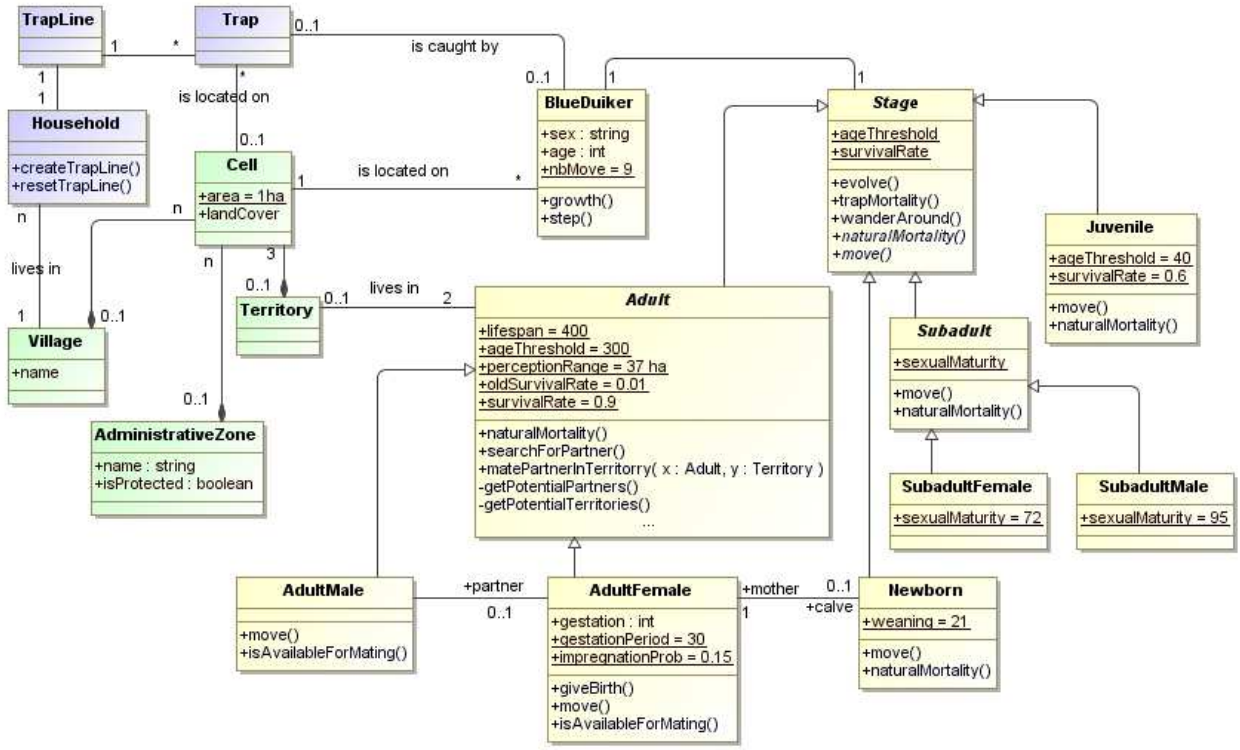

Figure 1: Frotembo class diagram

Process overview and scheduling

The time-step of the model is the week. Two seasons are represented in the model: the wet season (from mid-March to mid-November) and the dry season. Duikers are activated each step of the model in a random order. A duiker performs its specific sequence of actions and then the next duiker is processed. This sequence of action starts with the growth (duikers just get 1 week older), then if adult and alone, they look for a partner and a territory, then they move, then if gravid at term they give birth, then they suffer natural mortality and finally they suffer hunting mortality (except newborns).Hunters set their snares on the spatial grid once every 52 time-steps (once a year) at the beginning of the wet season. The snares are left at the very same place for 35 steps (8 months), and then they are removed. By the end of each time-step during the wet season, the snares are visited by the hunters; the caught duikers are collected and the snares are reset. The simulation experiments were run for 10 years.

Design concepts

The concepts irrelevant in the context of the Frotembo ABM are not mentioned here.

Basic principles

The model is meant to be run interactively: the number of traps and their locations are to be made by the participants. The decisions made the first year are recorded so that they can be repeated 10 times.

Sensing

Adult duikers can sense if a place already belongs to an established territory and whether a potential partner is available for mating (adult without partner, opposite sex) or not within a radius of perception of 300 meters (3 cells), i.e. a range of perception of 37 ha.

Stochasticity

The randomness of the model lies mostly in the mortality functions, both natural and related to hunting. The fecundation process is also based on a specific probability.

Observation

We used a beamer and a generator diesel engine to display the laptop screen on the wall of the meeting rooms. The small spatial grid (15 x 15 cells) provided a kind of close-up view of

the model, with the details of the coloured diamonds representing the various stages of the blue duikers being distinguishable by the participants even at the back of the room.

Details

Initialization

Figure 2 shows the initial situation of the intermediate version of the model (50 x 50 cells). At equilibrium, the simulated population is structured due to the effect of the age-dependent natural mortality rates. 535 individual blue duikers were created as a sample of structured population obtained by running until equilibrium a simulation initialized with random ages.

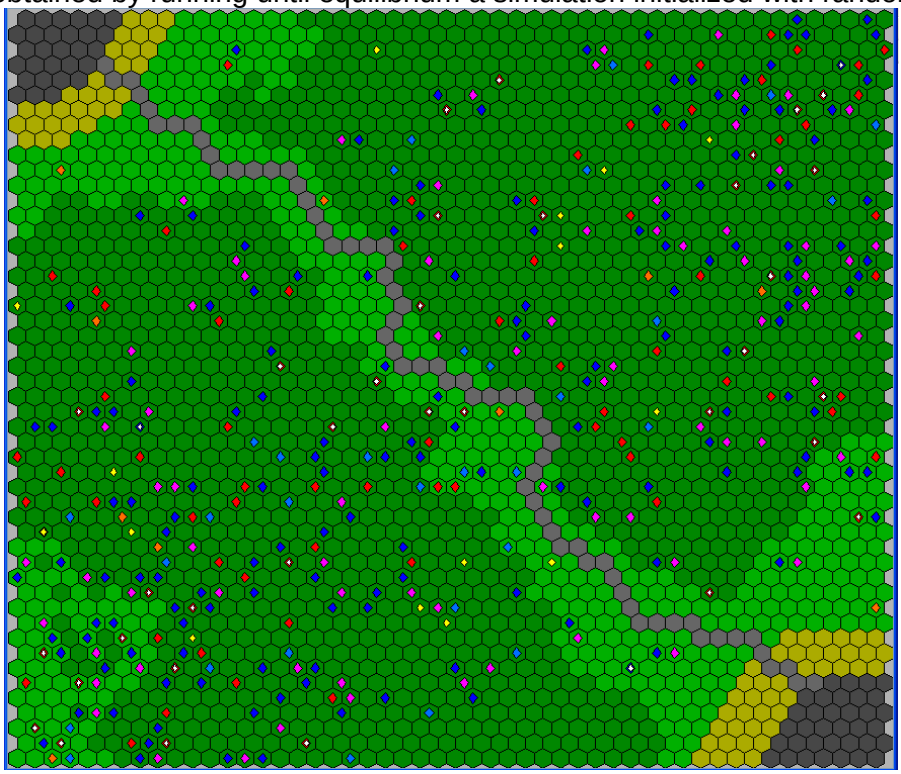

Figure 2. Initialization of the medium-size (5 km * 5 km) version of the model

Input data

According to the way we used the model, the number and the location of traps can be considered as input data provided on the go by the participants.

Submodels

Growth

The model time step is 1 week, which means that all the temporal attributes or parameters are expressed in weeks. Thus, the age of each duiker agent is simply increased by 1 at each time step.

Movement

In the model, newly borns (calves) till age of weaning (21 weeks) are moving together with their mothers. After the weaning and till 40 weeks old, a juvenile is still under parental care but can move randomly within parental territory. From 40 weeks to 72 weeks for female and 95 weeks for male (age of sexual maturity), an individual (hereby called sub-adult) can move randomly over adequate places (no village, no farm), occupied or not, but can not have a mating partner, thus can not defend a territory. Above the age of sexual maturity, the individual is adult and will search for a mating partner with which it will search for a closest suitable territory (3 contiguous free and suitable cells, i.e. no other couple of duiker agents present and with landcover being either primary or secondary forest). From that time, the couple will remain in their territory until one dies. The perception range of a duiker agent is

defined as a three-order recursive function based on the six-connex neighbourhood of the cell where it is located. In a weekly time step, a duiker agent can visit any of 37 cells that make up this area, including its territory.

Reproduction
In the model, a female established in a 3ha territory with a male partner has a weekly probability of impregnation set to 0.15. After impregnation, the gestation lasts 30 weeks, and a weaning period (i.e. the time that a female can not conceive after each birth and still very close to the calf) of 21 weeks, thus given a period of 51 weeks between two births. The number of offspring was set to 1, and a 1:1 sex-ratio was applied.

Mortality
In the model, we use a survival rate of 70% for young blue duikers between 0 and 40 weeks. Translated in terms of weekly probability of mortality, it gives $My = 1 - 0.7^{1/40}$. Similarly for adults between 40 and 300 weeks old, the survival rate was set to 90%, and the weekly probability of mortality is $Ma = 1 - 0.9^{1/260}$. For old individuals above 300 weeks old, with a limit at 400 weeks, a survival rate of 1% leads to a weekly probability of mortality of $Mo = 1 - 0.01^{1/100}$.

Hunting
The number and the location of the traps are indicated by the participants. The probability for an active snare to catch an individual duiker located there for a period of one week was set to 0.01. The participants mentioned that newborns were not concerned