An Agent Based Model to study stability of Ecosystems: Proposal

Simon Crase

January 26, 2019

Abstract

The Grass/Sheep/Wolves model [1] exhibits behaviour that I did not expect: it appeared stable with the default values of parameters, but when I increased the speed at which grass regrows slightly, regrowth time=20, the model ran for some 1,200,000 generations, the wolves become extinct suddenly–Figure 1. It is not clear whether this is a limitation of the simple model. The proposed model seeks to establish whether the well known link between diversity and stability emerges from simple dynamics.

1 What part of phenomenon would you like to model?

I would like to understand the relationship between species diversity and stability in a simulated ecology with Natural Selection. Although it is well accpeted that diversity is correlated with stability, e.g. [2], I would like to see whether this emerges directly from a simulation of behaviour of individuals. I plan to make the simulation asexual initially, to avoid the complexities of Mendelian inheritance.

2 What are the principal types of agents involved in this phenomenon?

1. Primary producers
2. Consumers. There may be multiple species in each level.
   (a) Primary
   (b) Secondary
   (c) Tertiary

3 What properties do these agents have?

1. Primary producers
   (a) Energy
2. Consumers
   (a) Energy
   (b) speed

4 What actions (or behaviours) can these agents take?

1. Primary producers
   (a) Grow–acquire energy at a uniform rate
   (b) Be eaten–lose energy to a Consumer
2. Consumers
   (a) Breed–transfer some energy to offspring; this is less than 100% efficient, so the cost of breeding exceeds the total energy transferred.
   (b) Wander/pursue–expend energy in source of food.
   (c) Feed–acquire energy from a producer or lower level consumer; energy gained is less than that lost by the food source.
   (d) Die–when energy is depleted, or after a certain number of generations.
   (e) Mutate–when offspring are created, some parameters may be changed, e.g. pursuit speed, number of offspring, energy per offspring. I expect this to optimize the parameters to maximize inclusive fitness [3].

5 If the agents have goals, what are their goals?

1. Live as long as possible
2. Make as many copies of itself as possible

6 Agents operate in what kind of environment?

I envisage a collection of patches that represent primary producers; consumers move around, either randomly or purposefully moving towards food.

7 How do agents interact with environment?

1. Consumers move around, which costs energy, and drive energy from the environment (primary consumers), or from lower level consumers.

2. Consumers can breed if they have enough energy to pay the cost; children get a portion of the parent's energy. We'll make it asexual to start with.

8 What do I hope to observe

Some evidence that more species at start $\implies$ a longer time before population crashes.

9 References

[1] Uri Wilensky. Netlogo wolf sheep predation model., 1997.

[2] E E Cleland. Biodiversity and ecosystem stability. *Nature Education Knowledge*, 3(10):14–20, 2011.

[3] Wikipedia contributors. Inclusive fitness — Wikipedia, the free encyclopedia. `https://en.wikipedia.org/w/index.php?title=Inclusive_fitness&oldid=869050703`, 2018. [Online; accessed 26-January-2019].

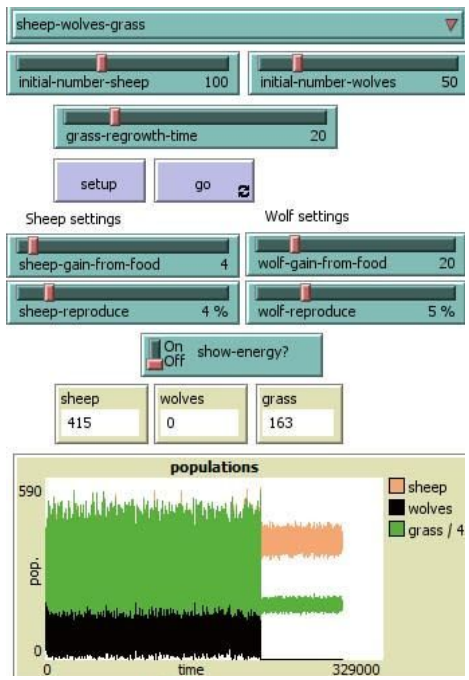

Figure 1: Wolves Sheep Grass. This run crashes after a couple of hundres thousand generations, but I have observed over 1,200,000. Notice that the crash is very sudden, and that the grass, and presumably the sheep, move through a smaller range after the crash.