HERD ANIMALS WITH MODERN CHALLENGES

An agent based predator prey model in a dynamic environment

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Introduction

The demand for renewable energy is increasing rapidly all over the world [1], and in order to meet this demand several wind farm projects are planned in northern Sweden [2]. Meanwhile, there is also an increase in exploration for mines in Sweden [3]. Combined, this produces an increased demand for exploitation of land in northern Scandinavia. However, this increased exploitation has raised concerns for the traditional reindeer husbandry.

In light of this, methods for investigating how reindeer husbandry is affected by changes in it's environment is needed. Therefore, an agent based predator prey model was implemented, simulating the reaction to changes in the landscape of an ecosystem consisting of herd grazing animals and a predator.

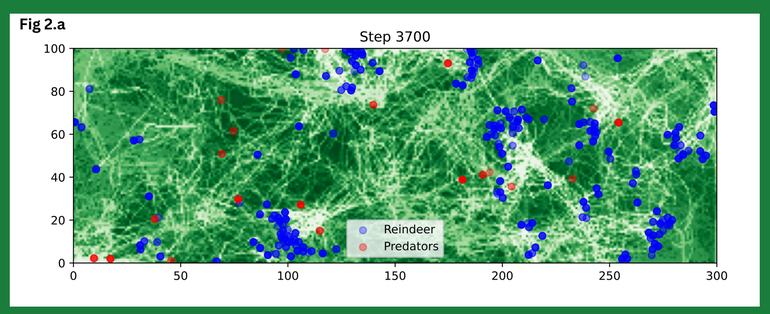

Figure 2. Figure a) shows the configuration for some time after initialization. The preys are now clustered together, and parts of the food grid have been eaten. The prey appear to flee from nearby predators. Figure b) shows the configuration after the intrusion with radius 60 (e.g. mine/wind farm) has been added to the arena.

Discussion

Our results show a clear trend that the introduction of an intrusion zone has negative effects on the reindeer herding.

There are a lot of different parameters that affect the dynamics of the system, however, the real-world system is much more complex and more could be added to closer mimic the real-world. For example, one important aspect could be the reindeer memory of where to graze, and where the herders allow the reindeer to graze.

Further research could also be made in order to find parameter values that corresponds closer to the real-world.

Simulation procedure

The simulation was carried out iteratively. Five predators and 150 preys were initialized on a 100x300 grid with a randomized amount of food in each cell. The system ran for a total of 10 000 time steps, with an intrusion of varying size added after half the time. For a flow chart of the simulation process see fig. 1. and for how the program looks when running see fig.2.

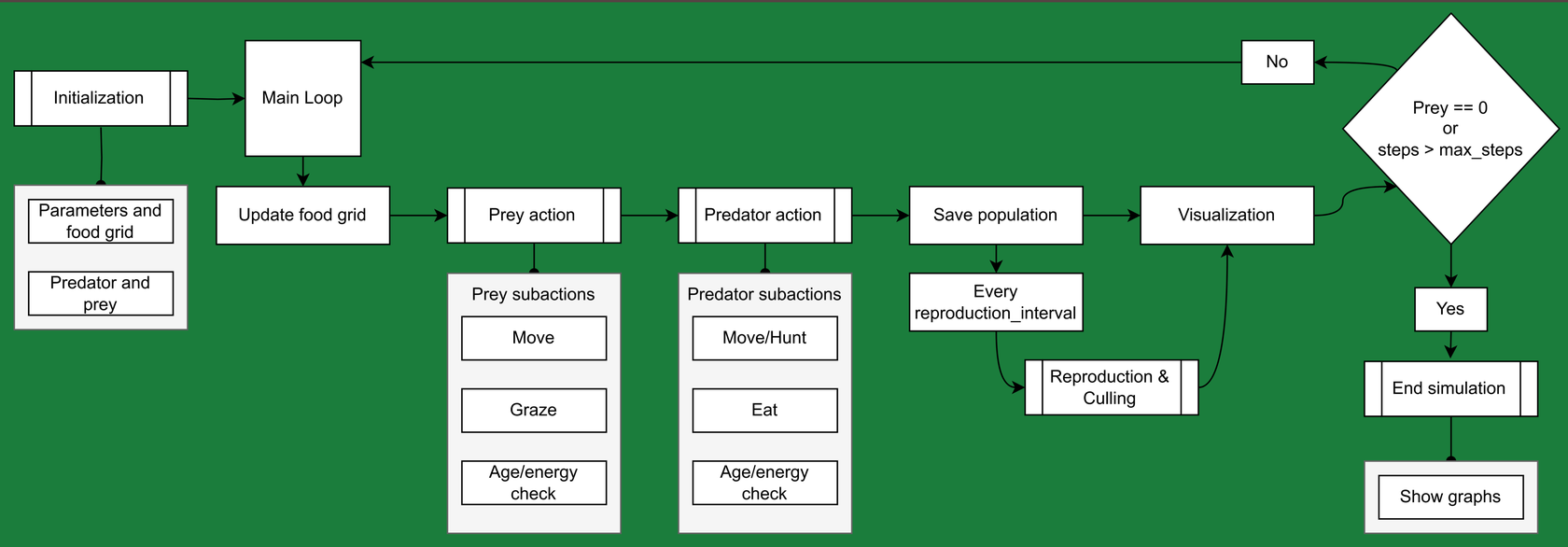

Figure 1. Flow chart of the simulation loop. The arena is initialized, and then the predators and preys make their actions iteratively until a goal is reached.

Model description

Prey

- Inspired by reindeer
- Clustering dynamic based on Boids model
- Age and energy characteristic for reproduction
- Frightened by predators

Predator

- Inspired by lynx
- Age and energy characteristic
- Hunt when energy is low
- Reproduce if energy and age adequate
- Track prey when far away

Environment

- Dynamic landscape
- Regenerative food grid for prey
- Possible to add intrusion, e.g. mine, wind farm etc.
- Simulated culling of reindeers for human sustenance

Results

A general trend that can be seen over multiple simulations are that the dynamics are more chaotic with bigger die offs after the intrusion is added, an example is shown in fig. 3. for a single seed, which adversely effects the amount of culling and thus the profitability of reindeer herding. When doing multiple runs with and without adding the intrusion but starting with the same random seed we could see a decrease of around 15% in the total amount of culling after the intrusion with radius 60 is added. The statistics from multiple runs are shown in fig. 4.

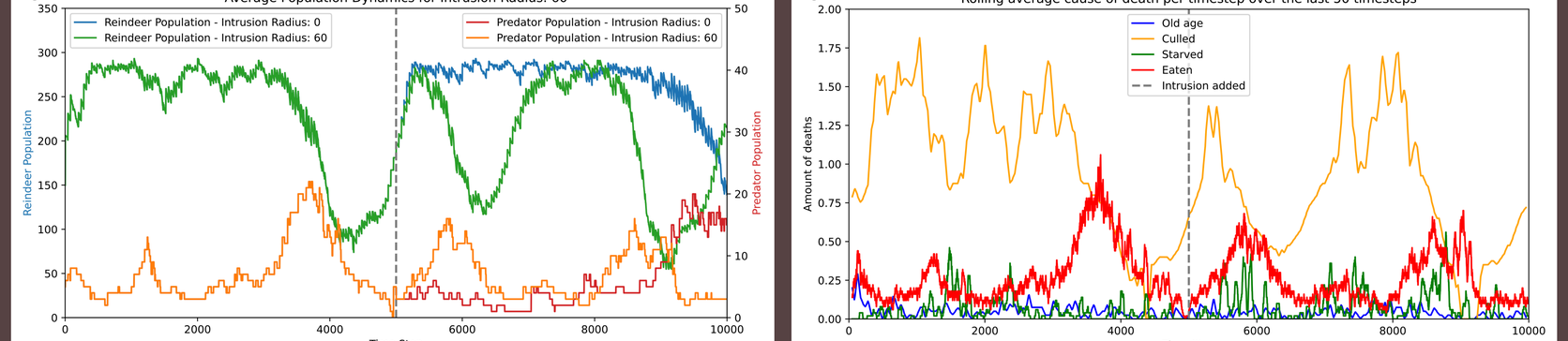

Figure 3. a) Population trajectories for a single predator–prey pair simulation, illustrating the difference in population dynamics before and after a significant intrusion. Both the baseline (no-intrusion) scenario and the intrusion scenario are shown for comparison. b) Shows the rolling average cause of death for the run with the intrusion.

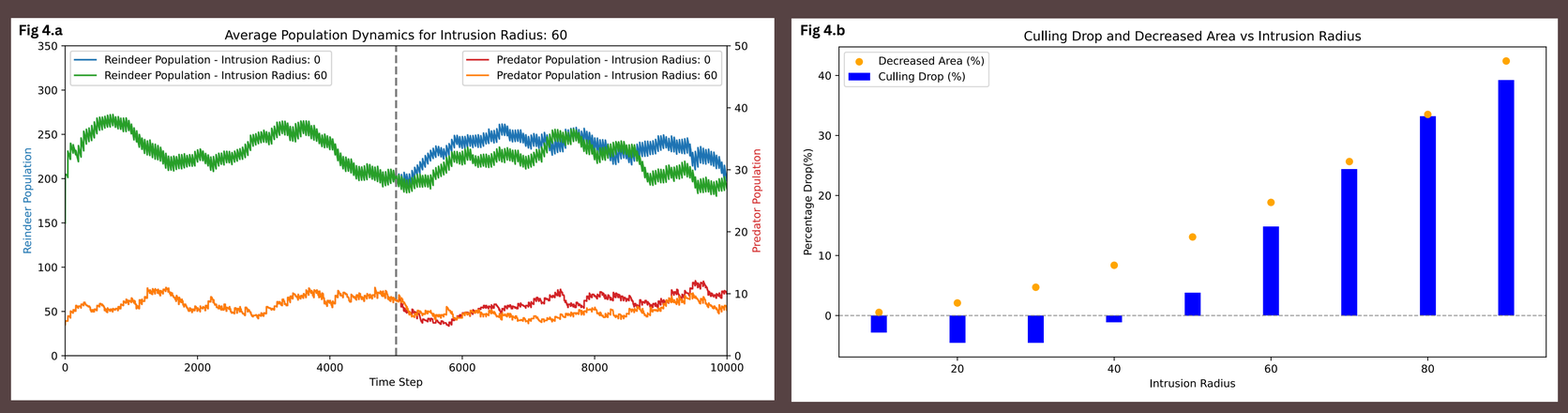

Figure 4. a) Shows the average population from 10 different simulations pairs, each pair start with the same random seed but only one of them has the intrusion added after half the time steps. The die offs are more severe in the runs when the intrusion was added. b) Shows how culling was effected by different intrusion radii.

References:

1. J. M. Northrup and G. Wittemyer, Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation, Ecology Letters 16, 112 (2013)
2. Vattenfall, Vindprojekt (2024), accessed: 2024-12-02.
3. C. Liljenstolpe, R. Hamberg, J. Hedström, D. Larsson, and H. Kjellson, Statistics of the Swedish Mining Industry 2023, Tech. Rep. 2024:2(Geological Survey of Sweden (SGU), 2024) exploration and exploration permits.