ABM narrative summary (Fauna)

Thank you so much for taking the time to help us! Please before proceeding any further, kindly read the following instructions to maximize your answer quality.

Given an Agent Based Model (ABM), we want you to produce a human-readable summary that captures the essential dynamics of the ABM which will then be used as a reference for evaluating LLM-generated summaries.

This ground truth is a narrative summary describing:

1. What the ABM is and does

2. What trends appear in the simulation outputs

3. Key numeric values and time points

We expect your summary to be 3 to 4 paragraphs long. We suggest keeping it concise and structured as followed:

Paragraph 1 focuses on the ABM purpose and parameters. It is describing what the model investigates, its goal, and key parameters with exact numeric values. We suggest to include which agents are involved as well as their role, the key initial parameters of the simulation setup and their exact value with units when applicable.   We request you to please not paraphrase parameter names incorrectly and to not add parameters not present in the source.

Paragraph 2 focuses on key trends (initial/early phase). It is describing what happens early in the simulation including initial values, early dynamics, key time points.

Paragraph 3 focuses on key trends (middle phase), if applicable. It is describing intermediate trends, secondary metrics, or continuing dynamics.

Finally paragraph 4 focuses also on key trends (later/final phase). It is describing what happens over time, final outcomes, stabilization, long-term patterns.

While describing trends, we recommend the following guidelines:

What to include:

- Initial values: What the metrics start at (e.g., "starts at 100,000 units")

- Direction of change: Increase, decrease, stable, fluctuating

- Key time points: Specific time steps where changes occur (e.g., "by time step 10", "at step 40")

- Numeric values: Exact or approximate values at key points (e.g., "drops to 6", "stabilizes at 500")

- Patterns: Cyclical, linear, sigmoidal, plateau, etc.

What NOT to include:

- Don't interpret causation (e.g., "because of X, Y happens"), just describe what happens

- Don't add explanations not in the data

- Don't use vague terms like "significant" without numbers

- Don't mention the plot itself (no "as shown in the figure")

In addition, here is a small collection of bad and good examples:

❌ Bad

"The number of agents goes down a lot"

✅ Good

"The number of agents declines from 80 to 10 by time step 5"

❌ Bad

"The biomass fluctuates"

✅ Good

"Reserve biomass starts at 300,000 units, drops by step 10, then stabilizes around 400,000 by step 500"

You will be provided simulation outputs using a plot format (one plot for each variable). Each plot represents the evolution of this variable over time. You will also be provided with the ABM documentation as well as the the simulation parameters.

Here is a quality checklist for you to quickly verify the summary you write. This quality checklist only includes some important aspects but is non exhaustive:

- Goal sentence: Clear one-liner explaining model purpose
- All key parameters: Numeric values from source included
- Initial values: Starting point for each metric mentioned
- Time points: Specific steps where changes occur
- Numeric accuracy: Values match source data
- Trend direction: Clear increase/decrease/stabilize
- Final outcomes: How the simulation ends
- No interpretation: Only describe, don't explain why
- No visual references: Don't mention "figure", "plot", "graph"

Below is the documentation of the ABM:

The Megafaunal Hunting Pressure Model (MHPM) is an interactive, agent-based model designed to conduct experiments to test megaherbivore extinction hypotheses. The model considers environmental change, human hunting behavior, herd demography, herd movement, animal sexual dimorphism, and animal life history.

You first see a simplified grassland environment with randomly generated patches of grass, male and female ungulates, and human hunters. Depending on the hypotheses and/or data from a specific case study, you can manipulate the sliders in the NetLogo interface to establish the socio-natural dynamics of the experiment matrix. Broadly, the model allows you to change the following unitless categories that exist on a continuous scale: fodder availability, seasonality, relative animal food value, animal fecundity, lifespans of hunters and animals, relative hunting danger, as well as the energy required to move in the environment. Ideally, experimental dynamics will demonstrate how environmental conditions, human hunting, and animal life history interact to either accelerate or buffer extinction or create equilibrium conditions which do not result in an extinction event. The temporal units used in NetLogo are “ticks,” which can be scaled to any temporal granularity.

The landscape consists of an abstract square universe that wraps at the edges. It exists on a 211x211 patch matrix and a relative spatial scale. Although these patches are unitless, it may, be useful to image the landscape in km2 based on approximations of daily distance traveled by megaherbivores. For example, S. caffer walks approximately 3.4 km/day which scales a single patch to ~911 km2. These values will change for each case study.

This is an interactive manual model. The user can fully manipulate the variables to test a wide range of hypotheses related to extinction in a socio-natural system. To begin first select the variables you would like to test in your extinction scenario (i.e., environmental patchiness or animal fecundity). We recommend keeping most variables constant, and only changing 1-3 variables per experiment. The user can also set the max ticks, which will stop the experiment after a designated number of ticks. Once the independent variables have been selected, use the interactive sliders to move them a few units at a time, avoiding large, drastic jumps in relative scale. When you are ready to run your experiment click the setup button. This will generate a landscape that matches the environment, herd demography, and hunting pressure reflected in the user’s parameterization. Then click the run button, and the experiment will begin.

Hunters are embedded with logic that approximates dynamic optimal foraging theory. In this model, hunter’s foraging decisions very in response to environmental feedback. The decision to pursue a prey item is balanced between the current energy-status of the hunter, the food value of the prey, the relative density of prey in the landscape, and the cost of pursuing, hunting, and processing the animal. Hunters do not reproduce and loose a user-set amount of energy as they move in their environment. Hunters can die if they run out of energy, they can also store energy from food and create an energy surplus, which is consumed before hunting is resumed. Users can turn human mortality on or off.

Ungulate herds are sexually dimorphic, with distinct user-determined food value and processing costs for males and females. Animals are also capable of reproduction, and

sex ratios and probability of reproduction can be controlled by the user. Additionally, females can become pregnant and spawn offspring. Once spawned, offspring nurse for a set amount of time determined by the user. A nursing offspring adds to the food value of the female. This allows the user to approximate animal life history with novel detail.
Animals are programmed to move as a herd with feedback from environmental conditions. Animals age, and the probability of random death increase once the animal reaches senescence. There is also external morality probability which can be adjusted by the user to simulate a percentage of animals that die from non-human predation at each time-step. Maximum animal lifespan is also a slider set by the user.
The environment can be controlled by the user by changing the density of fodder in the landscape (grass-proportion) and the time it takes for grass to regrow once it has been grazed (grass-regrowth). Grass regrowth can be turned off which will create a static environment. Additionally, users can choose to the keep-initial option, which limited grass regrowth only to the areas that were initially vegetated. Users can also utilize a seasonality slider, which limits grass regrowth to a user determined seasonal cycle.
The process of refining and experimenting with the relative value of independent and constant variables can be repeated until the experimental parameters appears to behave logically and work well to test the user's hypotheses. When selecting values, it is useful to keep in mind that these values have relative, as opposed to absolute, value. For example, when picking a value for food-value-male and food-value-female (the energy hunter's gain from eating male or female prey) do not think of the numbers in terms of kilogram or calories, but rather the relative size of males to females. In this case, a 2–5-unit difference may be sufficient to demonstrate how sexual dimorphism may impact human hunters operating under optimal foraging logic. The experiment will stop when: 1) human hunters die off, or 3) the experiment reaches the maximum number of ticks set by the user.

Summary statistics are shown on the bottom left side in labeled output boxes and are formatting as continuous line graphs that reflect new data from each tick. They include:

- Number of prey-items taken per 10 ticks. Three lines are generated to show how many males, females, or post-partum females are hunted over the past 10-tick cycle.
- Proportion of grazed to ungrazed grass on a scale of 0-100.
- Forager energy, which changes as hunters exploit prey and move in their environment.
- Number of animals in the environment. Three lines are generated to show how many males, females, or post-partum females are in the environment over time.

(More information about the NetLogo Behavior Space needed)

To begin manual experiments prior to identifying final experimental parameters for the behavior space, establish a baseline understanding of extinction without the presence of hunters, when the environment remains static, and males and females have identical food-value. Once you have a baseline understanding of model dynamics, you can begin changing a few variables at a time to see if extinction dynamics change.
To examine how environment alone may impact extinction without human hunting, select one of the environmental variables – either grass-proportion or grass-regrowth – and move them a few units to represent degradation to baseline environmental conditions. Then click setup and run to observe how changes to environment might impact extinction dynamics. To continue this experiment, move the second environmental variable, to see how even greater environmental degradation impacts the extinction dynamics. Now re-run the same

experiments with seasonality turned on, how does the presence of a 'dry' and 'wet' season impact extinction, herd movement, and herd demography? Do environmental conditions alone impact the likelihood of an extinction events? Identify a set of model parameters that test a range of environmental conditions (excellent – poor), with or without seasonality depending on your case study. Note that these differences between environmental conditions should represent only small differences between units – avoid drastic changes, which will make analysis very difficult.

To examine how hunting pressure and hunting behavior might impact extinction dynamics, begin by keeping the environment static. First decide on the population density of hunters. We recommend starting with a relatively low density of hunters, then increasing the number of hunters iteratively, adding a few hunters at a time, until the landscape best approximates your case study and/or hypotheses. Then, run your experiment without changing animal sexual dimorphism to see how hunting alone might impact extinction dynamics. Once you have a baseline understanding of how hunting might impact herd movement and demographics, you can begin creating a sexually dimorphic herd to observe how that might impact hunting behavior and the likelihood of extinction. Use data from your case study and/or hypotheses to select a sex that will be larger. Then, give that sex additional food-value (one or two additional units, which can be increased iteratively as needed). Now, click setup and run. How does sexual dimorphism impact hunting behavior? How does that behavior change the likelihood of extinction? What sex goes extinct first? This data will be available by observing the output in the lower left corner.

To examine how animal life history may impact extinct you can add to the hunting experiments above. Keep your herd sexually dimorphic and change the birth-spacing variable. Use data from your case study to inform the interbirth interval selected for the ungulate species. We recommend starting with a small number (for example 1 or 2) and increasing iteratively until the number accurately reflects your case study. Then use existing data to select a maximum lifespan for your animal. Once selected, we recommend keeping lifespan constant across all runs of the model. Then click setup and run. How does the interbirth interval (and the potential food value of the calf) impact hunting behavior? How does this impact extinction dynamics? Which sex is more likely to go extinct first?

Now you are ready to bring together environmental, hunting, and life history together into the experimental parameters. Begin by testing how hunting pressure and life history constraints play out in a 'lush' environment (with or without seasonality depending on your case study). Did the animals go extinct? What sex did hunters prefer? At what tick did extinction occur? Now, re-run that experiment with your 'moderate' environment, and then again with a poor environment. Compare the results between the three runs. When you are satisfied with the results you are ready to run your experiment in the behavior space to see how it behaves over hundreds of iterations.

As it exists, the landscape is a flat, rectangle with no topographical features. It would be useful to add GIS data so that specific case studies can be explored in greater detail. For example, how might environmental refugia impact – or buffer – the likelihood of extinction, like case studies seen in North America. To accurately test these hypotheses, the topographical features of the environmental must have more detail and plasticity.

The Diet Breadth Model is also a NetLogo model developed for testing how foraging decisions react dynamically to environmental feedback upon prey encounter. This model is simpler, and does not include environmental seasonality or animal life history.

This model was created by Isaac I.T. Ullah, PhD, and Miriam C. Kopels, MA, at San Diego State University and The University of Nevada, Las Vegas. It is intended for educational and experimental purposes only and comes with no warrantee or guarantee of accuracy. The original idea for this model derived from Richard Klein's case study of giant buffalo at the Klasies River Mouth, South Africa, during the Middle Stone Age. It is available under the GNU public license, and is published on the web at Please cite the authors if you use this model in any publication.

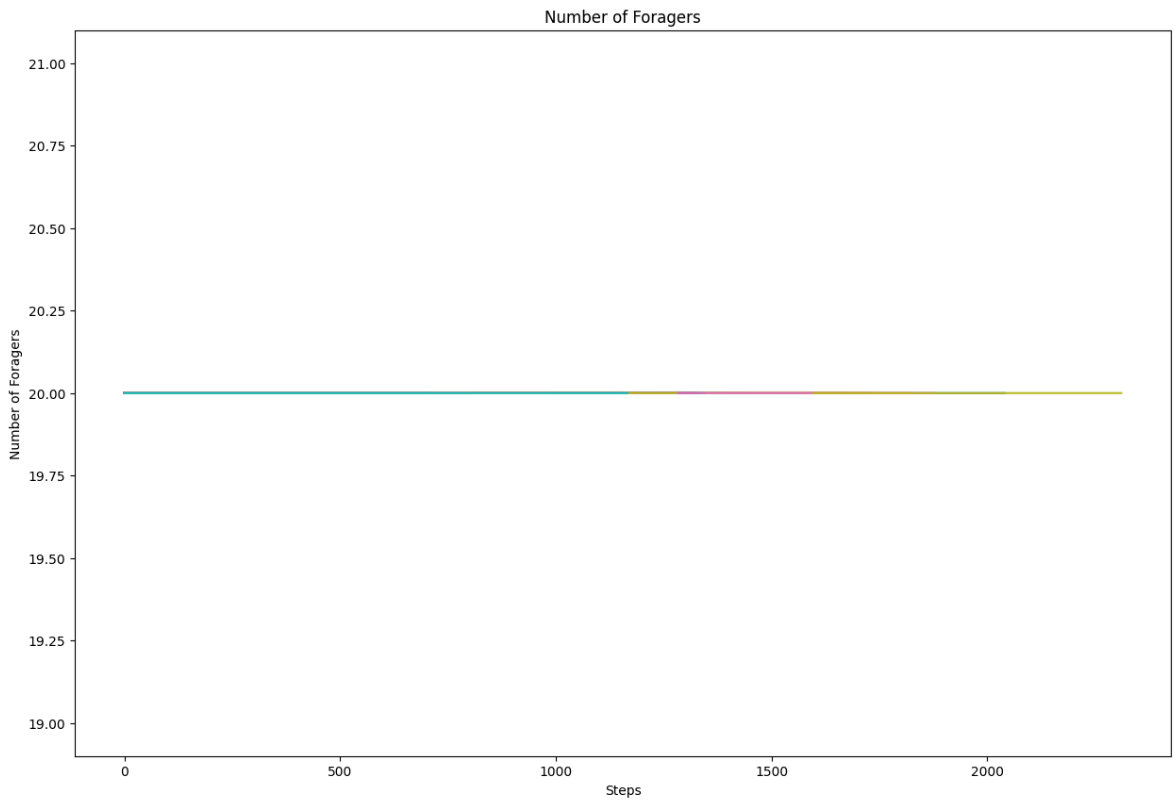
Below are the parameters used for our simulation run:

We have 29 parameters:

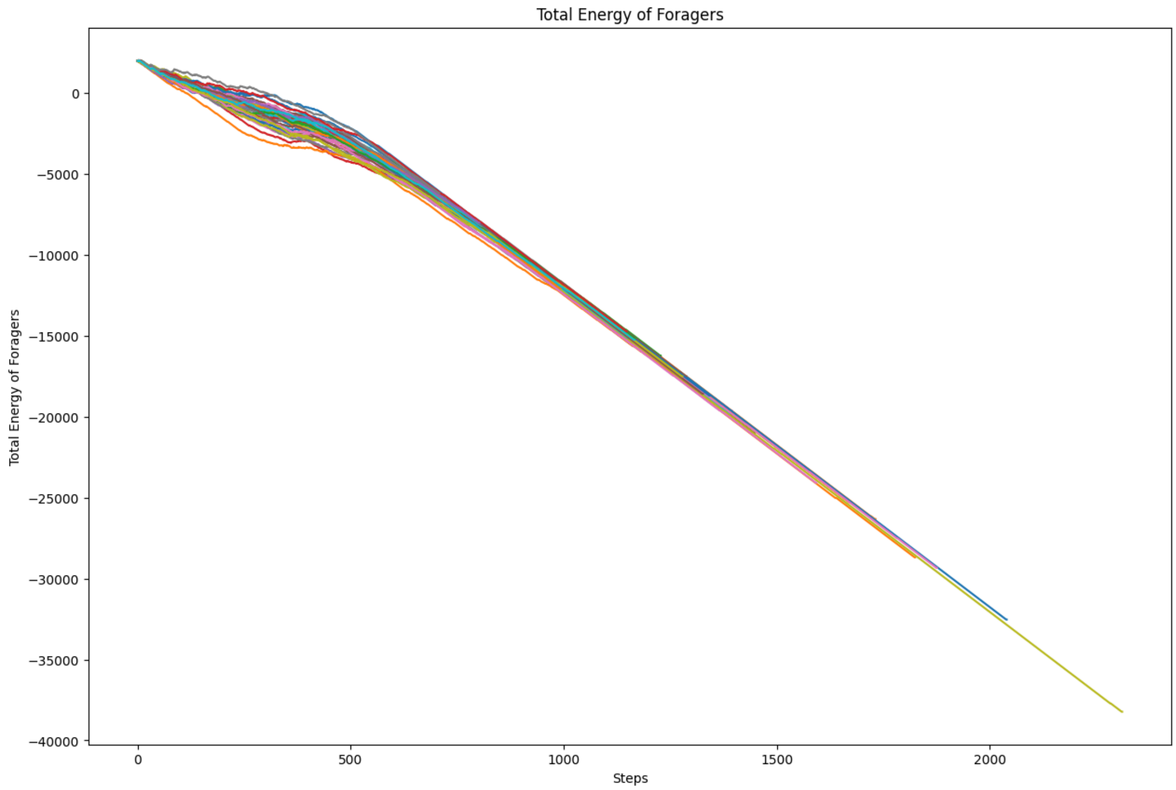
- init-foragers, from 0.0 to 100.0. We set it to 20.
- processing-cost-males, from 0.0 to 20.0. We set it to 6.
- food-value-males, from 5.0 to 100.0. We set it to 30.
- maximum-lifespan, from 0.0 to 12000.0. We set it to 10220.
- processing-cost-females, from 0.0 to 20.0. We set it to 3.
- food-value-females, from 5.0 to 100.0. We set it to 27.
- init-prey, from 0.0 to 1000.0. We set it to 250.
- internal-mortality, from 0.0 to 0.2. We set it to 0.025.
- age-of-senescence, from 0.0 to 10000.0. We set it to 7300.
- ticks-per-year, from 0.0 to 720.0. We set it to 365.
- animals-gain-from-food, from 0.0 to 10.0. We set it to 1.5.
- animals-starvation-threshold, from 0.0 to 100.0. We set it to 25.
- animals-movement-cost, from 0.0 to 10.0. We set it to 1.
- foragers-movement-cost, from 0.0 to 10.0. We set it to 1.
- grass-proportion, from 0.0 to 1.0. We set it to 0.33.
- external-mortality, from 0.0 to 0.2. We set it to 0.0025.
- birth-spacing, from 0.0 to 1000.0. We set it to 730.
- foraging-radius, from 1.0 to 100.0. We set it to 6.
- food-value-calf, from 0.0 to 20.0. We set it to 3.
- seasonality, from 0.0 to 1.0. We set it to 0.8.
- regrowth-time, from 0.0 to 365.0. We set it to 3.
- stop-at-max-ticks. We set it to True.
- stop-at-max-herd-size. We set it to False.
- grass-growth. We set it to True.
- keep-initial-grass-pattern. We set it to True.
- imortal-foragers. We set it to True.
- food-storage. We set it to True.
- max-ticks. We set it to 73000.
- max-herd-size. We set it to 500.

Below are the plots representing the simulation outputs

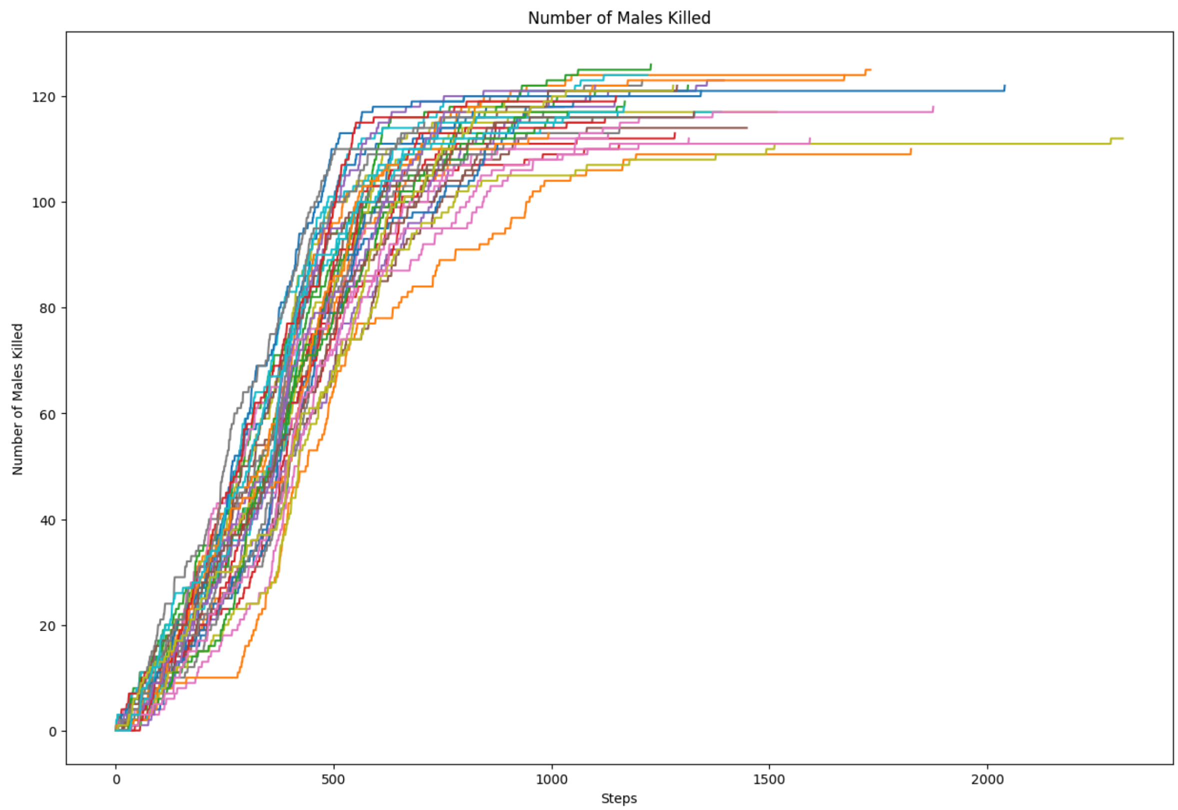
1) Number of Foragers



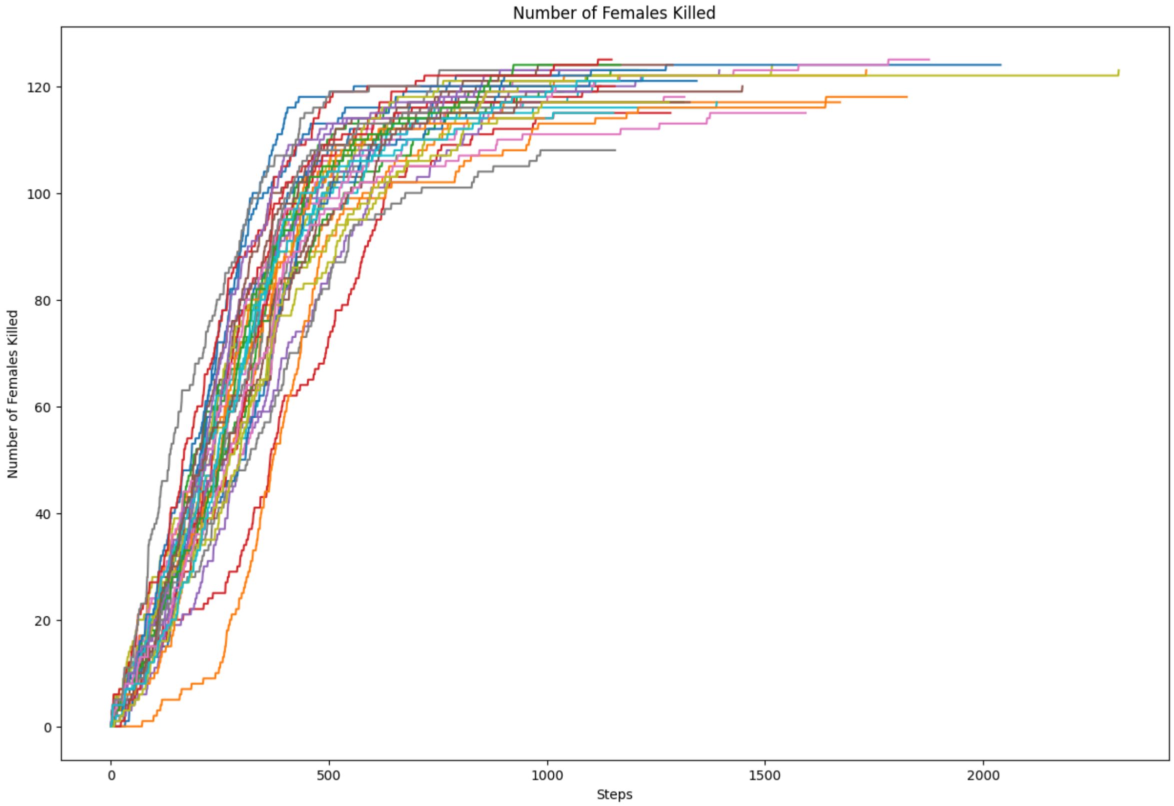
2) Total Energy of Foragers



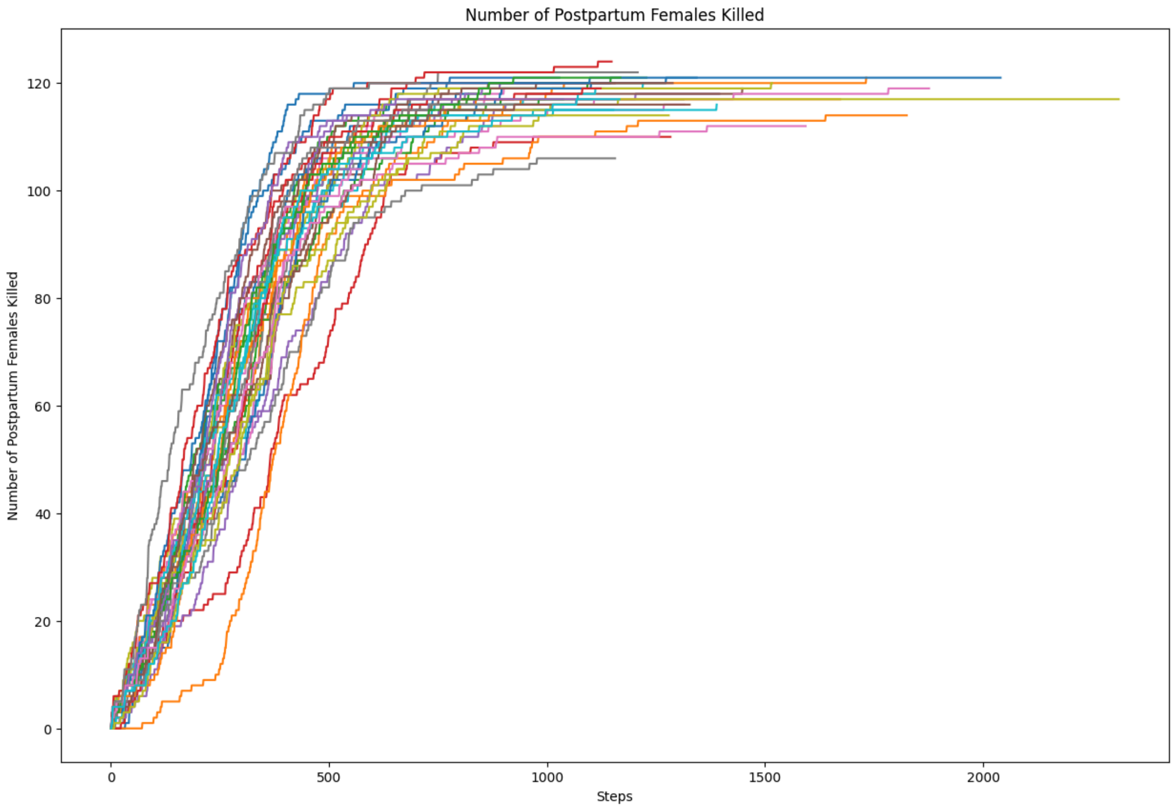
3) Number of males killed



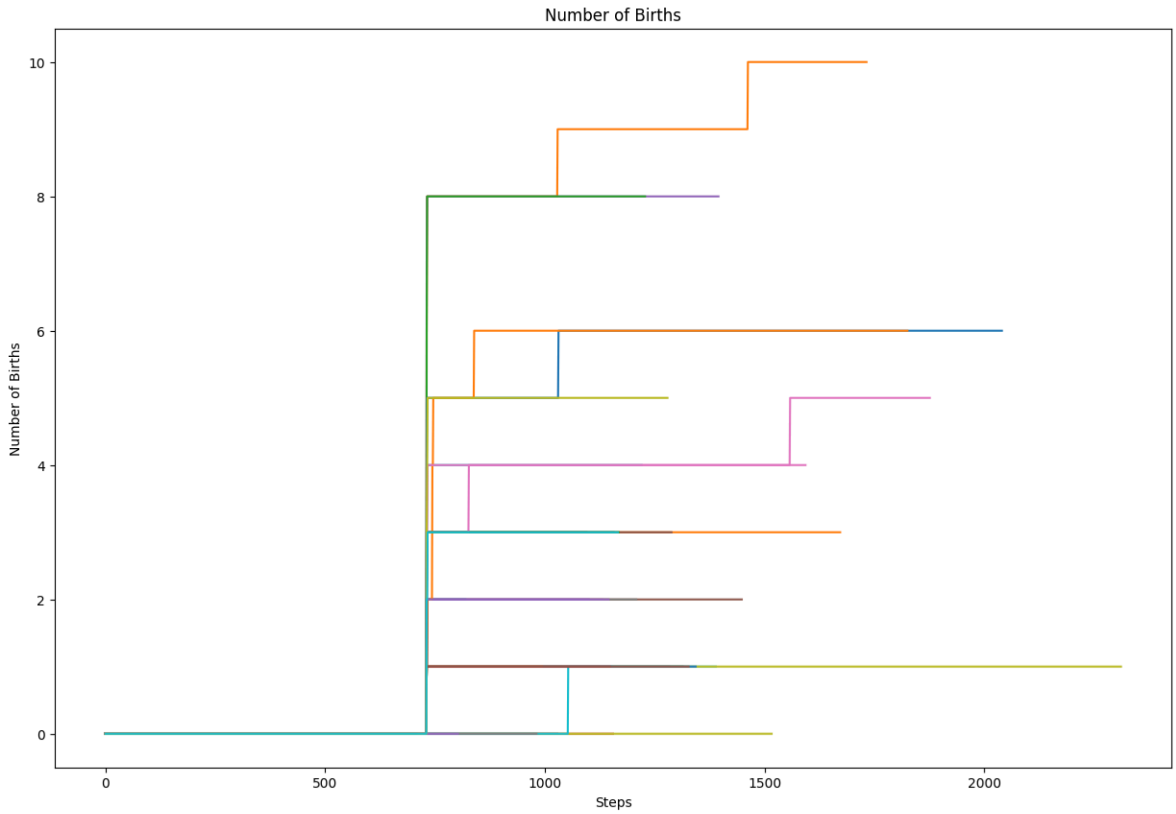
4) Number of Females Killed



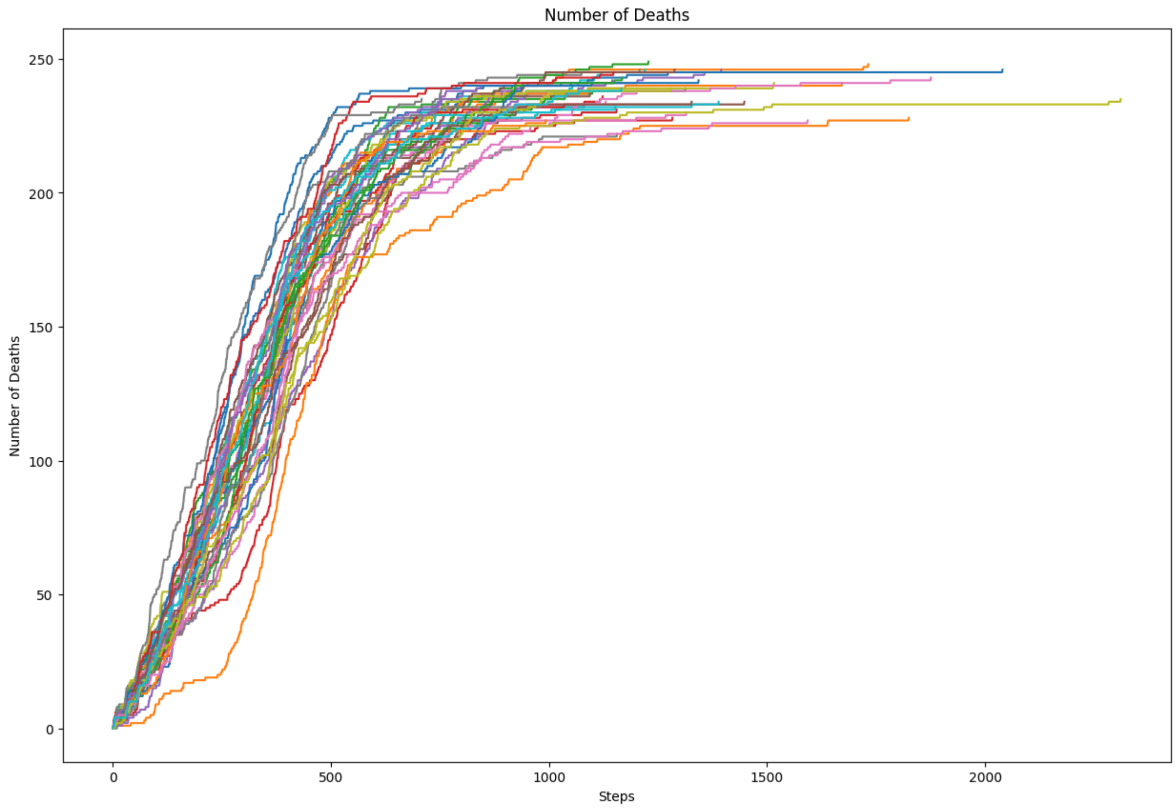
5) Number of postpartum females killed



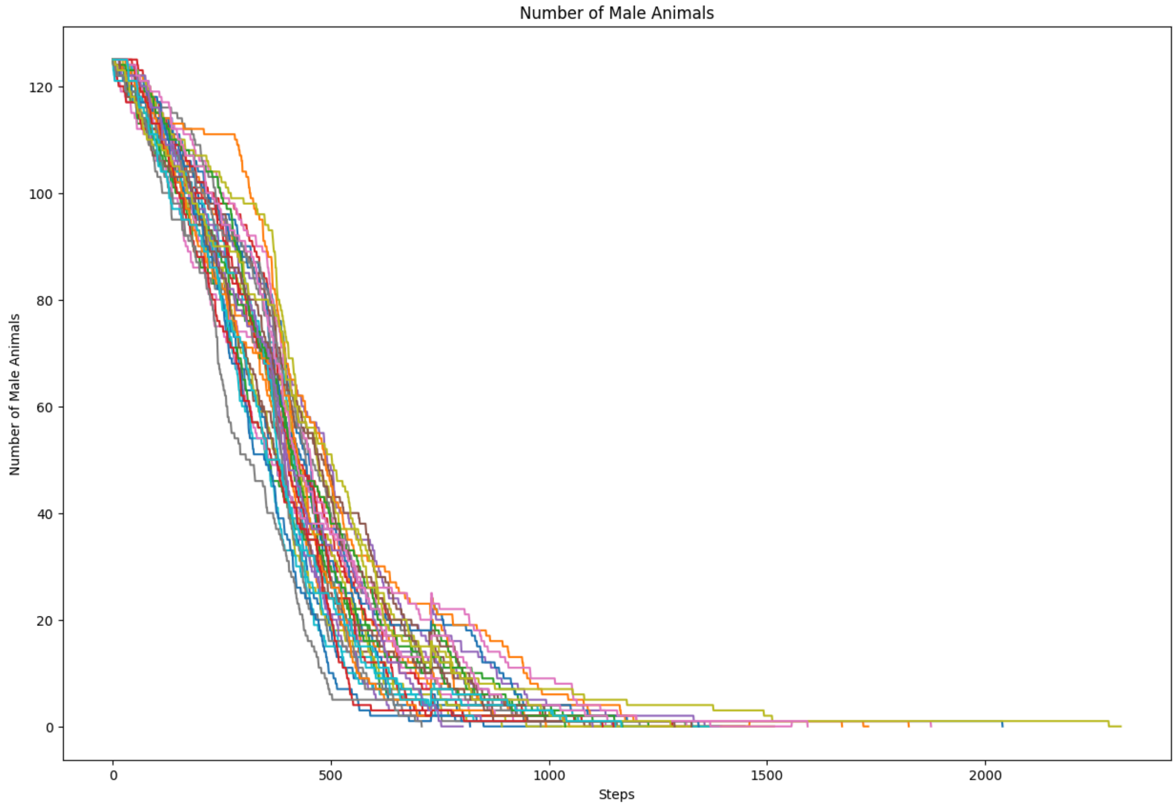
6) Number of births



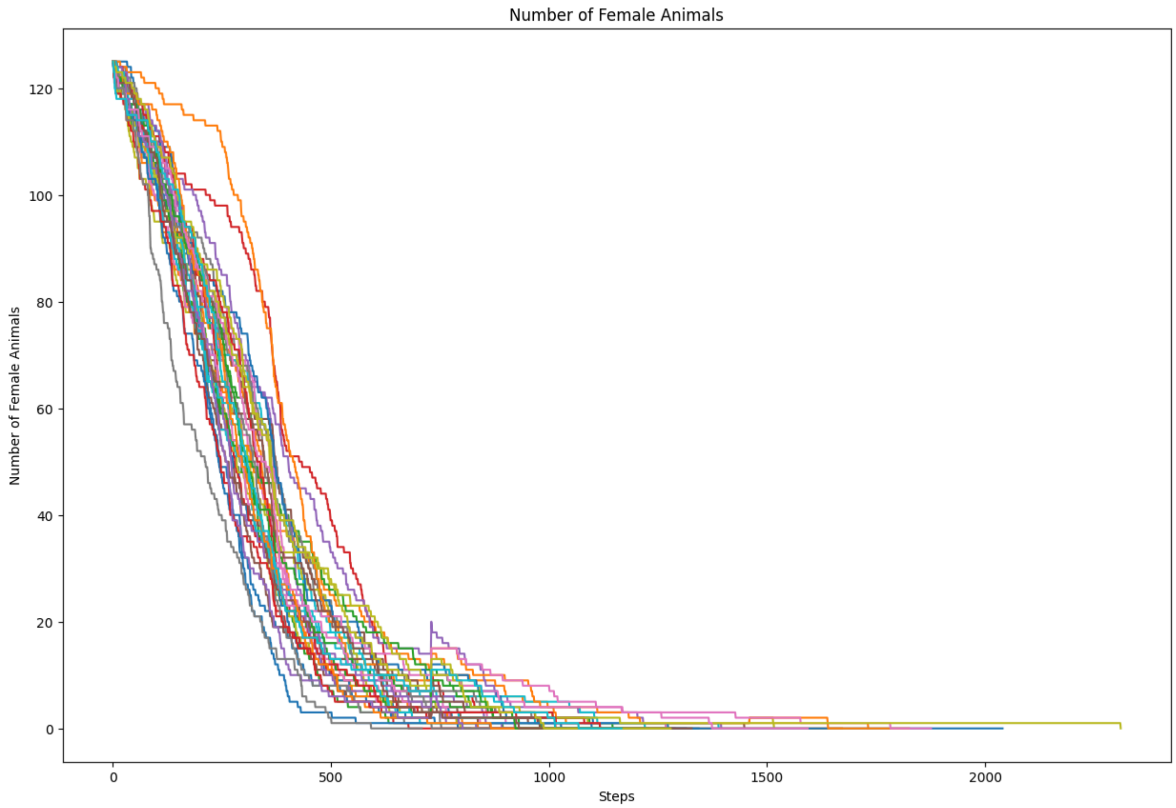
7) Number of deaths



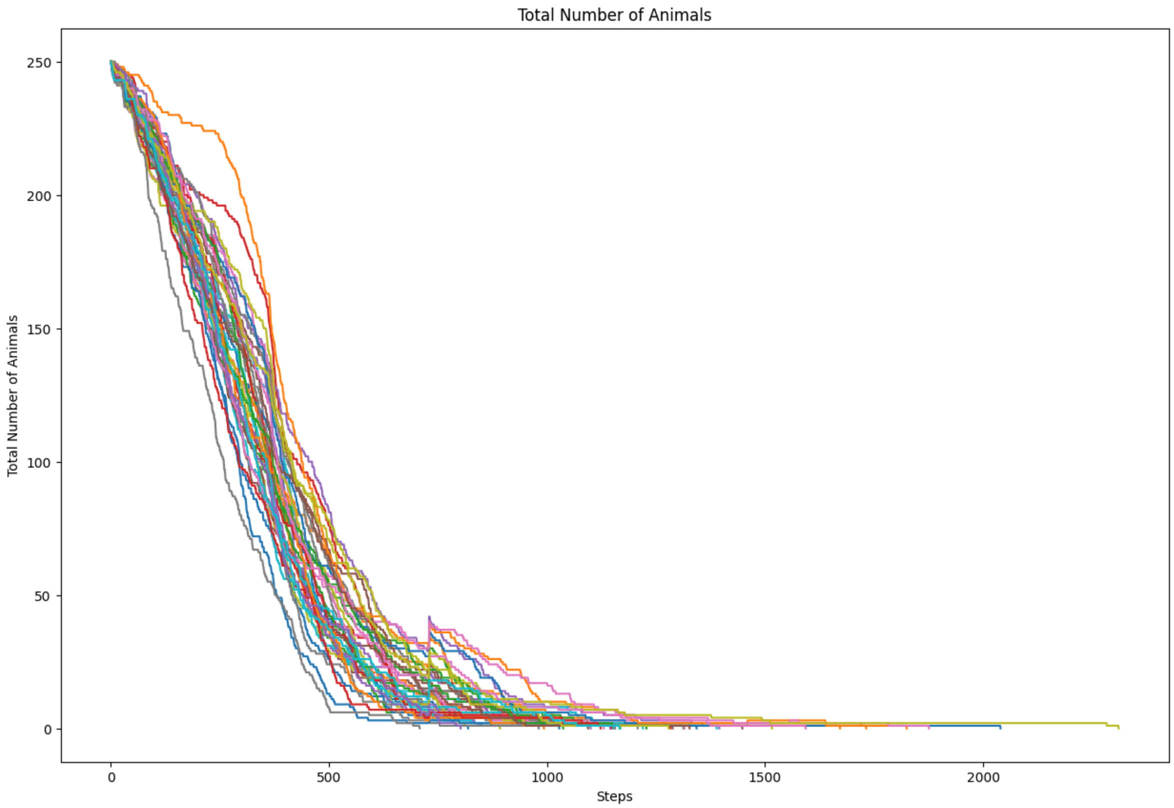
8) Number of male animals



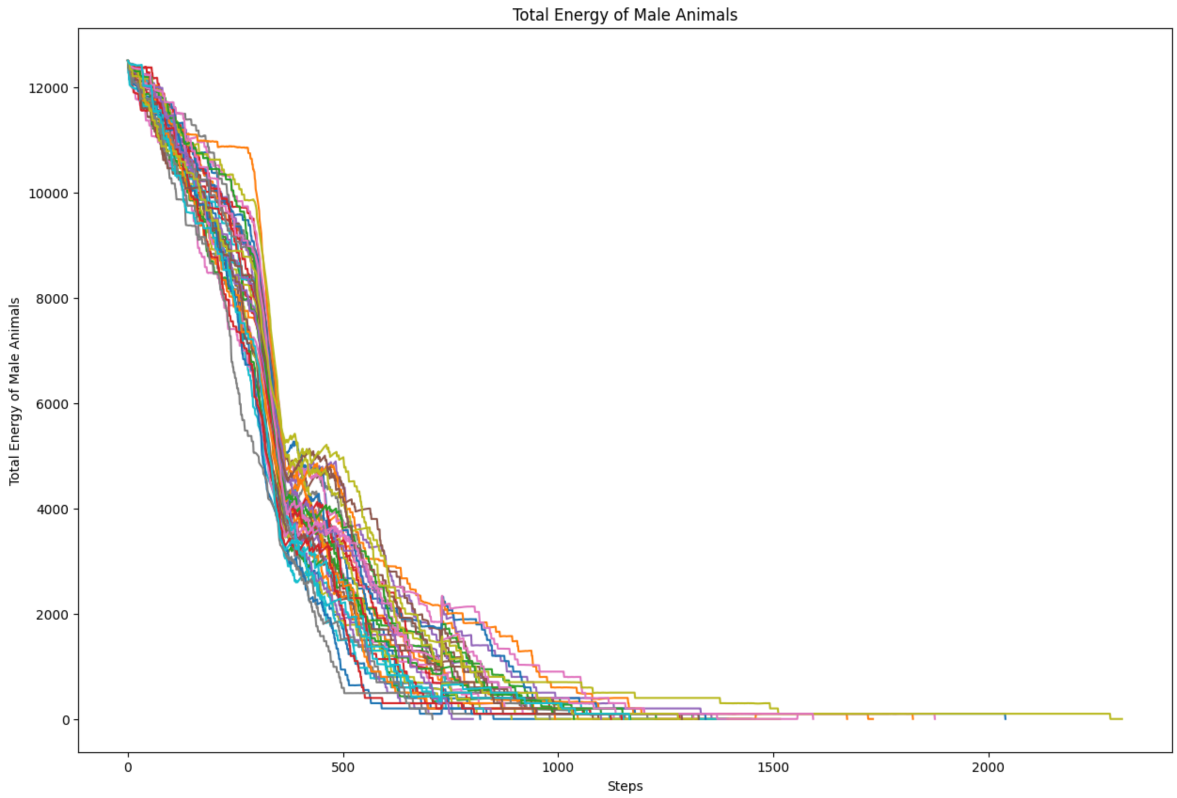
9) Number of female animals



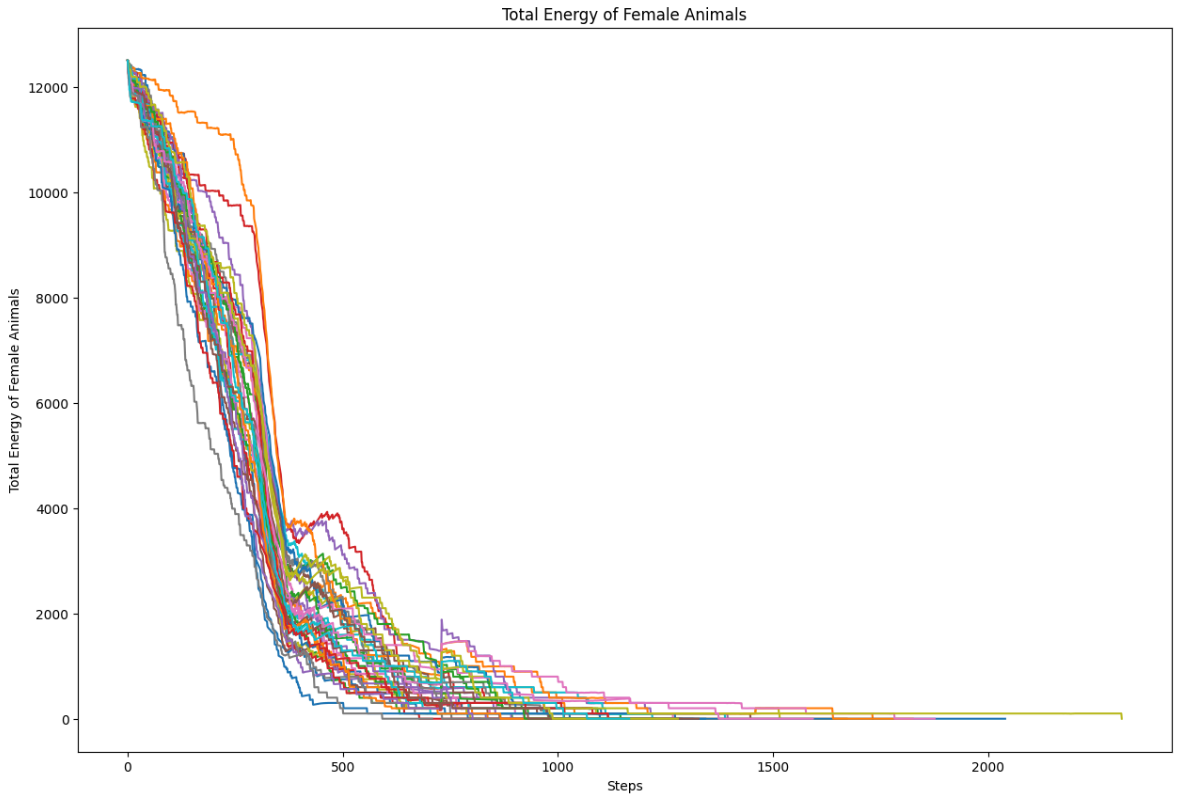
10) Total number of animals



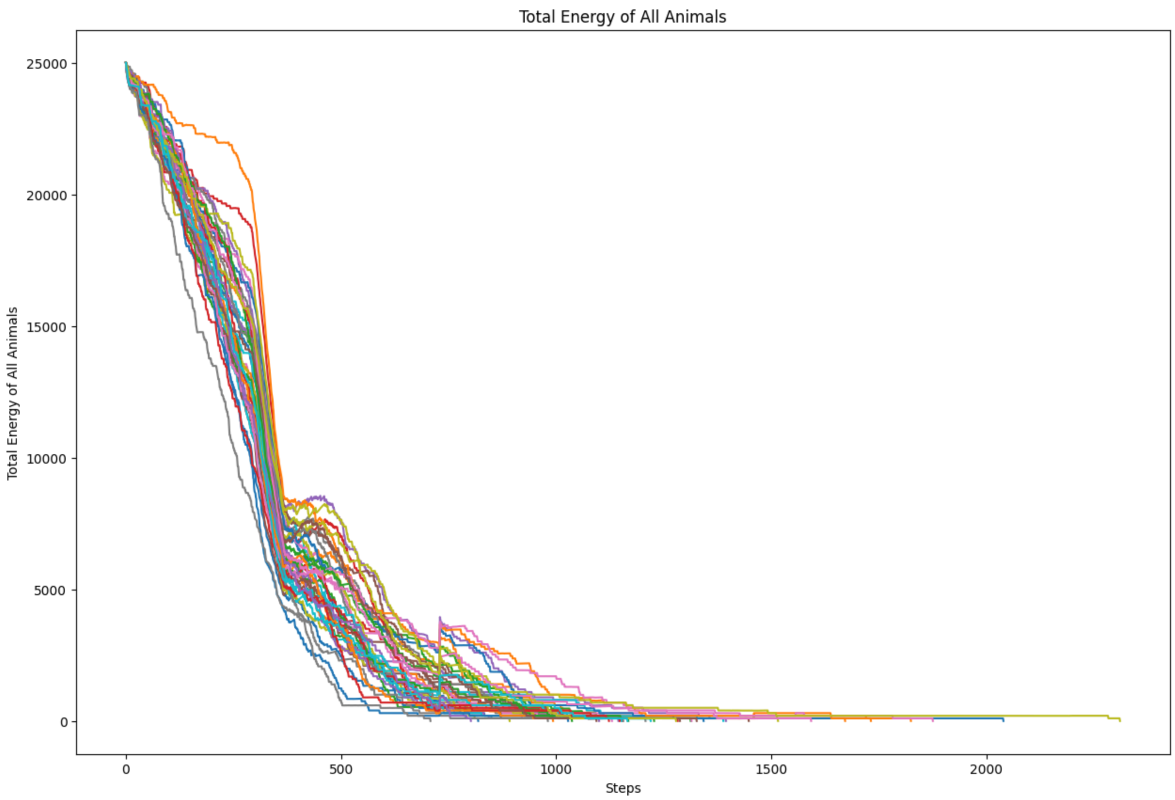
11) Total energy of male animals



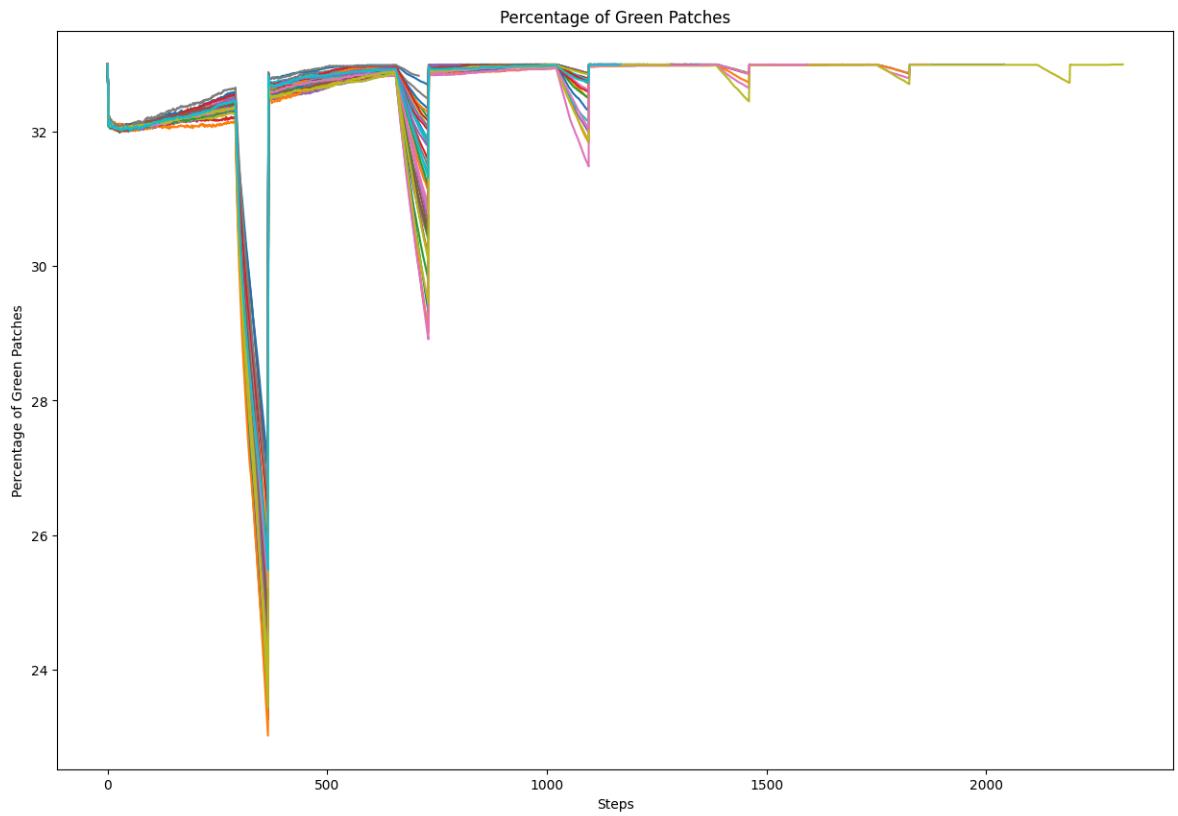
12) Total energy of female animals



13) Total energy of all animals



14) Percentage of green patches



Please provide your narrative summary here: *

Your answer

Submit

Clear form