Hunting Season
Sustainability and the Tragedy of the Commons

Click here for single-player game
Click here for multiplayer game

Overview
The Concept
Hunting Season is a combined single and multiplayer game designed to teach school students about some of the dynamic behavior that lies behind the problem of the Tragedy of the Commons. Designed with systems thinking in mind, the learning is split into two main parts:

- A single-player game that introduces the concept of sustainability and the necessity of prudent environmental stewardship to maximize the long-term utility of resources.
- A multiplayer game that reinforces the lessons of the single-player game whilst adding an apparent competitive component. With multiple players seeking to maximize their use of a resource in comparison to other agents, the common resource pool runs the risk of being depleted. The aim is to show that individual and group rationality may not always align and that higher-level communication and organization is necessary for resource sustainability.

So far, so abstract. But what does this mean in context?

The Story
The games are set in a frontier town of the Old West. Resources are seemingly scarce, but what the area is rich in, is Foxes and Rabbits. The pelts from these animals are the primary economic fuel of the area and are sold by the player to earn money.

In the single-player game, players must merely earn as much as they can without hunting either animal population to extinction. In the multiplayer game, they must do the same, but with an added complication. Players represent three local families with a long-standing rivalry. The winner’s ‘prize’ is the financial supremacy needed for that family to take control of the local town.
1. Quick Glance:

Key Concepts and Insights
1. Elements of the Tragedy of the Commons archetype
2. Individual self-interest and communal interest that contradict in hidden ways
3. Cooperation that proves more beneficial than competition, even for seemingly opposed parties
4. Value of sustainability versus constant growth and long-term versus short-term sacrifices
5. Costs associated with perpetual growth and the threat of vicious cycles
6. Existence of limits to growth

Curricular Connections:
Example connections from Next Generation Science Standards
ESS3.C Human impacts on Earth systems
Grades 6-8
“Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people’s impacts on Earth.”
Grades 9-12
“Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.”
ESS3.A Natural resources
Grades 6-8
Humans depend on Earth’s land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.
Grades 9-12
Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.

Related NGSS Cross-Cutting Concepts:
1. Patterns.
2. Cause and effect: Mechanism and explanation.
3. Scale, proportion, and quantity.
4. Systems and system models.
7. Stability and change.

Ages: Middle/High School

Times:
- Introduction – < 1 hour
- Game – 1+ hours
- Basic debrief – 1+ hour
- Assessment/Project – varies dependent on time allotted

Materials:
- One computer for every student (ideally)
- Game and all materials online at:
  http://www.clexchange.org/curriculum/simulations/huntingseason.aspx
- Technical Guide
- Introduction/Debrief Slideshows (optional)

2. Lesson Details
   Single-Player
   a. Preparation
   b. Introduction
   c. Running the Game
   d. Debrief and Assessment
   e. Single-Player Debriefing Notes

Preparation
1. Ensure that students have all the technical requirements for the lesson. Ideally this means one computer per student. Circumstances and class sizes may dictate sharing arrangements.
Introduction

1. The game backstory is relatively simple and is explained within the introduction screens of the game. However, teachers may wish to reiterate the theme, goals and controls of the game.

2. After clicking ‘Next,’ players are taken to an explanatory page where the controls of the game are explained. There is also a ‘Help’ tab which provides further explanations should they be required during the game. A practice slider is also included that does not affect the game. When ready, players may start to play.
Running the Game
1. The tabs to the left take players to different pages, which present players with different information on which to base their decisions.

2. On the ‘Decide what to Hunt’ tab, players may choose how many Rabbits and/or Foxes to hunt per year over a ten-year period using the sliders. They can also see a basic overview of information. When they have made their decision, they can click the ‘Click here to advance’ button to advance the game by 10 years and see the results of their decisions.
3. After each round, players will be given updated information and allowed to play for 10 additional years. After the last round, the ‘Click here to advance’ button will be replaced by a ‘How did you score?’ button.

**Debrief and Assessment**

1. Players should have the opportunity to complete the game at least once. Faster students may be able to play more rounds.
2. See **Single-Player Debriefing** below for essential information to discuss with students.

3. It is up to the teacher’s discretion to decide how and when to proceed to the multiplayer game. There is a link in the single-player game following the debriefing.
Single-Player Debriefing

**Note: How Scores are Determined**
Although the game is calibrated in such a way that players can avoid the disaster of extinction in many instances, it is still not surprising if students do not achieve sustainable earnings from hunting in their first attempt of the single-player game. For that reason, it's helpful to replay the single-player game.

*The intention is that most students are able, even if it takes more than one or two attempts, to earn a reasonable amount of money and maintain a healthy animal population.*

After they finish the single-player game, the students are awarded separate scores for:
1. The money they earn
2. Their conservation or sustainability efforts

The Money Score is calculated as a percentage of the maximum amount earnable by the player (irrespective of sustainability concerns). This was approximately determined by optimization runs of the model during development.

The Sustainability Score is calculated based on the end fox population and what percentage it is of the approximate equilibrium value of the Fox population when no hunting takes place\(^1\).

While it is not possible to achieve 10/10 on both scores at the same time, it is possible to score near 0/10 for both at the same time. This is deliberate. It is intended to show that even in optimal situations, trade-offs must be made.

\(^1\) It is not an aggregate of the two populations as that might allow favorable scores even in situations whereby Foxes become extinct and Rabbits reach their carrying capacity. This is clearly not an ideal situation.
However, it is very important to note that the model was calibrated in such a way that generally, *favoring sustainability will also favor better financial outcomes* [4].

This is because collapsing the populations to make as much money as possible will always result in 0/10 in sustainability. This is because the Fox population takes time to recover, if it even can, from overhunting. This overhunting may earn lots of money in the short term, but this cash will be exhausted by inflation over time. If done early this will mean no money left and no Foxes left to hunt.

Conversely, if players attempt to ‘game the system’ by overhunting at the end, they may well end up with a high Money Score, but they will not be able to fool the system into giving them a good conservation score. Balanced and careful hunting strategies will yield, on average, better results overall.

Ultimately, the students should generally feel that they have sufficient mastery and understanding of the game dynamics - even if only intuitively - to the point that they feel that, if left to themselves, they could manage the animal populations sustainably whilst making at least some money in the process.

**Multiplayer**
- Preparation
- Introduction
- Running the Game
- Debrief and Assessment
- Multiplayer Debriefing Notes

**Preparation**
Once the teacher feels students have sufficient experience with the single-player game, they can progress to the multiplayer game. The ‘storyline’ backdrop to this game is different. This is so to incorporate other players into proceedings, attach further stakes to the gameplay, and give the impression of a competitive environment.

The player is now a consultant to one of three rival families vying for control of control of the local town via cash gained from the pelt trade. How much the players themselves buy into the families’ petty, yet intractable conflict is up to them.

Importantly, most of the underlying model dynamics are the same as the single-player game. Some of the screens may show slightly different information due to the added players and will also give some sense of progression for students.

**Introduction**
1. Before the game begins, players are asked to input a nickname so that they can join a session. As the teacher, you may wish to provide guidance as needed.
2. Players can choose to make their own session if no session is available, or if they have been assigned, select their particular session.

3. They will then name the session and it will show up for other players to join.

4. The wait screen should look something like this:

5. Up to three players may take part, but a minimum of two are required. If only two students are present, the third player will be made up by an “AI” player.
6. When all players click ‘Ready to Start,’ the game begins.
7. Again, introductory information is provided by the game. *Please also note the three bars now visible in the upper, left-hand corner.* When clicked, this allows players to chat via the in-game messenger. Again, as the teacher, you may wish to provide guidance regarding appropriate chat behavior as needed.

8. Players are greeted by a familiar looking set of tabs, albeit now with more of them, giving them more information. In line with the added competitive element, is a ‘Bank’ tab, where players can view their balance relative to other players. They also now have the sigil of their family, the family name, and their running total to the right of the screen.
9. Play proceeds much as before, though faster players will have to wait for all teams to make their decisions before being allowed to advance to the next round.

10. Once players have completed their turns and the game, they are taken to more in-depth debriefing screens. After this, they will have the opportunity to re-run the game.

11. **Important Note: The Different Runs**: The multiplayer game is structured such that after the first run, players will be shown a brief series of slides that help illustrate the Tragedy of the Commons and spur them to act differently in the second run. After the first run, the game is reset, and the players can see if they can do better than they did the first time around. Though the information slides will not be shown again, players are free to replay the game as many times as they wish. The purpose behind these different runs is dealt with in the Debriefing section below.

**Multiplayer Debriefing**

In contrast to the single-player, failure to manage the hunted species is the *intended* outcome of the *first* run of the multiplayer.

Players adhering to the competitive mindset engendered by both the first game and briefing material are likely to hunt somewhat aggressively in order to make more money than other players. Even cautious and/or conscientious players are likely to have their plans ruined by similarly cautious co-players - let alone by those looking to gain an early lead.

Again, due to the potential for vicious, reinforcing cycles, animal populations are vulnerable to overhunting and extinction.

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The Scores
In the multiplayer game, students are given a collective sustainability score out of 10 - calculated as before. Scores below 7/10 will send players to a screen. This proclaims a “winner” of the contest but asks players at what ecological and financial cost this came at; since the animal populations are depleted, and the amount of money they have earned is smaller due to a lack of Foxes and/or Rabbits.²

Scores above this will show a different screen, congratulating players on hunting sustainably.

The Dialogue
Arguably the most important part of the two games is the communication among players, and a significant part of this takes part between the first and second run of the multiplayer game.

² The reasons for this are the same as described in the single-player briefing/debriefing.
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The teacher must impart to the students that in order for them to attain a sustainable balance between financial and ecological longevity, they must work together and communicate their hunting intentions in reasonably good faith - and that not doing so will only ever be to the ruin of all, including themselves.

Wording to this effect is included in the in-game briefing material between the two runs. Additional supplemental material from the teacher may also be beneficial.

Given recent experiences across the globe with online teaching environments and remote classes via Zoom, the game leaves options open for how to broach this inter-player communication. The teacher can determine which modality will best suit the needs of the class.

- If a physical classroom is in operation, students can potentially interact with others and discuss hunting strategies as advised by their teacher.
- To enable an approximately similar functionality online, a chat feature is included in the game itself.

Along with the calibration of the model parameters and difficulty, considerable thought was put into how much emphasis to place on this chat functionality in the in-game briefing notes.

There is a delicate line between keeping this functionality completely hidden, and openly advertising it so blatantly that it’s cooperative purpose becomes obvious and ‘spoils’ the ‘reveal’ of the game. (The ‘reveal’ being that cooperation not competition is key to achieving sustainability and better outcomes on the whole.)

We feel that we have done our best to walk this line, but we also recognize that teachers themselves are likely to be far better judges of this as pertains to their own students. For that reason, we recommend pre-game briefings by teachers to students reflect this and lay as much or as little emphasis on this aspect before any given run of the game.
In addition to the key concepts and insights, further, open-ended questions and discussions are encouraged if it is deemed suitable for the class. Here are some potential talking points and conversation starters:

- How true-to-life was the game? Does this affect the lessons we can take from it?
- Was there a hunting strategy that fared better than others?
- How easy was it to cooperate with other players?
- Is it even possible for players to successfully manage animal levels without an independent overarching authority or arbiter for disputes? How likely is this?
- What form should such an authority or arbiter take?
- Does the free market provide this role? Or does it make things worse?
- What alternatives might suit Huntsville, and would they be any better?
- Can you think of any similar examples in real life?
- What might be fair ways to resolve these disputes?

Addendum: The Artificial Intelligence (AI) Player
The game is designed for three students playing equivalent roles. However, on occasions where there are only two students available, the third role can be filled by an AI. To avoid insinuations of game-rigging, this ‘AI’ is actually little more than an aggregation of the other player’s hunting decisions, smoothed over time. They therefore cannot blame the AI for destroying the game, when it is in fact merely a reflection of their own decisions.

4. Technical Guide
- Follow the links to access the single and then multiplayer games. No account is necessary for either game, but players will need to choose a game to participate in for the multiplayer session.
- The timeline that players follow is a 100-year period.
- Each player has a number of hunters at their disposal. They are each given a yearly hunting quota every 10 years. The hunters are incredibly skilled and want to fulfill this quota to maximize their own earnings. Every year they hunt the maximum that players allow them to. They are limited only by the animal population.
  - If there are 100 Rabbits left and the hunters are asked to hunt 75 Rabbits, they will find 75, leaving 25 Rabbits left to breed new Rabbits for next year’s hunt.
  - If there are 100 Rabbits left and the hunters are asked to hunt 150, they will only return with 100 Rabbits and there will be no Rabbits left to breed. The rabbit population will be permanently extinct in the area.
● The price that the pelts fetch on the market is determined by rudimentary modelling of supply and demand. As the number of a given animal decreases and becomes more scarce, the prices that their pelts fetch goes up.

**Model behaviors to be aware of.**

● The pelts do not have an equal or static value.
  ○ Fox pelts are the more valuable of the two as a baseline.
  ○ As with real markets, the price varies with the scarcity of the resource. The more Rabbits there are, the less valuable their pelts are [5].
  ○ For example, if Foxes are overhunted to extinction, then the Rabbits may become abundant, thus leading to lower pelt prices.
● Rabbits breed and multiply faster than the Foxes.
● Foxes prey on Rabbits.
  ○ Foxes rely on Rabbits for food, but obviously, the opposite does not hold. More Foxes will mean that more Rabbits are eaten.
● Money depreciates
  ○ As in the real world, over the course of ten years, inflation will make a dollar worth less and less. The hunters will also have other associated costs that will drain their resources. For simplicity’s sake, these have not been modelled. They nevertheless provide another very strong impetus for quotas to be raised to offset these losses.

Beneath these are other, more implicit behaviors:

● The density of the populations affect the birth rates of their counterparts.
  ○ With fewer Foxes eating them, the Rabbits will breed faster.
  ○ With fewer Rabbits to eat the Foxes will breed slower.
● The density of the populations affect their own birth rates.
  ○ The fewer Foxes there are, the harder it will be to find a mate and the slower their numbers grow (and, by extension, the more likely they are to become extinct).
  ○ The Rabbit population has a limit beyond which it cannot grow - this is taken to be due to limiting factors such as insufficient food for example.

Because of these, it takes some care on the part of the student to prevent populations - particularly the Fox population - from lurching into a vicious downward cycle.

### 5. Acknowledgements by Richard Ruston and Nathan Cole

The model in this ILE uses Pål Davidsen’s *Maibab* model as its foundation. We have made significant alterations to it for the use of this project. Where the model is simple, uncluttered and clear it is likely Pål’s original work showing through. Where variables are left undefined, unitless, messily scattered across the screen, and equations hastily bunched into flows and graphical functions; this is likely our work.

**NOTE:** The guide, PowerPoint presentations, and game, i.e., Interactive Learning Environment (ILE) were created by Richard Ruston and Nathan Cole. Modifications and edits made by Creative Learning Exchange. Distribution by Creative Learning Exchange with permission from the original authors.

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