Robot, Robot, Goose!

Age Levels:

- Ages: 9-12
- Subjects: Zoology, Robotics & Engineering

Total Time Required:

- # hours

Prepared by:

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- June 2023

Unit Objectives:

Students will be able to:

- Inquire into the ecological impacts of an increasing North American snow goose population and discuss state implemented conservation orders.
- Design and construct a snow goose decoy with biomimicry.
- Design and construct 3D printed joints giving motion to the decoy.
- Construct and program a robotic platform for the decoy.
- Defend and market their design in a presentation and demonstration of the decoy's capabilities.

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Science Standards and Standards for Technology Literacy:

Next Generation Science Standards:

High School – Life Science:

- **HS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics-** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- **HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics-** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics-** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- **HS-LS4-5 Biological Evolution: Unity and Diversity-** Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

High School – Earth and Space Science:

- **HS-ESS3-3 Earth and Human Activity-** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

High School – Engineering Design:

- **HS-ETS1-1 Engineering Design-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- **HS-ETS1-2 Engineering Design-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- **HS-ETS1-3 Engineering Design-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- **HS-ETS1-4 Engineering Design-** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous

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criteria and constraints on interactions within and between systems relevant to the problem.

Recommended Instructor Preparation

- This lesson is meant to use a variety of materials. We sourced cardboard, FIBC bags (flexible intermediate bulk containers), and fabric. There are countless other materials that could be used or repurposed for this lesson. Prepare enough for your class, but allow students to propose alternates.
- We used the VEX V5 platforms to allow the decoys to move. Any robotic platform that is large enough to house the decoys would be appropriate.
- Contact your local wildlife department prior to this lesson. Inform yourself of local laws and bird migration patterns/seasons to best time your lesson. Classroom visits from experts make for excellent
- Hunters or outfitters in your local area are another great source. They may volunteer for classroom visits or as field test judges.

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Lesson Focus:

Inquire into the ecological dilemma of the snow goose on the North American continent, specifically focused on arctic breeding ground habitat destruction.

Total Time Required:

- 2 class periods ~100 minutes

Lesson Objectives:

Students will be able to:

- Demonstrate a knowledge of the ecological dilemma of habitat destruction by the light geese on the arctic regions of the north american continent.
- Understand population dynamics of the light goose populations and the ramifications of population explosion on the population and the habitat.
- Demonstrate an understanding of the need for light goose conservation efforts.

Equipment and Materials

Tools and Materials	Quantity Needed
iPads, Chromebooks, or laptops	1 or more per student or student group.
Ducks Unlimited article handout	extra copies(for students who prefer to annotate on paper)

Special Notes on Materials:

Lesson Procedures:

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1. **Open with video:**Non-Stop MONSTER Snow Goose Rainouts: FEED THE CYCLONE
   Ask the students to reflect on their feelings about what is occuring. Is this activity sustainable? ethical? How does it make you feel?
2. **Share the following article:**
   https://www.ducks.org/conservation/national/light-goose-dilemma
   have the students read and annotate the article, then discuss in groups. How does this information affect your initial analysis of the hunting video? sustainable? ethical? Does it change the way you feel about this kind of hunting?
3. **Population Explosion Simulation**
   https://learn.concord.org/resources/658/population-explosion
   Students will use the population explosion simulation to model what happens to populations as they increase beyond carrying capacity. Students will be asked to insert different parameters into the simulation and test the results. Once familiar with the simulation, students will be asked to adjust the parameters to best assimilate the light goose population and its impact on arctic habitats.

Student Resources:

Non-Stop MONSTER Snow Goose Rainouts: FEED THE CYCLONE
https://www.ducks.org/conservation/national/light-goose-dilemma
https://learn.concord.org/resources/658/population-explosion
*Alternative to ducks.org article above - Video: “Snow Geese in Peril” - DVD or VHS

Student Worksheets:

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Environmental Study: Day 1 Student Answer Sheet

1. After watching the video: Non-Stop MONSTER Snow Goose Rainouts: FEED THE CYCLONE please reflect individually on what you saw:

Is this kind of hunting activity sustainable? Why or Why not?

Do you believe it is ethical to harvest so many geese at one time?

How does it make you feel to see so many birds being killed for sport?

2. Pair up with a partner and read the following article to each other: **https://www.ducks.org/conservation/national/light-goose-dilemma**

As you read this to each other, please INDIVIDUALLY highlight important information and annotate in the margins. (Provide paper copies and highlighters to student pairs who request them).

3. When you have finished, please discuss with your partner and answer the following questions:

How does the information you read in the article above affect your initial analysis of the hunting video?

Do you think this hunting activity is sustainable?

Is it ethical?

Does it change the way you feel about this kind of hunting?

Population Explosion and its Effects on Habitat and Other Species

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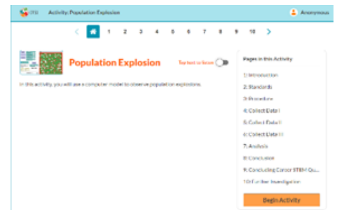
Objective: Use an online simulation to study the possible future effects of an exploding snow goose population and an effective conservation order.

Resouce: You will use this concord activity available here: https://learn.concord.org/eresources/658.run_resource_html

Home Page: Click "Begin Activity" We will only use the first 6 pages of this online activity, but we will use it to extend to our snow goose issue. You may choose to complete the entire activity though.



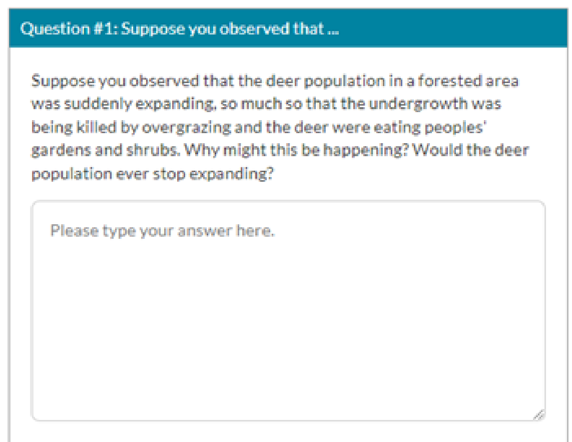
Page #1 Introduction

In this activity, you will use a computer model to observe population explosions.

Can populations go out of control?

A population is a collection of individual organisms that can interbreed, such as a single species of gray squirrels or a species of dandelion.

In the natural world, such populations of animals and plants increase and decrease with changing environmental conditions. Over time, however, many populations are relatively stable. They don't grow forever, and they don't disappear.



Record your observations in your engineering/science notebooks

If you don't have one, record your answer on this document.

Page #3 Procedure

How the model works:

Picture yourself as a rancher with a large field of sheep. You start with an equal number of males (horns) and females (no horns). The sheep live for six years. The sheep move around the field and eat grass, which grows back at a certain rate.

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Patches are green if there is grass, and brown if there is no grass. In the model, the sheep move and eat during the year. They use up energy as they move, and gain energy from eating grass. If their energy goes to zero, they die.

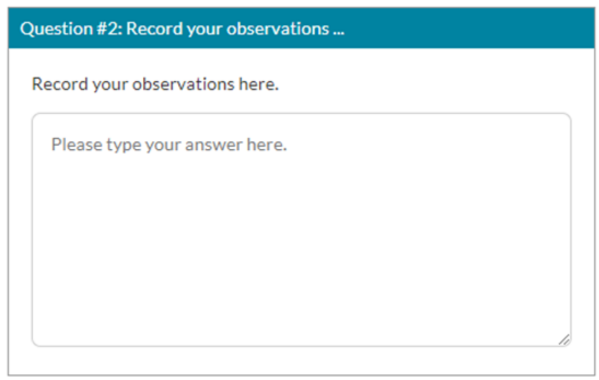
Once a year, from age 3 to age 6, each female gives birth to a baby.

To run the model, click SETUP; this gets the model ready to run. Click GO ONCE to run the model for one year. Click GO/STOP to run the model continuously. To stop, click the GO/STOP button again. The graph shows the amount of grass (green) and the total population of sheep (black) as time passes in the model.

Page #4 Collect Data I

What would happen to the population if the sheep had as much grass as they wanted?

Try this with the model. Change the LIMITED-GRASS? Switch to OFF. Then there is unlimited grass for the sheep to eat. Click on SETUP. Click on GO-ONCE five times. As the number of sheep gets very large, the model will run more slowly! What happens to the population?



Click on the snapshot button and describe the image. Click OK to close the snapshot album.

Page #5 Collect Data II

Start again by clicking on SETUP. Try using the REAPER button, which reduces the flock at the end of each year. The NUMBER-REMOVED slider sets how many sheep are removed by the REAPER button. Run the model with the GO/STOP button. Can you keep the population under control using the REAPER button?

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Click on the snapshot button and describe the image. Click OK to close the snapshot album.

What you just did with the REAPER button is what must happen in nature to keep a population stable. The birthrate (babies born divided by total population) must roughly equal the deathrate (animals that die divided by the total population). Many animals die every year!

Question #3: Were you able to keep the ...

Were you able to keep the population under control?

Please type your answer here.

Page #6 Collect Data III

Now try changing the variable BIRTHRATE-%. In this model, this is defined as the chance that a female will have a baby once a year. Try to keep the population stable even when the GO/STOP button is on and grass is unlimited. If the population gets out of control, stop, click on SETUP, and start again.

Click on the snapshot button and describe the image. Click OK to close the snapshot album.

Compare your results with the rest of the class and record your answers below.

Question #4: What is a value of

What is a value of BIRTHRATE-% that keeps the population roughly steady when the grass growth is unlimited?

What is the lowest value of BIRTHRATE-% for which the flock doesn't die off?

Please type your answer here.

Question #5: Notice that the effect of ...

Notice that the effect of changing the birthrate is delayed. Why is this?

Please type your answer here.

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THIS IS WHERE WE BREAK FROM THE ONLINE ACTIVITY

But, we will still use it.

Question #6 What factors in this simulation are useful for you to study the population of snow birds?

We will use the initial-number as the number of MILLION SNOW GEESE that were alive in 2000. That number was about 5 million snow geese. You will need to choose the other variables that best describe the growing population of snows.

Grass-regrowth rate:________________

Gain-from-food: _________________

Birthrate%: _________________

Reaper:________________ and how often?: _________________

If your numbers do not faithfully show an example of what is happening to the snow goose population now, change them until you find a satisfactory set. Then answer the last few follow-up questions.

Question 7: Does you model show optimism or doom for the population of snow birds? Is this close to what is actually happening on the North American continent?

Question 8: Is the reaper button an effective means for population control? If food is plentiful for snow geese, can the conservation order be used to mitigate their population explosion?

Conclusion: Give your final thoughts on the correlation between this simulation model and the North American Snow Goose.

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Lesson Plan: Plan #2 – Decoy Design

Lesson Focus:

Design a faithful snow goose decoy.

Total Time Required:

- 2 class periods (~100min)

Lesson Objectives:

Students will be able to:

- Design components that mimic specific motions of a snow goose
- Draw a layout of each individual component of their decoy

Equipment and Materials

Tools and Materials	Quantity Needed
Vex V5 Kit with 2-5 motors	1 per decoy
Large paper for designing in groups	1 per group
Markers, pencils, or pens	several per group
Cardboard	2-4 large boxes
FBIC bags	1 per group
Fabric	3-4 sq ft per decoy
Metal wire, fasteners, and optional hardware	Optional

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Special Notes on Materials:

There are many materials that can be eliminated, substituted, or supplemented to this plan. Students may even create decoys that require materials not on this list. Be prepared for flexibility to your student's needs.

Lesson Procedures:

Day 1

1. Supply students with the list of video links of snow geese in the wild. Choose one to show the class. Prompt students to look for specific motions and behaviors of the geese.
2. Move students into their working groups (1 group per decoy) and have them illustrate several individual motions of the geese.
3. Students will use these motions to develop mechanical joints. For each motion drawing, design a mechanism for adjoining two pieces of a decoy to recreate this motion.
4. Students present their designs at the end of this activity.

Day 2

5. Open fusion 360. Students will design a two or more piece joint to mimic the motion seen by the geese. This motion should be manipulated "at a distance" via a string, wind, or momentum. No motor should be used directly at the joint.

Student Resources:

https://animalia.bio/snow-goose
https://www.audubon.org/field-guide/bird/snow-goose
https://www.allaboutbirds.org/guide/Snow_Goose/lifehistory
https://www.youtube.com/watch?v=SBvIYWzD8M4 - Snow goose vs Ross's goose
https://www.iqsdirectory.com/articles/hinge.html - more than you'll ever need to know about hinges

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Student Worksheets:

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Robot Goose Decoy Design

1. Illustrate the essential movement of a goose that your decoy will mimic:

2. What joints will your decoy utilize to achieve this motion? Illustrate the joint here and show the motion paths of that joint. You may need to show more than one position of the joint:

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3. Present you design to another group. That group will score your design and record their opinions here:

	(low)			(excellent)	
Mimicry:	1	2	3	4	5
comments:					
Motion:	1	2	3	4	5
comments:					
Joint Durability:	1	2	3	4	5
comments:					
Creativity:	1	2	3	4	5
comments:					

4. Reflection: What do you expect from your decoy? Have you created something unique? Write a short reflection of your design. Start with your design process and include why you included certain aspects. Your reflection should be 1-2 paragraphs.

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Lesson Plan: Plan #3 – Decoy Construction & Testing

Lesson Focus:

Create and test a working prototype decoy

Total Time Required:

- 2-3 days (~150min)

Lesson Objectives:

Students will be able to:

- Implement a fully constructed decoy in the field.
- Collect valid testing data on design, construction, and function of their decoy

Equipment and Materials

Tools and Materials	Quantity Needed
Cardboard	2-4 large boxes
FBIC bags	1 per group
Fabric	3-4 sq ft per decoy
Metal wire, fasteners, and optional hardware	Optional
Paint (White, Black)	1-2 bottles
3D print spools (PLA or other)	1 roll for ~5 groups
Vex Kit for a basic square base + 1-2 extra motors.	1 per group

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Special Notes on Materials:

Lesson Procedures:

1. Start the 3D print process early. Students use fusion 360 or other program to create a .stl file of their joint design. This may be done as a whole group or an individual role within the group. Once the .stl is created, use a slicer program or fusion 360's capabilities to print out the joint prototype. Prepare for failed prints, monitor plastic use (print size), and the time it takes to complete.
2. If access to a laser cutter is available, the entire decoy can be designed in fusion 360 and a .dxf file can be extracted to cut cardboard, paper, or fabric. Otherwise, traditional scissors can be used for the "handmade" look. But, additional machinery can make for faithful and sleek designs a reality.
3. Redesigns can be found mid process - at the midpoint of each hour, take 5 minutes for groups to compare their design and the product they have so far.

Student Resources:

https://www.ducks.org/hunting/decoys/ten-ways-to-improve-your-decoys

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[1] How many of you decoys could realistically be used by a hunter group?

[2] How well does your decoy mimic a specific trait of goose behavior/morphology?

[3] At what distance can you decipher the difference between a real goose and your decoy?

[4] Over what time period is your decoy active? Does the motion repeat or is it unique each time?

[5] What maintenance procedures will your decoy need over time?

[6] Is your decoy visible from far enough distance for birds to see yours before other hunter groups?

[7] Is your decoy “hands off” or “hands on”?

[8] Are there optional set-ups for your decoy? Can parts be swapped to make an effective decoy in specific situations?

[9] How does your decoy improve a larger spread?

[10] Where is the most effective distance/direction for a hunter to set up using your decoy?

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