LESSON 4:
What Impacts Migratory Birds?

Photo by © Nathan Cooper

LESSON 4:
DISCOVERING THE IMPACTS OF ENVIRONMENTAL CHANGES ON MIGRATORY BIRDS

OVERVIEW

In Lesson Four, students will build a model that demonstrates how variables impact the population of the Kirtland's warbler. They will begin by understanding what a model is and building a model that is familiar to them. Next, they will learn about the Kirtland's warbler and look at variables that impact its population across its annual cycle. Students will share information and build a complete model in their small groups.

ENGAGE	What is a model?	Create a familiar model with students: what impacts my grades?	15 minutes
EXPLORE	How can a model illustrate impacts to the Kirtland's warbler populations?	Students will learn about the Kirtland's warbler and look at a model of what might impact its population.	30 minutes
	What are the impacts to Kirtland's warblers at different stages of their annual cycle?	Students will add two to three impacts on warbler population to the class model. They will then add solutions to the impacts.	45 minutes
EXPLAIN	How will the model change when the new impacts are added?	Students will run a simulation of their model.	25 minutes
ELABORATE	What does my model show?	Students will share their models with the class.	45 minutes
EVALUATE	Exit Ticket	Students share their final model with the class.	10 minutes

DISCIPLINARY CORE IDEAS

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

OVERARCHING UNDERSTANDING

We use models to help us understand complex scientific processes. Computer models are only as good as the inputs we put into them and it is important to understand the concepts we are trying to model so we can make appropriate conclusions.

Kirtland's Warbler
Photo by Nathan Cooper

LESSON 4: DISCOVERING THE IMPACTS TO MIGRATORY BIRDS

ESSENTIAL QUESTIONS

1. How can we predict the impact of threats and conservation actions on migratory bird populations?
2. Given what we know about a bird's annual cycle, is there a way to see what would happen to the population if a variable changes?
3. What is a model and how can it help us understand the impacts on migratory bird populations?

RELATED MISCONCEPTIONS

- Students may think a model is static, like a model airplane.
- Students may not understand how multiple variables interact to impact migratory bird populations.

KNOWLEDGE

Students will know...

Various factors impact migratory bird populations.

SKILLS

Students will be able to...

Use a model, based on scientific information, to understand how multiple variables can impact migratory bird populations.

PRIOR STUDENT KNOWLEDGE:

- Students should understand the various factors of the annual cycle that can impact migratory birds.

SCIENCE AND ENGINEERING PRACTICES:

- Asking questions
- Using mathematics and computational thinking
- Developing and using models
- Obtaining, evaluating, and communicating information
- Constructing explanations
- Engaging in argument from evidence
- Analyzing and interpreting data

CROSSCUTTING CONCEPTS:

- Patterns
- Cause and effect
- Systems and system models

MATERIALS:

Activity 1: ENGAGE

- None

Activity 2: EXPLORE

- Computers with Internet access
- Activity Sheet 1: What Impacts Kirtland's Warbler Populations?

Activity 3: EXPLAIN

- Computers with Internet access
- Activity Sheet 1: What Impacts Kirtland's Warbler Populations?

Activity 4: ELABORATE

- Computers with Internet access
- Activity Sheet 1: What Impacts Kirtland's Warbler Populations?
- Activity Sheet 2: Making a Prediction

Activity 5: EVALUATE

- Computers with Internet access
- Activity Sheet 1: What Impacts Kirtland's Warbler Populations?

TERMS:

dependent variable • independent variable • model

Refer to the Glossary in the Appendix

TEACHER BACKGROUND INFORMATION

Before you begin, view the Sage Modeler video to see how the modeler works. IMPORTANT NOTE: SageModeler works best on desktop or laptop computers and is not well suited on a tablet.

Review the following article for additional information on modeling:

Damelin, Daniel, Joseph S. Krajcik, Cynthia McIntyre, and Tom Bielik. *Students Making Systems Models: An Accessible Approach.* Science Scope. January 2017. Pp. 78-82.

Modeling for teachers[1]

Scientists use computer models to help them think about complex phenomena. Visual representations can capture complexity in a single, organized image. This "structural level" of modeling a system, the level at which things are connected within a system or phenomenon, is crucial to the deeper understanding of how the system behaves.

System structure is interesting but static. For most scientific phenomena it is behavior that interests us, and behavior flows directly from structure. Structure dictates a pattern of influence, which is modulated by the combined effects of the "weighted" influences of system components on one another (see Activity 4). It is in the realm of behavior that computer modeling shows its real power. Not only can the modeler organize and display her mental understanding of system structure, but she can also incorporate assumptions and understandings about how things are connected, specifying precisely the impact of one system component on another. The power of using a computer to predict model behavior is its ability to consider all relationships simultaneously, a process that becomes exponentially more difficult for a human mind as the number of connections increases.

Kirtland's Warbler
Photo by Nathan Cooper

[1] *Intro to Modeling.* Teacher Guide V2. Sage Modeler

TEACHER BACKGROUND INFORMATION continued

Simulation of a completed model allows the user to experiment with his or her mental assumptions about system structure and influence. SageModeler will compute the impact of all defined cause and effect or correlational connections in the model, and generate data showing variations in all dependent variables as a result of changes made to any independent variable. These data can be displayed in several ways: as tables of changing variable magnitude, as graphs showing comparative change in different variables, and as graphical representations showing the resulting value of any variable as a dependent variable is changed.

Simulating a model helps to challenge and refine our thinking. The data generated in a simulation can be compared with a variety of other data sets as the modeler seeks to gain better understanding.

1. **Simulation data can be compared to hypothetical data expected by the modeler.** This is a technique often used early in an investigation. When a model is first being tested, the scientist or engineer may have a "sense" of what is to be expected when some variable within a model is changed. The expectation is often hypothetical and based on incomplete knowledge, but serves as a starting point for modeling. When discrepancies between the model's output and expectation arise, the investigator is challenged to revisit her hypothesis about how the world is constructed (the model structure) and the original behavioral expectations that went along with it.
2. **Simulation data can be compared to real-world data.** Discrepancies between simulation data and expected data will often lead a scientist to further research a question or phenomenon in order to better understand it. The research might involve an exploration of current literature and/or undertaking laboratory investigations, and uncover real-world data for the same phenomenon as that being modeled. A comparison of data patterns generated by the simulation to those from the real world can be used to evaluate a model and its ability to match reality, in turn increasing or decreasing the scientist's confidence in the accuracy of her "thinking." A good match can boost confidence and encourage the modeler to make only minor tweaks to a model (and the thinking behind it), in order to better match reality. A poor match can cause the modeler to challenge fundamental assumptions, undergo more background research, and completely overhaul a model (and the thinking behind it). It is the "back and forth" between changes to the model's structure and its ability to simulate reality that helps the modeler refine and clarify her thinking about a phenomenon.
3. **Simulation data can be compared to data expected by or collected by others.** Science, at its best, is a collaborative effort. Model structure can be a very valuable way of expressing one's beliefs about how the system underlying a phenomenon might be constructed. It allows for others to quickly visualize, question, and discuss another's thinking. Simulation adds another dimension to collaboration as it can show behavioral data patterns that can be compared to the personal experience of others, enhancing critical debate and encouraging the sharing of ideas. In a classroom this can be very powerful. As students see that they are contributing to the learning of others as well as learning from them, they are encouraged to make collaboration important and to take greater responsibility for their own learning.

Good models respond to input in ways that match responses in real-world systems. A model that does not respond in ways that cohere with responses in real-world systems is an indication that the model is incomplete or incorrect, and, therefore, the thinking that went into its creation must be thoroughly examined.

What to know about the modeling exercise

Students will be building models that describe how the environment can impact Kirtland's warbler populations. Pressures on Kirtland's warblers' survival and reproductive success are described in the text of the Kirtland's warbler bird profile. Models that the students develop will be a subset of the Full Population Model.

ACTIVITY 1

ENGAGE - What is a model?

1. Activate students' prior knowledge. Discuss models as a class.
   - Ask: *What does it mean to* ***model*** *something? What is a model? What are some examples of models?* Record their responses so everyone can see.
   - Give students the formal definition.

2. As a class, build a model on the board.
   - Tell students they are going to build a model of things that might impact their grades. Give them a moment to think about the different things, or variables, that might impact their grades.
   - On the board, draw a circle in the middle with "Grades" written inside the circle.
   - As students provide their responses, write them down around the circle and draw an arrow to the "grades" circle. Responses should be on a scale from low to high impact. Responses may include, but are not limited to:
     - Following class and/or school rules
     - Turning in your homework
     - Studying for tests
     - Participating in class discussions
     - Having a good breakfast

Note: if students offer responses such as "behavior," try to get them to be more specific. What kind of behavior? Can they phrase it so it's on a scale from low to high? For example: talking out of turn, making statements off topic, raising your hand to respond to questions, etc.

3. Discuss the model you built as a large group and introduce the next activity.
   - Reiterate/reinforce the importance of variables being on a scale from low to high impact on a given subject.
   - Looking at your class' model, ask students to identify which are the **independent variables** and which are the **dependent variables**. Label each on the board.
   - Tell students they are going to build their own computer models for migratory birds.
   - If time allows, open Sage Modeler and build your class model as a demonstration.

ACTIVITY 2

EXPLORE - How can a model illustrate impacts to the Kirtland's warbler populations?

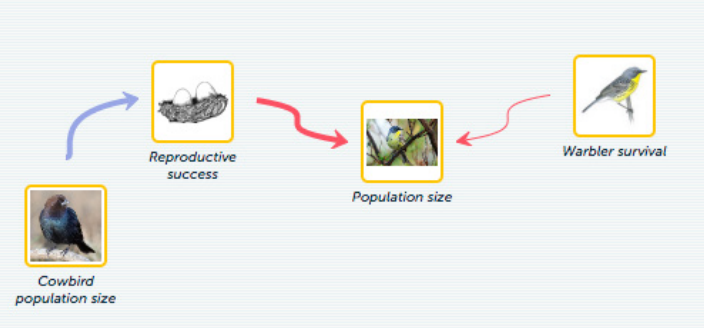
Have students read for understanding about the Kirtland's warbler.

- As groups or individually, have students navigate to the Follow that Bird! website and select Kirtland's warbler from the Follow that Bird! Species Profiles. If you prefer, print out the reading and distribute.
- Give students time to read about the Kirtland's warbler.
- Check for understanding
  - *How do scientists track the warblers?*
  - *What does it mean for an animal to be endangered?*
  - *What is the relationship between the warblers and Jack Pine trees?*
  - *What is the relationship between cowbirds and warblers?*
  - *How has managing Jack Pine habitat helped the warblers?*
- Next, tell students they will build their own computer model about Kirtland's warblers.

Kirtland's Warbler
Photo by Nathan Cooper

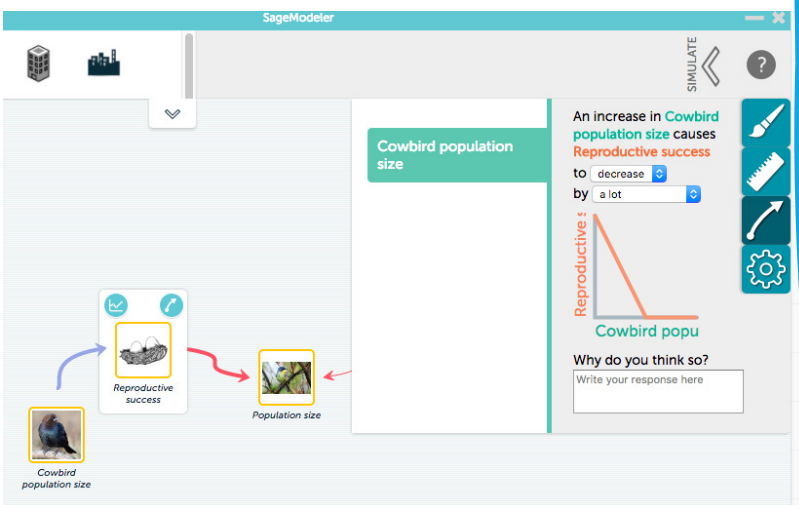
LESSON 4: DISCOVERING THE IMPACTS TO MIGRATORY BIRDS

1. Show students the intro video and pre-programmed model.
   - Watch the SageModeler How-To video as a class. Tell them they are going to build a model based on what they know about Kirtland's warblers.
   - Distribute Activity Sheet 1: What Impacts Kirtland's Warbler Populations?
   - Go to the Follow that Bird! model builder application. You may also navigate to this page using the link at the bottom of the Kirtland's warbler species description page.
   - Walk students through the variables on the screen:
     - The dependent variable in the center is labeled "population size." This variable refers to the population of the Kirtland's warbler. Ask students if they can identify another dependent variable: "reproductive success" (of the Kirtland's warbler).
     - Independent variables are "cowbird population size" and "warbler survival".



2. Instruct students to click once on the arrow that connects "cowbird population size" and "reproductive success" to highlight it. Then double click it. The window below opens.

   - Read the sentence to students: *An increase in cowbird population size causes reproductive success (of the warbler) to...*
     - Show them the drop-down menu with the options they have.
     - Ask: *How much do you think this variable (cowbird population size) impacts reproductive success?*
   - Ask students to explain their answer. ***Why do you think so?*** This is the most important question! Students need to justify their reasoning for selecting the options they did. Discuss as a class to formulate a response. Refer back to the Kirtland's warbler reading, if needed.
   - Students should record their responses on Activity 1: Building a Model.
   - As a class, repeat this exercise for the other variables and make sure students record their responses. Tell students they will add their own variables next.
   - Sample responses could include:
     - An increase in reproductive success causes population size of the warbler to increase because as the warblers have more offspring there will be more hatching, thereby increasing the population.
     - An increase in warbler survival will cause an increase in the population size because there will be more birds to add to the population.



ACTIVITY 3

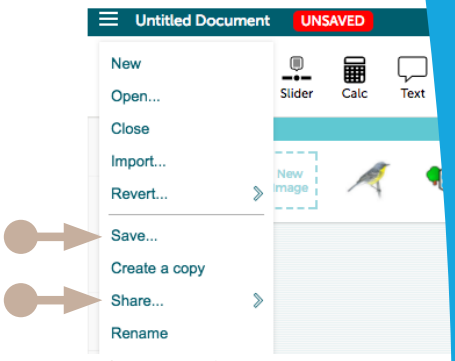
EXPLORE – What are the impacts to Kirtland's warblers at different stages of their annual cycle?

1. Assign students to one of three groups: Breeding Season, Migration, or Wintering.
   - Break students up into groups of three or four.
   - Assign each group one of the three parts of an annual cycle: Breeding Season, Migration, or Wintering. Have groups refer to the Kirtland's warbler description again to determine two to three other factors that could impact Kirtland's warbler populations as it relates to their topic. Tell students to record the factors they came up with and justify their responses.

2. In small groups, customize the existing model.
   - Tell groups to open the Follow that Bird! starting model. Remember that you can also access this link at the bottom of the Kirtland's warbler description.
   - Following the directions on the student hand out, instruct groups to add one or two variables to this model based on their topic (Breeding Season, Migration, or Wintering).

3. In small groups, come up with conservation solutions.
   - In the species description narrative, a conservation measure is given for each stage of the annual cycle and potential factor impacting the population.
   - Once students have listed two to three impacts on the population, have them add solutions to their models. Make sure they fill out the relationship dialog box to fully explain and justify their reasoning.
     - Example: Cowbird populations negatively affect reproductive success. A box can be added that describes cowbird population control efforts. This will reduce the cowbird population size. Students will observe increased Kirtland's warbler population size as a result.

Note: If you run out of time, make sure students save or share their models.

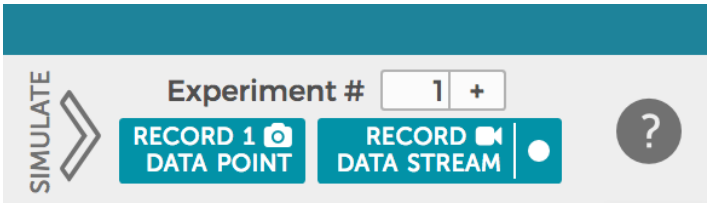


ACTIVITY 4

ELABORATE - How will the model change when the new impacts are added?

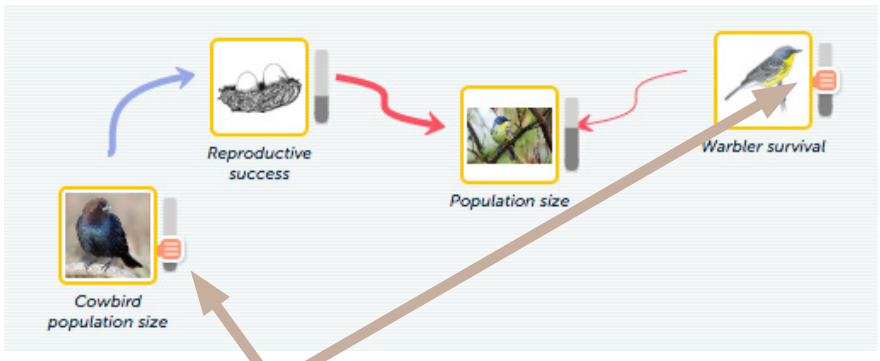
1. Develop a hypothesis.
   - Have students gather in their groups from Activity 3 and open their models.
   - Hand out Activity Sheet 2: Making a Prediction and have them formulate a hypothesis for one of their independent variables. Tell groups to also sketch a graph of how they think their hypothesis would look. Allow students five minutes to work.
   - Ask a few groups to share their hypotheses and graphs. Possible questions to ask:
     - *Why is the direction of your prediction graph sloped that way?*
     - *Why did you choose to make the steepness of the line the way you did?*
     - *If there is a curve to the prediction, why is it there?*
     - *If there is an inflection point, or sudden change in the line, what is happening at that point?*

2. Open and explain the simulation tool in SageModeler.
   - Tell students to watch closely so they know how to run the simulation when they open their models.
   - Walk students through the steps for running a simulation of their model:
     - Click the **Simulate** arrow at the top of the model window. The simulation **control bar** opens.

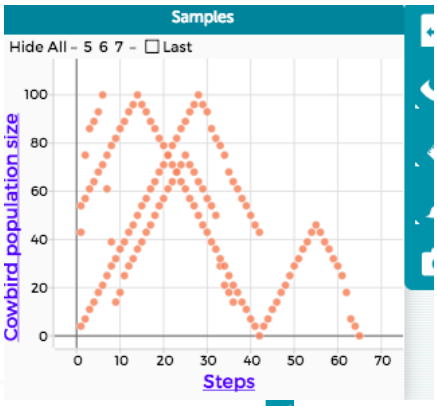


- Point out the important components in the simulation control bar:
  - **Experiment #** - Simulation data is collected in "batches" or experiments. If you make changes to independent variables WITHOUT CHANGING the experiment number, data for all of the changes will be recorded in one "batch" and it may be difficult to isolate the results of one change from the results of another. To avoid this issue assign a new experiment # each time you make changes by clicking on the "+" sign or directly on the number shown in the box. This will allow you to conduct "experiments" on your model by saving the data from each experiment in its own individual dataset.
  - **Record 1 Data Point** - Choosing "Record 1 Data Point" is like taking a snapshot of the current state of the model. If you choose "Record 1 Data Point," then adjust an independent variable and repeat, you will see that the output data differs from one row of the output table to the next.
  - **Record Data Stream** - Choosing "Record Data Stream" will automatically record snapshots of the model state as you adjust the independent variables. You can make changes to independent variables by using the sliders located next to each variable.

3. Run a simple simulation.
   - Show students how to adjust levels of the independent variables. Explain that once they open the simulation bar, they will notice bars next to each independent variable that they can adjust up and down (high and low impact).



- Demonstrate this by adjusting the level of cowbird population size. Have students observe how this changes reproductive success and warbler population size.
- Repeat the demonstration using "warbler survival."
- Roll your mouse over "cowbird population size" and click on the graph icon.
- Change "Steps" to "Reproductive success" by clicking on "Steps" ➔ Samples ➔ Reproductive success.



4. Students run their own simple simulation.
   - In their groups, have students run their own simulations. You may need to go through some of the steps again. Allow enough time for them to understand the relationships being modeled.

5. Create a "data stream" and recording in a data table.
   - Now, have students follow along using their own models.
   - Under simulation, tell groups to click once on the "Record Data Stream" button. Explain that they are now recording their model - the button will become highlighted and its text will change to say "Stop Recording." Students will also see that the orange "record light" will turn on and pulse, and the bars in the indicators next to all variables in the model will turn to orange if their value is above zero.
   - To create a data table in streaming mode, students must adjust the value of an independent variable. Have students try this out by moving the slider next to a chosen variable. Once students are done collecting data, tell them to select the "Stop Recording" button.
     - Show students that if they sweep the slider from low to high and back to low again, a table will appear that displays data for each model variable. Students will notice multiple rows, each one containing the values of all variables in the model based on the values you are setting by moving the slider for one of them.
     - Explain what students are seeing in the simulation. Tell students:
       - *The name of each model variable is found at the top of each column.*
       - *The colored horizontal bars give a qualitative representation of the values of each variable for each step. A long bar represents "more," a short bar represents "less."*

6. Examine the data.
   - Have students examine the graphs and the table they created with the simulation. Reading graphs can be a difficult task for middle school students. Assist them in deciphering what the graphs and tables are showing. Allow students time to compare the graph generated by Sage Modeler from step 3 to the one they created. The axes may be different, so they will need to adjust.

Sage Simulation

Simulation (1)

index	Exp.#
1	5

Samples (22)

index	Steps	Reprod... re success	Summe... robability	Survival ... Migration	Winter s... robability	Populati on size	Cowbir... ation size	Acres of... oung pine
1	1					47	39	
2	2					39	43	
3	3					33	46	
4	4					25	50	
5	5					25	61	
6	6					25	64	
7	7					25	71	
8	8					25	75	
9	9					25	79	
10	10					25	75	

This table shows some of the results from a data stream in which the "Cowbird population size" variable was changed from low to high.

ACTIVITY 5

EVALUATE - Sharing Models

1. Groups present their final model to the class.
   - Give groups the option to present their hand-drawn sketch or their computer model.
   - Ask them to focus on explaining the relationships. How did increasing or decreasing the impact on one variable change the other variables?
   - Provide feedback about the accuracy of their relationships and if they need to change any variables (label them to be in a high to low format).
   - As a class, review some of the variables common among all the presentations. If time allows, have students explain the relationships they created between variables.
   - Use the provided Student Model Scoring Rubric to score each group's model. Adapt the rubric as needed to fit your class.

2. Check for understanding. Have students respond to the following questions:
   - *What is a model?*
   - *How can a model help me understand the impacts on migratory bird populations?*

EXTENDING THE LESSON

1. Watch the career connection video (page 58).
2. Discuss what students can do to protect birds (page 58).
3. Have students complete the Bird-Friendly Schoolyard extension (page 59).

CAREER CONNECTION

SPOTLIGHT ON: EMILY COHEN, RESEARCH ECOLOGIST

GOOD AT RECOGNIZING PATTERNS AND SOLVING PUZZLES?

Meet Dr. Emily Cohen, a Research Ecologist at the Smithsonian Migratory Bird Center who is solving mysteries about animal migration. In this career connection video, find out how she uses tools like weather radar maps to piece together the puzzle of a migratory bird's annual cycle.

HOW CAN YOU HELP?

Taking Action to Protect Birds!

As you've learned in this lesson, there are many variables that impact a bird's population size. Cats are the largest threat to birds, killing billions of birds each year. **You can help** by keeping your cat indoors. Not only are birds safer when cats stay indoors, but cats live longer, healthier lives, too! If your cat currently is an outdoor cat, your vet can give you advice on how to transition your cat to a happy indoor life.

BIRD-FRIENDLY SCHOOLYARD

WHAT YOU NEED TO MAKE YOUR SCHOOLYARD ATTRACTIVE TO BIRDS

FOR THE BIRDS...

As you now know, habitat is very important for migratory birds. See if your schoolyard has good bird habitat. If there are areas that need improvement, what can you do to change it? Use the checklist below as a starting point.

1. **Choose native plants.** Plants that are adapted to the climate in your area probably also attract a lot of birds that are used to having those plants as resources. Native plants provide food, shelter, and nesting habitat for migrating and wintering birds.

Do you see...	Because...	Yes ✓	No ✓
Bugs	Native trees and plants host caterpillars and other insects that are an important part of a bird's diet, especially during the breeding season. Look for oaks, willows, birches, maples, goldenrod, milkweed, and sunflowers.		
Fruit	Shrubs and small trees provide berries that ripen at just the right time for the birds to eat at various times of the year. Look for serviceberry, dogwood, spicebush, cedar, and holly.		
Nuts and Seeds	Finches and sparrows love to feast on various nuts and seeds. Some people will put up bird feeders and fill them with nuts and seeds to attract birds. You can find them on oaks, hickories, and walnuts. Sunflowers, asters, and coneflowers also produce tiny seeds that birds love to eat.		
Nectar	Pollinators such as hummingbirds, butterflies, moths, and bees need nectar. Look for red tubular flowers such as columbine, penstemon, and honeysuckle. Also, asters and Joe-Pye weed will attract these birds and insects.		

2. **Plan your habitat.** Now that you know what's on your schoolyard – what's next? Now comes the fun part - You get to plan your bird-friendly habitat! Use these tips to help you:
   - Research the native plants for your area. Decide what kinds of birds you want to attract and make a list of appropriate plants.
   - Take inventory of your space:
     - Where is there sun or shade and at what times of the day?
     - Where is the ground wet or dry? Are you going to have to water frequently? If so, what will happen during summer vacation?
     - What is your soil like? Is it sandy or full of clay? Do some experiments and see how different soil types hold water. If there is a lot of clay, will you have to add new soil so the new plants can take root?
   - Draw a map of your space. Try to draw it to scale.
   - Create "layers" of habitat:
     - Large canopy trees provide roosting spots (great for spotting prey), nesting cavities, and food.
     - Shrubs and small trees are preferred by some songbirds for nesting, shelter, and foraging.
     - Herbaceous plants, such as groundcovers, annuals, and perennials provide food and habitat for pollinators.
     - Decaying leaves, wood, detritus, and soil are the base of your habitat. Yards that are too manicured do not provide birds with good habitat. This is where birds will find many insects, worms, and protein-rich caterpillars. Yum!
   - Convert green, high-maintenance grass to bird-friendly habitat. Come up with a fun garden shape that cuts down on timely lawn maintenance. Often, those lawns are devoid of wildlife. Be sure to work with your maintenance crew on selecting a good space!
   - Cluster your plants. Group five or more of the same plants together. These same-color clusters attract more pollinators.
   - About the plants: think about the height of each plant and how wide each one will grow. While you can prune later, you might save time and money by giving each plant the appropriate amount of space to grow.
   - Water year-round. All good habitats will have a water source. How will your birds get water in the summer? Planting your habitat near a rain barrel will help with plant maintenance. Consider a solar-powered drip bath or fountain feature – many birds are attracted to the sound of running water.

3. **Prepare your habitat.** Remove any grass or invasive species before you begin planting. Lay down newspaper or landscape fabric to keep out weeds. Use 4-6 inches of mulch to reduce weed growth and retain moisture. Edging around your habitat area will help keep grass from inching its way in.

4. **Planting.** Ok, NOW is the really fun part! Plant in the fall or the spring on cooler days. Follow planning instructions and water well. Check on your new space frequently. Native plants should require less maintenance, but all plants needs need extra care until they are well established.

NOTE: Once you have your new habitat, compare the number of insects, birds, and mammals you find in your habitat to the maintained lawn area.

5. **Care for your habitat year-round.** Again, a native plant garden should be less maintenance, but keep these things in mind as you observe your new space:
    - WEEDING – remove non-native and invasive weeds. While this may seem like a chore, it's also a great time to make observations about your space:
        - *What insects do you see populating the area? How is it changing over time?*
        - *What is the soil like? Does it need more water? Less water?*
        - *Are certain plants growing well while others sluggish? Perhaps they need to be moved to a different spot?*
    - LEAVE THE LEAVES – leaves and woody debris are an important habitat layer and serve as a natural mulch. They also carry important nutrients that will help "feed" your plants.
    - LEAVE THE SEEDS – don't worry about pruning your perennials or "dead-heading" annuals. They can re-seed themselves and put nutrients back into the soil.
    - LEAVE THE BRANCHES AND DEAD TREES – fallen branches and dead trees are great habitat for birds and insects. Some birds only nest in hollowed out dead trees. Insects also find these great homes, so birds find them to be great restaurants!
    - SKIP THE PESTICIDES – a bug-friendly garden is a bird-friendly garden. Providing a variety of foods and habitats will bring a variety of birds for you to observe.
6. **Use your space!** Now that you've got this great space, get out there and use it! Some ways might include:
    - Create a photo collage of the space throughout the different seasons.
    - Make sketches of plants, insects, and birds.
    - Count the different types of insects attracted to this space. Does is change over the seasons? Years?
    - Add a space for people to sit quietly and read or reflect.
    - Observe what happens during a rain event.
    - How else can you use this space? The possibilities are endless!

FINAL TIPS!

Don't forget to include the following people when planning your garden:

- Principal and other administrative staff. They may help with watering over the summer break.
- Grounds maintenance staff. They'll need to know what not to mow and may have insight on where to plant your habitat.
- Other classrooms. Introduce the new habitat to them and ways they can benefit from it.

RESOURCES:

- Audubon – *How to Make Your Yard Bird-Friendly*

Name: _____

Making a Prediction

Your challenge is to propose a hypothesis and make a prediction about Kirtland's warbler populations. Both hypothesis and prediction should be based upon the model seen here and address the question for the model, What impacts Kirtland's warbler populations?

You were assigned to focus on **Breeding, Migration, or Wintering** for the Kirtland's warbler. Write down what you predict will happen to warbler populations based on what your group came up with.

For example, your hypothesis might be:
If cowbird populations **"X" (increase/decrease)**, *then reproductive success (of the warbler) will* **"Y" (increase/decrease)**.

1. Your hypothesis:

   If _____,

   then _____.

Draw a graph of your prediction. Be sure to provide a title for your graph and label the axes.

2. Following your teacher's instructions, run the simulation and see if your hypothesis was accurate.
   - You may see a data table that says "Sage Simulation". If it is in the way, move it to the side.
   - Look at the graph that is created. Does it resemble your graph? If not, why?

   - Expand the Sage Simulation box and look at the two variables you tested. What happened to the dependent variable when you increased or decreased the independent variable?

Be sure to save or create a link for your model before you close out!

Name: _____

What Impacts Kirtland's Warbler Populations?

Computer models are useful tools for helping us understand and visualize complex relationships in nature. We will use a computer model to look at different variables that impact Kirtland's warbler populations. However, you should note that computer models are only as good as the inputs that we put in there. We have to make sure that the information we put in there is accurate.

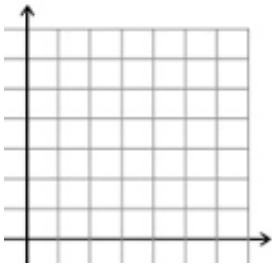
PART 1: STARTING THE MODEL

Define **dependent variable:**

Define **independent variable:**

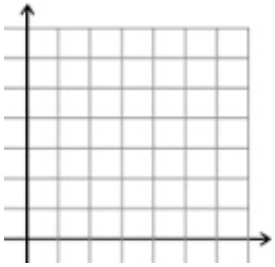
1. An increase in cowbird population size causes reproductive success (of the Kirtland's warbler) to (circle one): **increase** **decrease** **vary**
   by (circle one): **about the same** **a lot** **a little** **more and more** **less and less**
   Why do you think so?

Fill in the graph:



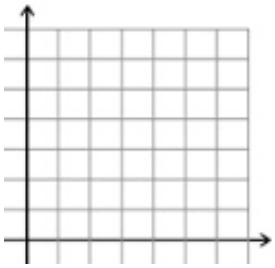
2. An increase in reproductive success (of the Kirtland's warbler) causes population size to (circle one): increase decrease vary
by (circle one): about the same a lot a little more and more less and less
Why do you think so?

Fill in the graph:



3. An increase in warbler survival causes population size (of the Kirtland's warbler) to (circle one): increase decrease vary
by (circle one): about the same a lot a little more and more less and less
Why do you think so?

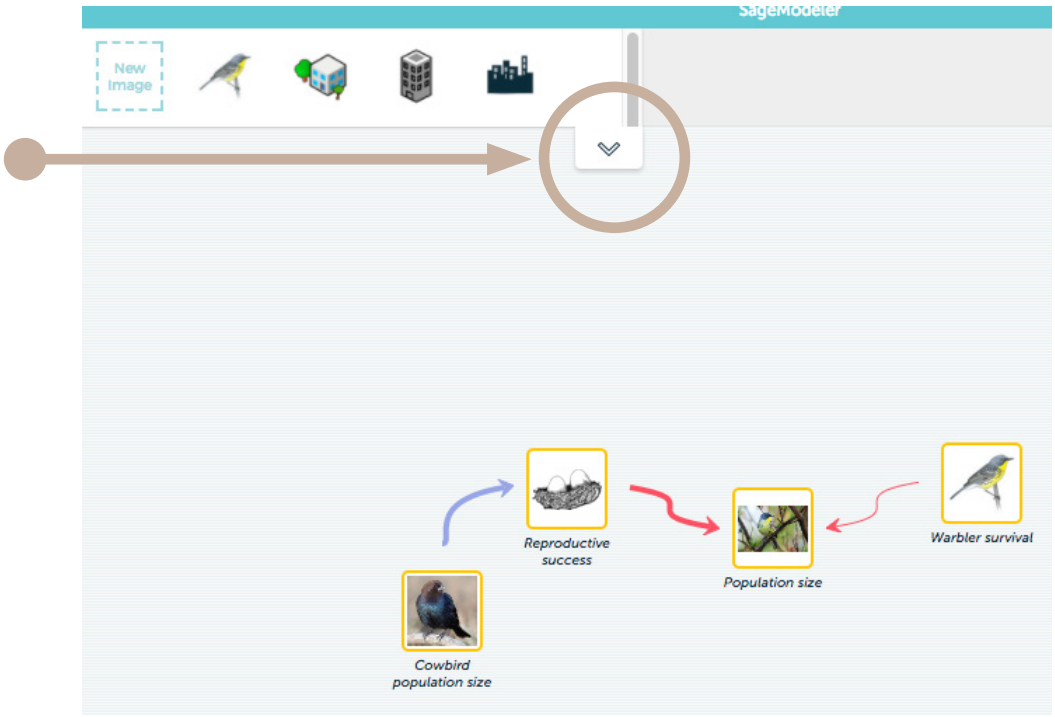
Fill in the graph:



PART 2: BUILDING THE MODEL

1. As you work in your small groups, think of two to three other factors that might impact Kirtland's warbler populations (either positively or negatively).. Write down your ideas here. Be sure to **(a) indicate if the population will increase, decrease, or vary** and **(b) by how much**. Also, be sure to **(c) justify your response**. **(d) Draw a graph** to predict how you think the impact will look.

2. Open the starting model and add your variables
   - Go to the Follow that Bird! Starting Model
   - In the menu bar, click on the down arrow. Search for an image that best represents your variable. Drag and drop it to your workspace.

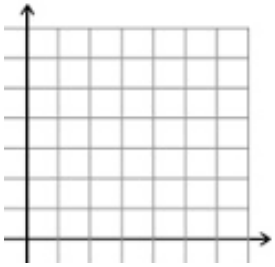


   - Label the image by clicking once on it and changing the label. Be sure your label includes the high to low description. *For example, don't just call it "pine trees"; call it "acres of young pine trees" or "number of young pine trees."*
   - Create the relationship of that variable to another variable.
     - Hold the cursor over the relationship tool: Click, hold and drag the arrow to the other variable.
     - Next, click once on the arrow you just created to highlight it. Now double-click it. The relationship box you saw earlier when your teacher was demonstrating will now pop up.
     - Make sure you choose all of the options and, most importantly, fill in your justification.
     - Record your relationship here and repeat this process for your second variable, if you have one.

3. Which group are you (circle one)? **Breeding Season** **Migration** **Wintering**

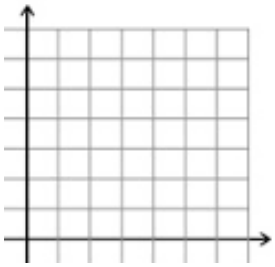
VARIABLE 1:
An increase in _____ causes _____
to (circle one): **increase** **decrease** **vary**
by (circle one): **about the same** **a lot** **a little** **more and more** **less and less**
Why do you think so?

Fill in the graph:



VARIABLE 2 (if you have one):
An increase in _____ causes _____
to (circle one): **increase** **decrease** **vary**
by (circle one): **about the same** **a lot** **a little** **more and more** **less and less**
Why do you think so?

Fill in the graph:



4. Add some conservation solutions to your model. Be sure to justify the relationships that you create. Draw a sketch of your final model:

Student Model Scoring Rubric

	EXCEEDS EXPECTATIONS (4-5 points)	MEETS EXPECTATIONS (2-3 points)	DOES NOT MEET EXPECTATIONS (0-1 points)
The variables are labeled appropriately (have a low to high scale and are descriptive)			
Each relationship is ecologically accurate			
Each relationship is completely filled out with justification			
A sketch of the graph of the relationship is included			
The simulation has the appropriate variables tested			

Kirtland's warbler breeding habitat
Photo by Nathan Cooper