



# Integrating Science Practices Into Assessment Tasks

The Next Generation Science Standards call for the development of “three-dimensional science proficiency,” that is, students’ integrated understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts. To assess three-dimensional science proficiency requires *multicomponent tasks* (National Research Council, 2014). These are sets of tasks linked by a common scenario, phenomenon, or engineering design challenge.

Developing three-dimensional science assessments is challenging. Most current assessments focus on testing students’ knowledge of science facts. Few focus on having students apply their understanding of disciplinary core ideas in the context of engaging in a science or engineering practice. Fewer still make connections to crosscutting concepts.

These “task format” tables included in this document are tools to help teachers and district leaders design three-dimensional assessment tasks. They are based on the language of *A Framework for K-12 Science Education* and the NGSS Evidence Statements, focusing on all eight science practices and two engineering practices.

These task formats represent different ways that assessment tasks can be written to engage students in science practice. They do not specify precisely which disciplinary core ideas are to be integrated into tasks, a process that would be determined by an analysis of the disciplinary core ideas.

The different formats get at different aspects of the focal science and engineering practice. In addition, some formats are likely to be more demanding cognitively for students. The idea of presenting multiple formats is to give task developers a sense of the range of tasks that can be written. A good “test” (comprised of multiple tasks) of a student’s grasp of a particular practice, in the context of a disciplinary core idea and crosscutting concept, would draw on multiple formats.

These task formats provide some specific suggestions for the intellectual work associated with the science and engineering practices. However, there are many possible ways of engaging in relevant forms of the intellectual work for the practices. It is important in instruction and assessment that the practices not become fixed, narrow routines or procedures

## How to Read a Template Task

Scenario presented to students

Format	Task Requirements for Students
1	Present students with a textual description of an investigation of an observable phenomenon, <i>then</i> Ask students to formulate a scientific question relevant to investigating that phenomenon.

Task(s) for students to complete

An example multi-component assessment task is included on page 16 of this document.

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## Potential Task Formats: Asking Questions (Science)

Format	Task Requirements for Students
1	<p>Present students with a scientific phenomenon and questions related to that phenomenon, <i>then</i>            Ask students to identify which questions are testable scientific questions.</p>
2a	<p>Present students with an observable scientific phenomenon to be explained, <i>then</i>            Ask students to formulate descriptive questions about the phenomenon they observed.</p>
2b	<p>Present students with a scientific phenomenon to be explained, <i>then</i>            Ask students to formulate a scientific question to investigate the phenomenon.</p>
2c	<p>Present students with a scientific phenomenon to be explained, <i>then</i>            Ask students to generate a scientific question relevant to investigating that phenomenon, <i>and</i>            Ask students to describe what evidence is needed to answer the question they generated.</p>
3a	<p>Present students with a scientific phenomenon to be explained and a scientific question, <i>then</i>            Ask students what questions we need to answer along the way to answer the scientific question, <i>and</i>            Ask students to describe what evidence is needed to answer those questions might and how they help build toward an explanation of the phenomenon.</p>
3b	<p>Present students with a scientific phenomenon to be explained and a scientific question, <i>then</i>            Ask students to evaluate whether or not the question is relevant to explaining the phenomenon.            If the question is relevant, ask students to describe what evidence is needed to answer that question.</p>
4	<p>Present students with a textual description of an investigation of an observable phenomenon, a scientific question, and a set of data and findings, <i>then</i>            Ask students to formulate a follow-up question to extend the investigation.</p>
5	<p>Present students with a scenario of a scientific argument in the context of an investigation, <i>then</i>            Ask students to generate questions they would ask to clarify the argument or to ask for elaboration of the ideas presented in the argument.</p>

6	Present students with a scientific phenomenon to be explained and a scientific question, <i>then</i> Ask students to revise the question to make it investigable with available resources in the classroom.
7	Present students with a scientific phenomenon to be explained and with a question or a set of questions, <i>then</i> Ask students to evaluate and explain whether or not the question(s) is empirically testable.

## Potential Task Formats: Defining Problems (Engineering)

Format	Task Requirements for Students
1	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world and a defined problem, <i>then</i>            Ask students to describe why the problem is a major global challenge.</p>
2	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world that includes quantitative and qualitative data, <i>then</i>            Ask students to describe the problem, <i>and</i>            Ask students to interpret quantitative and qualitative data to describe the major consequences of the problem if it remains unsolved.</p>
3	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world and with excerpts from related scientific research, <i>then</i>            Ask students to describe how each piece of scientific research is relevant background research for defining the problem.</p>
4	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world and a defined problem, <i>then</i>            Ask students to define the components and relationships between the components of the system in which the problem is embedded, <i>and</i>            Ask students to define the boundaries of that system and what is and is not part of the system.</p>
5	<p>Present students with a textual description a defined problem and with experts of scientific research and popular texts, <i>then</i>            Ask students to analyze and describe the societal needs and wants relative to the problem.</p>
6a	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world, <i>then</i>            Ask students to describe the problem, <i>and</i>            Ask students to define the criteria and constraints for acceptable solutions to the problem.</p>
6b	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world, <i>then</i>            Ask students to describe the problem,            Ask students to define the criteria and constraints for acceptable solutions to the problem, <i>and</i>            Ask students what evidence is needed to know whether or not a solution fits within the defined criteria and constraints.</p>

7	<p>Present students with a textual description of a scenario of a need or desire of society and/or the natural world along with design criteria and constraints, <i>then</i></p> <p>Ask students to plan an investigation that would allow them to better understand the design space for the problem.</p>
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## Potential Task Formats: Developing and Using Models (Science)

Format	Task Requirements for Students
1	Present two models to students, <i>then</i> Ask them to compare the models to identify both common and unique model components, relationships, and mechanisms.
2	Present students with an illustration or drawing of a scientific process or system, <i>then</i> Ask students to label the components, interactions, and mechanisms in the model, <i>and</i> Write a description of what is shown in the drawing.
3	Present students with a model of an observable scientific process or system and some evidence about how the system behaves that does not fit the model, <i>then</i> Ask students to revise the model to better fit available evidence.
4	Present students with a textual description of an observable scientific phenomenon, <i>then</i> Ask students to draw and label the model components, interactions among components, and mechanisms in the model, <i>and</i> Ask students to write an explanation for the phenomenon, using the model as supporting evidence.
5	Present students with a textual description of an observable scientific phenomenon, <i>then</i> Ask students to draw a model that helps explain how this phenomenon occurs by applying their understanding of a disciplinary core idea, <i>and</i> Write a prediction about something that might happen in the future that could be explained by the model.
6	Present students with two different models for the same observable phenomenon, <i>then</i> Ask students to compare the two models with respect to their accuracy, <i>and</i> Apply what they know about a disciplinary core idea to justify their answer.
7	Present students with two different models for the same observable phenomenon, <i>then</i> Ask students to develop a test to determine which model better fits available evidence.
8	Provide students with a digital modeling tool that is intended to represent a system or process in which the mechanisms are not visible to the naked eye, <i>then</i> Ask students to use the modeling tool to identify and describe model components, interactions, and mechanisms.

## Potential Task Formats: Planning and Carrying Out Investigations (Science)

### Relevant definitions

- An *investigation plan* encompasses a description of data sources and measures to be used, procedures for observing and recording data, and, where relevant, a plan for how observations will be sampled.
- A *data source* refers to a type of data only (“We would need data on the size of the white-colored moth population” or “We would need data comparing the color of tail feathers in birds in the mountains and in the city”)

Format	Task Requirements for Students
1	<p>Present students with a scientific phenomenon to be explained, <i>then</i>            Ask students to identify questions to ask, <i>and</i>            Ask students to evaluate different ways of observing and/or measuring to answer those questions, <i>and</i>            Ask students to conduct the investigation by observing and/or measuring and then making comparisons between data collected.</p>
2	<p>Present students with a scientific phenomenon to be explained, a scientific question, and an investigation plan, <i>then</i>            Ask students to perform the investigation plan and collect and record data.</p>
3	<p>Present students with a scientific phenomenon (or scientific model) to be explained and a scientific question, <i>then</i>            Ask students to create an investigation plan to investigate the scientific phenomenon (or model), <i>and</i>            Ask students to describe how the investigation will generate relevant patterns of evidence for answering the scientific question or for supporting the model.</p>
4	<p>Present students with a scientific phenomenon (or a scientific model) to be explained, <i>then</i>            Ask students to generate a scientific question to investigate the phenomenon (or model) with resources available in the classroom (or with a given list of resources), <i>and</i>            Ask students to identify the variables needed in the investigation to explain the phenomenon (or model), <i>and</i>            Ask students to characterize each variable as dependent or independent and to explain any variables to be controlled and why.</p>
5	<p>Present students with a scientific phenomenon to be explained, a scientific question, and an investigation plan, <i>then</i>            Ask students to describe how the data will be collected precisely, <i>and</i>            Ask students to how much data is needed to be reliable.</p>

6	<p>Present students with a scientific phenomenon to be explained, a scientific question, and a description of the type of investigation to be conducted, <i>then</i>          Ask students to describe the possible confounding variables, <i>and</i>          Ask students to write an investigation plan that addresses the confounding variables.</p>
7	<p>Present students with a scientific phenomenon to be explained, a scientific question, and investigation plan, and data collected from the investigation, <i>then</i>          Ask students analyze how well the data collected generated relevant evidence to answer the scientific question, <i>and</i>          Ask students to revise the investigation plan to be more relevant and to generate more accurate and precise data.</p>
8	<p>Present students with a scientific question, <i>then</i>          Ask students to generate ideas about data sources they would need to answer the question, <i>and</i>          Ask students to say how the data sources are relevant to answering the question</p>
9	<p>Present students with a scientific question and a list of data sources they could gather to answer the question, <i>then</i>          Ask students to select which data sources are most relevant to answering the question, <i>and</i>          Ask students to say how the data are relevant to answering the question</p>

## Potential Task Formats: Analyzing and Interpreting Data

### Relevant definitions

- A *pattern of evidence* from data is what the data say (“The population of white-colored moths disappeared in cities,” or “The birds’ tail feathers are whiter in the mountains than in the city”)

Format	Task Requirements for Students
1	Present students with recorded observations of the natural world, <i>then</i> Ask them to describe a pattern or relationship they can infer from the observations
2	Describe an investigation, the phenomenon under investigation, and one or more recorded observations from the investigation, <i>then</i> Ask students to organize, represent, and analyze the data in at least two different ways, <i>and</i> Ask students to compare how the representations and analyses help them to identify patterns in the data.
3	Describe an investigation, the phenomenon under investigation, and one or more recorded observations from the investigation, <i>then</i> Ask students to use grade-level appropriate mathematics and/or statistics to analyze patterns the data, <i>and</i> Ask students to draw conclusions supported by their mathematical analysis.
4	Describe an investigation, the phenomenon under investigation, and recorded observations from the investigation that are directly relevant to explaining the phenomenon, <i>then</i> Ask students to organize the data and describe how this organization helps them to analyze the data, <i>and</i> Ask students to identify and describe the patterns they see in the organized data, <i>and/or</i> Ask students to student to describe how the patterns of evidence in the data help to explain the phenomenon.
5	Describe an investigation, the phenomenon under investigation, a hypothesis about the phenomenon that the investigation was intended to test, and multiple recorded observations from the investigation, <i>then</i> Ask students to organize the data and describe how this organization helps them to see whether the evidence supports the hypothesis, <i>and</i> Draw a conclusion about whether the data are consistent with the hypothesis.
6	Describe an investigation, the phenomenon under investigation, and recorded observations from the investigation from multiple groups of investigators, <i>then</i> Ask students to organize (e.g., tabulate, graph, or statistically summarize) the data, <i>and</i> Ask students to identify outliers in the different data sets, <i>and</i> Develop hypotheses about what sources of error might have caused the outliers.

7	<p>Present a causal explanation of a phenomenon developed from either an experiment or from a simulation, empirical data from the experiment or simulation, <i>then</i>          Ask students to decide whether the data presented provide causal or correlational evidence, <i>and</i>          Ask students to assess whether the data are consistent with the causal explanation presented.</p>
8	<p>Describe an investigation, the phenomenon under investigation, one or more recorded observations from the investigation, the results of analyses, and an interpretation of the data, <i>then</i>          Ask students to assess whether the interpretation is consistent with the data and the analysis, <i>or</i>          Ask students to evaluate how the interpretation is affected by variation or uncertainty in the data.</p>

## Potential Task Formats: Using Mathematics and Computational Thinking (Science)

Format	Task Requirements for Students
1	<p>Present students with multiple objects, <i>then</i>            Ask students to construct quantitative attributes (e.g., measurements of heights) of the objects, <i>and</i>            Display the data using simple graphs.</p>
2	<p>Present students with a dataset from an investigation, the question the investigation is intended to answer, <i>then</i>            Ask students to identify features of the dataset (e.g., range, average) that should be analyzed in order to answer the question.</p>
3	<p>Present students with a textual description and measured quantities of an observable scientific phenomenon, <i>then</i>            Ask students to develop a grade-level appropriate equation or algorithm that corresponds to the textual description, <i>and</i>            Explain how the equation or algorithm represents the textual description.</p>
4	<p>Present students with a textual description, measured quantities of data, and a grade-level appropriate mathematical equation of an observable scientific phenomenon, <i>then</i>            Ask students to make a prediction about the state of the phenomenon in the future that the equation can be used to support, <i>and</i>            Ask students to write an explanation for the prediction, using the mathematical model as supporting evidence.</p>
5	<p>Engage students in using a simulation of an observable scientific phenomenon, <i>then</i>            Ask students to compare the simulation results with real-world data, <i>and</i>            Write an argument for whether or not the simulation makes sense using the comparison as supporting evidence.</p>
6	<p>Present students with a large data set from an investigation, the question the data are intended to answer, and computer tools (e.g., a spreadsheet) for analyzing the data set, <i>then</i>            Ask students to develop statistical summaries of the data set that help them answer the question about the dataset.</p>

## Potential Task Formats: Constructing Explanations (Science)

### Relevant definition

- “Scientific explanations are accounts that link scientific theory with specific observations or phenomena... Very often the theory is first represented by a specific model for the situation in question, and then a model-based explanation is developed.” (NRC Framework, 2012).

Format	Task Requirements for Students
1	Describe a phenomenon to students along with relevant evidence (which can come from a media source), <i>then</i> Ask students to write an evidence-based account of what causes the phenomena.
2	Describe a phenomenon to students along with some related qualitative or quantitative data/observations, <i>then</i> Ask students produce an explanation about the mechanism for the phenomena using their interpretation of the data as evidence.
3	Describe a phenomenon to students and present qualitative or quantitative data for independent and dependent variables, <i>then</i> Ask students to produce a causal account that explains how the independent variables relate to the dependent variables.
4	Describe a phenomenon to students along with a related set of evidence and an explanation that includes multiple scientific principles, <i>then</i> Ask students to say which pieces of evidences support particular components of the explanation.
5	Present students with a model or representation of an observable scientific process or system, <i>then</i> Ask students to write a causal explanation for a relevant phenomenon using the model as supporting evidence.
6	Describe a phenomenon and present students with a causal explanation of it, <i>then</i> Ask students to identify gaps or weaknesses in how it scientifically explains the phenomenon based on their level of scientific understanding.
7	Describe a phenomenon and present students with a range of evidence obtained from a variety of sources (empirical investigations, models, theories, simulations, peer review), <i>then</i> Ask students to articulate (construct) a causal explanation for the phenomena, <i>and</i> Describe how the evidence relates to the mechanisms or principles they have included.

## Potential Task Formats: Designing Solutions (Engineering)

Format	Task Design for Students
1	<p>Describe or showcase a human problem, desire, or need along with design criteria and constraints, <i>then</i>            Ask students to sketch or describe a design approach that develops a possible solution to the problem.  <i>and</i>            Ask them to explain how the relevant scientific ideas are taken into account within their design.</p>
2	<p>Describe or showcase a human problem, desire, or need along with design criteria and constraints, <i>then</i>            Ask students to sketch and prototype a design that is a possible solution to the problem using relevant materials. (Performance Task)</p>
3	<p>Describe a designed system and data from a failure scenario associated with the design, <i>then</i>            Ask them to analyze the data and identify the scientific causes of the failure. Possibly ask them to sketch or describe a design iteration that might be an improvement to the design.</p>
4	<p>Describe a design in active development and a scenario where the design team has encountered a design tension between two or more criteria perhaps also related to the project constraints, <i>then</i>            Ask students how they would proceed with the design work to develop a working system. (The goal is to see if students think about considering trade-offs and prioritizing one design criteria over another in order to accomplish a working design.)</p>

## Potential Task Formats: Engaging in Argument from Evidence

Format	Task Requirements for Students
1	<p>Present two different arguments related to a phenomenon, one with evidence and one without, <i>then</i>            Ask students to identify the argument that is more scientific and ask them why they think that is the case.</p>
2	<p>Describe a phenomenon to students, <i>then</i>            Ask students to articulate (construct) a claim about that phenomenon, and            Identify evidence that supports the claim, <i>and</i>            Articulate the scientific principle(s) that connect each piece of evidence to the claim.</p>
3	<p>Present students with a claim about a phenomenon, <i>then</i>            Ask students to identify evidence that supports the claim, <i>and</i>            Articulate the scientific principle(s) that connect each piece of evidence to the claim.</p>
4	<p>Present students with a claim <b>and</b> evidence about a phenomenon, <i>then</i>            Ask students to assess how well the evidence supports the claim.</p>
5a, 5b	<p>Present students with a claim <b>and</b> evidence <b>and</b> reasoning about a phenomenon, <i>then</i>            Ask students to assess the reasoning of a given link between claim and evidence <i>or</i>            Ask students to assess the logical link between claim and evidence.</p>
6a, 6b	<p>Describe a situation in which two or more explanations are offered for a phenomenon, <i>then</i>            Ask students to identify the different claims at issue (easier), <i>or</i>            Ask students to identify different claims and the evidence with each claim (harder).</p>
7a, 7b	<p>Present students with a claim, a list of data sources that are relevant to the claim (but not what the data say), <i>then</i>            Ask students to identify (select from a list) a pattern of evidence from the data that would <b>support</b> the claim, <i>or</i>            Ask students to identify (select from a list) what pattern of evidence from the data would <b>refute</b> the claim.</p>
8a, 8b, 8c, 8d	<p>Present students with a claim <b>and</b> a pattern of evidence relevant to the claim, <i>then</i>            Ask students to assess whether the evidence is logically consistent with the claim, <i>or</i>            Ask students to assess whether the evidence is consistent with a scientific theory or model they have studied, <i>or</i>            Ask students to generate ideas about additional evidence needed to support the claim, <i>or</i>            Ask students to generate ideas about additional evidence needed to support the claim.</p>

## Potential Task Formats: Obtaining, Evaluating, and Communicating Information

### Relevant definitions

- A “scientific text” is any form of scientific communication including but not limited to prose, graphs, videos, posters, symbols, and mathematics.

Format	Task Requirements for Students
1	<p>Present students with a set of grade-appropriate texts related to a scientific phenomenon, <i>then</i></p> <p>Ask students to synthesize the information from across the texts, <i>and/or</i></p> <p>Ask students to compare and contrast information across the texts to determine which are most relevant to explaining the phenomenon.</p>
2	<p>Present students with a set of grade-appropriate texts related to a scientific phenomenon, <i>then</i></p> <p>Ask students to construct an explanation of the phenomenon and/or ask questions about the phenomenon based on combined information from relevant texts.</p>
3	<p>Present students with textual description a scientific phenomenon or of an investigation of a scientific phenomenon, <i>then</i></p> <p>Ask students use multiple forms of scientific texts to communicate about the phenomenon to a given audience or an audience of their choosing.</p>
4	<p>Present students with a set of grade-appropriate scientific literature and/or media reports related to a scientific phenomenon, <i>then</i></p> <p>For each text, ask students to analyze and write about the validity and reliability of the information in the text (e.g., data, hypotheses, conclusions).</p>

# Example Three-Dimensional Multiple Component Assessment Task

## Target Performance Expectations, Practices, and Crosscutting Concepts

- HS-LS4-3: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
- HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- Practices: Analyzing and Interpreting Data, Constructing Explanations
- Crosscutting Concepts: Patterns, Cause and Effect

## Task Templates

- Analyzing and Interpreting Data Format #4
- Constructing Explanations Format #2

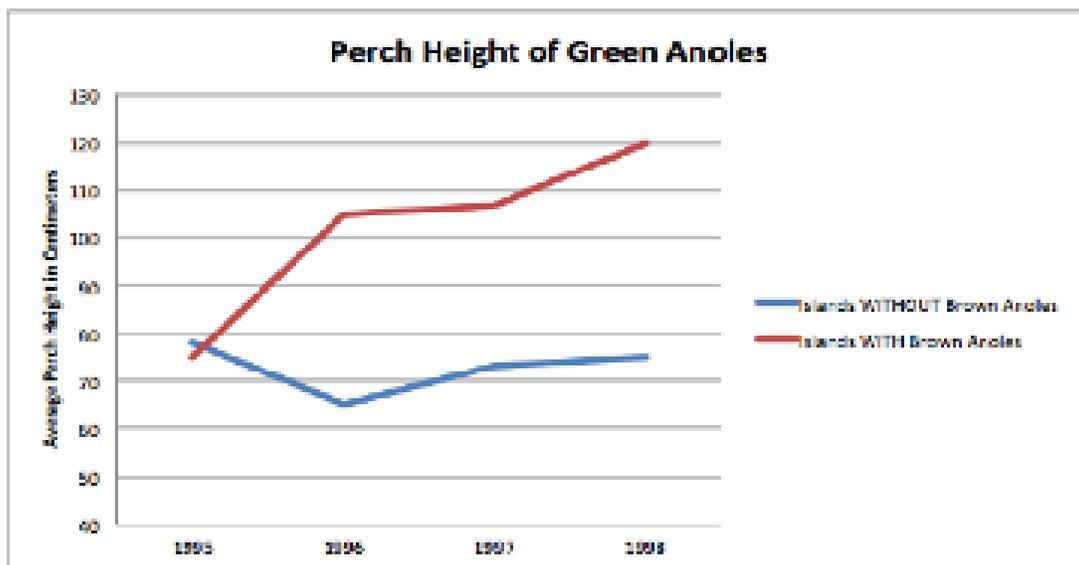
## The Task



Green anoles are a type of lizard that live in trees in Florida. In the 1950s, a similar species of lizards called brown anoles invaded Florida from Cuba. We know two things about the two species of anoles:

- They live in similar habitats and eat similar food.
- They are known to eat the newly hatched lizards of the other species.

Scientists conducted two investigations to determine whether or not the population of green anoles was evolving due to the invasion of brown anoles. First, they introduced brown anoles to three islands and left three islands alone. Then they measured the average height green anoles could be found in the trees (perch height) before and after introducing the invasive brown anoles. Here is a graph of the data they collected on perch height:



Next, scientists knew that living higher in the trees was associated with larger footpads and more sticky scales on the anoles' feet. So in 2010, the scientists collected data on the populations of green anoles that had been invaded by brown anoles and those that had not been invaded to investigate whether or not the population of green anoles adapted because of the invasion. Below is a summary of the data the scientists collected:

	Green Anoles on an Island WITHOUT Brown Anoles	Green Anoles on an Island WITH Brown Anoles
Average Perch Height in Trees	70cm	120 cm
Average Size of the Toe pads (Standardized for body size)	1.27cm	1.33cm (4.5% increase)
Average Number of Sticky Scales on the Feet (Standardized for body size)	51 sticky scales	54 sticky scales (6.5% increase)

1. What pattern do you see in the perch height data?

After the brown anoles invaded, over time, the green anoles average perch height increased.

2. When the brown anoles invaded, scientists noted that they ate similar food and lived in similar habitats as the green anoles, why does this matter for the survival of the green anoles?

The brown anole competed for space and food resources of the green anole thus the green anoles that were able to live in higher in the trees with larger and stickier feet were able to survive.

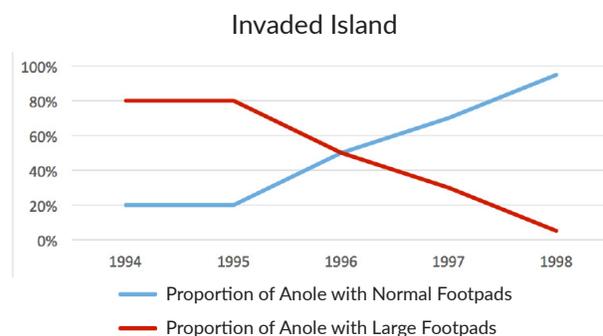
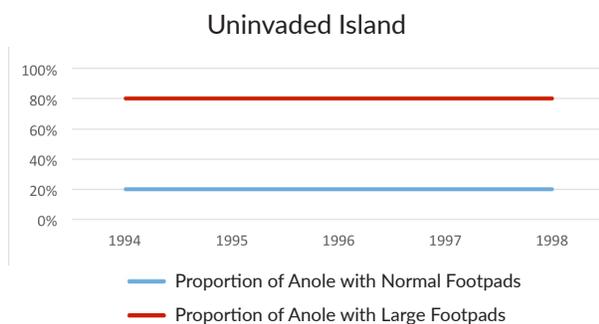
3. Why might being able to go higher in trees be an advantage for survival?

Higher up in the trees the green anoles experience less competition for resources and greater safety from the brown anoles eating their offspring.

4. The scientists noted that the anoles did adapt because of variation in foot pads and sticky scales. Describe the pattern of the average number of sticky scales and average foot pad size traits of anoles on invaded and uninvaded islands.

The anoles' foot pads are larger and the anoles have more sticky scales on islands that were invaded by brown anoles. These are the same islands in which the green anoles have a higher average perch height.

5. Complete the graphs below showing how you think the proportion of green anoles with larger foot pads in the population changed over time on the invaded and uninvaded islands.



Using your graphs and the data above, what explains the patterns you see between invaded and uninvaded islands?

The green anoles on the invaded islands survived if they were able to climb and perch at higher heights. They could do this because they had larger foot pads and more sticky scales on their feet. Therefore over time, the population of green anoles that survived and reproduced had a higher average foot pad size and a larger number of sticky scales on their feet.

6. Write an explanation for how natural selection led to the adaptation of the population of green anoles when the brown anoles invaded their habitats in Florida.

When the brown anoles invaded the habitats of the green anoles in Florida, they competed for food and habitat therefore impacting the survival of the green anoles. The green anoles that were able to survive could climb higher. Therefore they passed on those traits to the next generation and over time the population of green anoles could climb higher on average because of larger toe pads and more sticky scales on their feet.

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The [story](#) and data ([journal article](#) and [supplemental materials](#)) were adapted from study of brown and green anoles by Yoel Stuart and colleagues at the University of Texas Austin. [Yoel Stuart](#) researches ecology and evolution, including how the two interact over time. Many species today cope with dramatic changes in their environment brought about by climate change, habitat destruction and the introduction of invasive species. In response to ecological changes such as these, Stuart examines the role of rapid evolution.



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