**Unit Essential Question:** *Why do species change over time and should we intervene?*

**Introduction**

In this unit, students will explore how organisms change over time, as well as the various pieces of evidence that exist to document these changes. This Lift-Off Task hooks students with the classic case of the Peppered Moth. It is a case of natural selection that is easy to study because it happened so rapidly. This task also introduces students to an environmental change directly caused by human beings that had a dramatic effect on a species. Students will select a similar case as the focus of their culminating project. In this lift-off task, students draw on their prior knowledge to generate questions about the phenomenon of the changing Peppered Moth. These questions will guide their learning throughout this unit.

**Alignment Table**

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

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| **Crosscutting Concepts (\*depending upon student-generated questions)**   * Patterns:   + Graphs, charts and images can be used to identify patterns in data.   + Patterns can be used to identify cause-and-effect relationships. * Cause and Effect:   + Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. * Scale, Proportion, and Quantity   + Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. * Structure and Function * Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. * Stability and Change   + Stability might be distributed either by sudden events or gradual changes that accumulate over time.   + Small changes in one part of a system might cause large changes in another part. |
| **Equity and Groupwork**   * Share and listen to broad and diverse student contributions. * Make connections between each other’s ideas. * Work together to co-construct a concept map. |
| **Language**   * Use connector words to link ideas. * Generate and write questions about the phenomenon. * Organize key questions in a concept map. |

**Learning Goals**

This learning task introduces students to the concept of a species changing over time and begins generating questions that will guide them through this unit. More specifically, the purpose is to:

* Individually generate a list of questions about the case study of the peppered moth.
* Make connections between related questions.
* Generate possible answers to questions based on prior knowledge.
* Select and research an organism currently affected by an environmental change that is caused by humans.

**Content Background for Teachers**

In this unit, students will be thinking about how and why organisms change over time and what evidence exists for us to study and draw conclusions about these changes. This task jumpstarts their exploration about the first part of these objectives: how and why organisms change over time.

The phenomenon in this task is the case of the changing Peppered Moths. This is one of the best known cases of natural selection, and is particularly interesting for this unit since the change of environment was human-caused. Before the industrial revolution in England, the dominant form of the moth was a lighter color (as shown in the picture above on the right). These lighter moths were very difficult for predators to pick out against the light-colored bark of many trees common in England. In the mid-1800s, however, a new form of the moth began to appear. This version of the moth was a dark-colored peppered moth, first appearing in 1848 (as shown in the picture above on the left). By 1895, scientists reported that 98% of the peppered moth population was this darker color. This increase in darker moths corresponded with the industrial revolution. Factories produced soot that turned the bark of the trees darker. This made the lighter moths easier to spot by predators, so they were eaten, while the darker-colored moths survived to reproduce and pass on their genes.

The case of the Peppered Moth serves as an interesting phenomenon for students to begin to think about how organisms might change over time and why they might change over time. This sets the stage for their culminating project, in which students consider whether or not we should save all threatened and endangered species or let some die.

In this task, students create a concept map, which is a graphical representation that helps students to organize and represent knowledge, and supports their academic language development. As students learn more about the ways in which species change over time, they will add more questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see instructions in Part B below for strategies on teaching this skill.

**Academic Vocabulary**

* Population
* Species
* Peppered Moth
* Think Tank
* Environmental

\*Additional academic vocabulary will vary by class

**Time Needed (Based on 45-Minute Periods)**

2 Days

* Introduction, Part A and B: 1 period
* Part C, Project Organizer, and Reflection: 1 period

**Materials**

* Unit 3, Lift-Off Task Student Version

Part B

* Poster paper and markers
* Post-Its (Optional)

Part C

* Class Poster Paper and Markers
* \*See instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

* Culminating Project Handout
* Project Organizer Handout

**Instructions**

**Part A**

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud. Introduce the phenomenon of the unit by reading the first sentence on the student guide aloud as a class.
2. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon. Ask students to think about the case of the peppered moths and take a few minutes to answer the question: If you wanted to understand more about how and why this happened to the Peppered Moth, what questions would you ask? Students should individually record any of the questions that they would need to ask to get a better understanding of how and why this happened.
   * For students who need more support, encourage them to look at the picture on their student guide and make observations.
   * Some potential questions students may generate: Why are the moths different colors? What was the cause of the color change? Does it help them to be black? Does it help them to be peppered? Did the genes change or just their appearance? Did they ever change back? What was happening in England at that time? Are there other colors of these moths? Did other animals change colors too?
   * This should be done independently, as students will have time in the next section to share ideas.

**Part B**

1. In this part of the task, students create a concept map as a group.

* Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member’s list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
* Remind students that there are no right or wrong questions or ideas, so students feel encouraged to contribute any and all questions and ideas they think of.
* Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See “How to Use this Curriculum” for more details).

1. Students will post their posters on a wall and then walk around and look at each group’s ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

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| Macintosh HD:Users:laurenstoll:Downloads:Sample Concept Map (1).jpg**How to Concept Map**  For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.   1. Write the phenomenon in the middle of the poster, in this case “Humans breathe harder when they exercise.” 2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board. 3. Model the process of reviewing the list and finding similarities amongst the questions.    * Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge. 4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles. 5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student’s prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.    * Use connector words to identify the relationships between the content boxes (See image above for an example). 6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. \*Note: not all boxes and circles will necessarily have a crosscutting concept. |

**Part C**

1. Construct a whole-class concept map that begins to help students to make sense of the phenomenon of The Changing Peppered Moth.

* Start with the phenomenon in the middle.
* Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you’ll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
* Ask students to identify any connections they see between the questions and record these as lines between the questions.
  + Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in a class-wide activity.
* The purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.
* This whole class concept map will be revisited at the end of each task, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?

1. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.

* If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
* Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
* We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

1. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).

* The crosscutting concepts for this unit are: Patterns, Cause and Effect, Scale, Proportion, and Quantity, Structure and Function, and Stability and Change. Assign a color for each crosscutting concept that can be used throughout the unit.
* Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.
* We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
  + **Patterns**: These could be phrases such as, “has in common with” “shares,” “is also shown in,” “is the same as,” “looks the same as,” etc.
  + **Cause and Effect:** These could be phrases such as, “which results in,” “which causes,” “that explains why,” “is due to,” etc.
  + **Scale, Proportion, and Quantity:** These could be phrases such as, “is proportional to,”“compared to,” “has a ratio of,” “is bigger/smaller than,” “is longer/shorter than,” etc.
  + **Structure and Function**:These could be phrases such as, “which shape affects”, “and its function comes from,” “which structure leads to,” etc.
  + **Stability and Change**: These could be phrases such as, “remains the same”, “is changed by”, “is disrupted by”, “changes”, “disrupts,” etc.

**Connecting to the Culminating Project**

1. Hand out the Culminating Project Task Card and read aloud the Challenge and Group Project Criteria for Success.
   * Take questions for clarification.
   * Optional: You may want to show a video to spark student interest. The following link is one option: <https://www.youtube.com/watch?v=QwLyscT3NgI> (Show until 0:38).
2. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.

* Students have been tasked with arguing whether humans should intervene on the behalf of threatened species of organisms or let nature take its course. The student prompt is as follows:
  + Select and research a species affected by a change in their environment that is caused by humans.
  + Describe the change in the environment and its effect on this species.
* Optional: You may want to show the following TedEd video to help set the context for the culminating project: <https://www.youtube.com/watch?v=ZCKRjP_DMII> (Stop at 3:56) This video shows examples of species that are affected by climate change but surviving. Be sure to emphasize that there are also species that will likely not survive climate change.
* Optional resource: <https://www.smithsonianmag.com/science-nature/ten-species-are-evolving-due-changing-climate-180953133/>. This may serve as a jump-off point for students to begin their research about threatened/endangered organisms.

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you made a list of all the questions you have about what happened to the Peppered Moth. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?
  + In this unit, we will be focusing on five crosscutting concepts:
    - **Patterns**: Patterns can be used to identify cause-and-effect relationships;
    - **Cause and Effect**: Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability;
    - **Scale, Proportion, and Quantity**: Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small;
* **Structure and Function:** Models can be used to describe how function depends on the structure;
* **Stability and Change:** Stability might be interrupted by sudden events or gradual changes that accumulate over time.

Looking at your class concept map, give one example of how one of the crosscutting concepts came up in today’s task.

* Now that you understand a little more about the project that you’ll be working on over the course of this unit, what else do you need to know? What additional questions do you have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their list based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.