CENTRAL QUESTION: What is the future of a forest under attack?

TIME: 3-4 hours

OVERVIEW:

- **SECTION 1: GATHER** (45-60 minutes)
  How do biotic and abiotic changes impact an ecosystem?
- **SECTION 2: ANALYZE** (40-50 minutes)
  What happens when change occurs in an ecosystem?
- **SECTION 3: INTERPRET** (45-60 minutes)
  What is the future of organism populations in this forest?
- **SECTION 4: COMMUNICATE** (45-70 minutes)
  What does the future look like for a forest under attack?

MATERIALS:

- One computer per two students
- One computer with the ability to broadcast material onto a screen visible by the entire class
- Printed ***Research Assistant Notebooks*** for students to record notes
- White board or other surface for teacher to use while facilitating class discussions
- Additional resources found on the "Support Materials" page:
  - ***Student Learning Assessment Tool***
  - ***Student Rubric for Presenting Arguments***
  - ***Student Rubric for Assessing Learning Outcomes***

Standards Alignment:

Utah SEEd Standard

- **6.4.4** - Construct an argument supported by evidence that the stability of populations is affected by changes to an ecosystem. Emphasize how changes to living and nonliving (biotic and abiotic) components in an ecosystem affect populations in that ecosystem. Examples could include Utah ecosystems such as mountains, Great Salt Lake, wetlands, and deserts.

NGSS Standard

- **LS2-4** - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

ELA Standards

- **Writing Standard 2:** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- **Reading: Informational Texts Standard 7:** Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

GETTING STARTED

This investigation provides support for teaching the content standards, along with the nature of science/how science is done, developing claims, working with evidence, and using reasoning skills. (**Hint:** Review the documents entitled *Curriculum Alignment* and the *Student Learning Assessment Tool* for other alignments and to assess learning with your students.)

Before class...

- Review this instructional guide and determine your student learning goals, which sections you want students to work on during each class period of the investigation, and the steps which your students will need guided instruction.
- Review the following recommended strategies for optimizing student learning outcomes.
    - Working in pairs ensures that every student has the opportunity to share their ideas. As students progress though the investigation, you may want to combine pairs of students into small groups to provide more practice sharing and responding to the ideas of their peers.
    - Build a shared vocabulary for the learning tasks by identifying key vocabulary beforehand and encouraging students to use these words often. Model correct usage, if needed.
        - **Key Vocabulary:** phenomenon, producers, primary consumers, secondary consumers, tertiary consumers, population, organisms, biotic, abiotic, montane, ecosystem, limiting factors, resources, precipitation, drought, temperature, simulator, correlation, causation
    - Think about places you can activate prior knowledge by prompting students to relate new concepts to a familiar context.
    - Think about how to integrate the *Research Quest* investigations with other curriculum-aligned activities.
    - Create and engage student interest in the program by expressing your enthusiasm and/or describing your personal interest in this investigation. You may also want to emphasize that students will be working with authentic materials on research questions that scientists actually address in their work.
    - Introduce students to sentence stems that reinforce flexible thinking and help students verbalize their thought processes:
        - "I see..."
        - "I think..."
        - "I wonder..."

Set Up...

- Make copies of the Research Assistant Notebook (RAN) for each of your students, or use the PDF with your desired digital classroom system (ie. Google Classroom, Canvas, etc).
- Navigate to www.researchquest.org and login using the email address and password you used to create your *Research Quest* account. Then, click on the "My Account" tab at the far right of the navigation bar. You will find your **Student Access Code**.
- Have your unique Student Access Code and URL link [www.researchquest.org/student/] ready for students. **It is important you have students use this particular URL and access code to get into the investigations for FERPA.**

In class...

- Introduce the daily objectives and provide a brief overview of the investigation to the class.
- Provide each student with a copy of the *Research Assistant Notebook* (RAN).
- Arrange students into pairs, one pair per computer. Instruct them to navigate to the URL [www.researchquest.org/student/] and enter your unique Student Access Code.
- Students will find themselves on a landing page with the option to go into one of two investigation modules. They should choose, "Change in the Uinta Mountains: Normal or Not?" Then, they should click on investigation #4 "What is the Future for a Forest Under Attack?"
- Once logged in, students will be on the introduction page for this investigation. They can read the overview and start at your direction.

SECTION 1: GATHER - HOW DO BIOTIC AND ABIOTIC CHANGES IMPACT AN ECOSYSTEM?

(30-45 minutes)

OVERVIEW

Students build an energy pyramid model to visualize populations of producers, consumers, and decomposers in this montane ecosystem.

ASSESSMENT

In this section, the instructor may find it useful to focus on the following critical thinking skills, defined in more detail in the *Student Learning Assessment Tool* located in the **Support Materials** page for this investigation.

- **Observation:** Make detailed, sense-based observations that discriminate between trophic levels.
- **Comparisons:** Note similarities and differences between organisms and trophic levels.

	STUDENT ACTION	TIPS FOR SUPPORTING CRITICAL THINKING
STEP 1 *(5 minutes)*	• Watch the video on Step 1 of the investigation. (2:33 min.) • Define food web. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 1*	• Direct students' attention to the following before beginning the video: *In this video you'll be introduced to the phenomenon of change in the Uinta Mountains. Listen carefully for what the forest means to all the organisms living there and how to examine the affects change may have on them. Dr. Mitch will also share how he uses models to study phenomena like this.*
STEP 2 *(10 minutes)*	• Drag and drop populations of organisms from the food web into the energy pyramid model. • Define energy model, producers, consumers, and decomposers. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 1*	• Based on your learning goals review producers, primary consumers, secondary consumers, tertiary consumers either before students being their work or after students have worked for a few minutes. • **Key Vocabulary:** food web, energy model, producers, consumers, and decomposers
STEP 3 *(5 minutes)*	• Watch the video on Step 3 of the investigation. (1:31 min.) • Define biotic factors and abiotic factors. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 1*	• Direct students' attention to the following before beginning the video: *In this video you'll learn about the difference between biotic and abiotic factors. You'll also hear how changes to these factors can affect populations of organisms.*
STEP 4 *(15-20 minutes)*	• Select a change for your Energy Pyramid Model, examine the changes in your Energy Pyramid Model and Population Chart, and record your results in your *Research Assistant Notebook*. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 2*	• You may elect to use the first model for guided instruction before having students move forward on their own. Discuss looking for patterns in the results. A change that affected all organisms, no organism, one trophic level and not another. • This is a good time to get a baseline reading of students' observation and comparisons skills. • **Key Vocabulary:** biotic factors and abiotic factors
STEP 5 *(8-10 minutes)*	• What have you learned about the effect of different types of changes on the populations in this ecosystem? Answer the reflection questions then click "submit" to compare our answers.	• Depending on your learning goals, you may want to use this Reflection page to facilitate group sharing and discussion about student observations. Did students see patterns in the biotic and abiotic changes? Can they transfer this information to apply it to another scenario?

SECTION 2: ANALYZE - WHAT HAPPENS WHEN CHANGE OCCURS IN AN ECOSYSTEM? *(40-50 minutes)*

OVERVIEW

Students use precipitation and temperature models as well as a simulator to explore how changes to abiotic and biotic factors affect populations of organisms in this ecosystem.

ASSESSMENT

In this section, the instructor may find it useful to focus on the following critical thinking skills, defined in more detail in the *Student Learning Assessment Tool* located in the **Support Materials** page for this investigation.

- **Evaluate:** Compile information from multiple sources to formulate a scientific prediction.
- **Observation:** Recognizing patterns in data and making warranted inferences about changes in populations.
- **Flexible Thinking**: Keep mind open to multiple ideas until all data is evaluated.

	STUDENT ACTION	TIPS FOR SUPPORTING CRITICAL THINKING
STEP 6 *(5 minutes)*	• Watch the video on Step 6 of the investigation. (2:04 min.) • Define limiting factors. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 2*	• Direct students' attention to the following before beginning the video: *In this video you'll learn about how limiting factors affect populations in different ways. Listen for what resources every living organisms needs to survive.*
STEP 7 *(15-20 minutes)*	• Take a look at how each of these four organisms is affected by precipitation and temperature. Then make predictions about what their limiting factors might be and how changes to temperature and precipitation might affect them. Finally, you'll compare your prediction with the predictions from our simulator. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 3*	• Encourage students to consider what other limiting factors are for an organism, like ourselves. Do this as a way to check for understanding and reinforce this vocabulary. • Have students work on the reading portion of this in pairs or as a larger group based on reading and note-taking skills. Analyze one of the changes as a class before students do this with their partner. • **Key Vocabulary:** limiting factors
STEP 8 *(5 minutes)*	• Watch the video on Step 8 of the investigation. (2:20 min.)	• Direct students' attention to the following before beginning the video: *In this video you'll hear about how scientists are able to make reliable predictions about precipitation and temperature based on historical data and models. Listen for how we can use this information to make predictions about populations of organisms in a changing ecosystem like the Uinta Mountains.*
STEP 9 *(15 minutes)*	• Identify patterns in future models of temperature and precipitation. Then choose three years to focus on as you make your predictions about the future of this forest in the Uinta Mountains. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 4*	• Discuss predictive models and how they can be used to predict possible, future outcomes. • If needed, have students make a quick predictive model of a classroom procedure. How expectations in the past will likely lead to expectations in the future. Or how past behavior will likely predict future behavior. • **Key Vocabulary:** predictive models
STEP 10 *(25 minutes)*	• Choose an organism to learn more about possible impacts to their populations based on future models for temperature and precipitation.	• Support students in their analysis, as needed, to make connections between the organisms limiting factors and the models.

SECTION 3: INTERPRET - WHAT IS THE FUTURE OF YOUR ORGANISM'S POPULATION IN THIS FOREST?

(45-60 minutes)

OVERVIEW

Students will use their evidence collected throughout this investigation to make an evidence-based claim that explains what the future may look like for their case study organism.

ASSESSMENT

In this section, the instructor may find it useful to focus on the following critical thinking skills, defined in more detail in the *Student Learning Assessment Tool* located in the **Support Materials** page for this investigation.

- **Evaluation:** Consider the strength of each piece of evidence.
- **Interpret:** Use information from multiple sources to construct an evidence-based explanation.
- **Connections:** Interpret information from complex models to formulate conclusions.

	STUDENT ACTION	TIPS FOR SUPPORTING CRITICAL THINKING
STEP 11 & STEP 12 *(20 minutes)*	• You will use the case study from Steps 9 & 10, the data from predictive models of temperature and precipitation, and other evidence you gathered throughout the investigation to develop an evidence-based argument to explain what the future may look like for populations of the organism you chose and the forest they live in. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 5*	• Guide students, as needed, through completing this form outline. Depending on your learning objectives have students expand on this in paragraph form in their notebooks. • *Note:* This is just one suggestion for the communication section and is closely aligned with the ELA Speaking and Listening standards. Select a communication strategy that best aligns with your learning goals. Regardless of your approach we recommend using the "Student Rubric for Presenting Arguments" located under the "Teacher Support" tab of the website.

STEP 13 *(15 minutes)*	• Use this chart to help you better understand causation vs. correlation.
	• Consider the changes to your case study organism. Are they caused by the abiotic factors or just correlation to the abiotic factors?
	
	RESEARCH ASSISTANT NOTEBOOK (RAN): page 6
		• Have students work in pairs or small groups. Have each student select a different "causation" and "corresponding" effect to share with their group.
		• **Key Vocabulary:**
		  • Causation indicates changes in A results changes in B.
		  • Correlation indicates a relationship between variables.

SECTION 4: COMMUNICATE - WHAT IS THE FUTURE FOR A FOREST UNDER ATTACK? *(45-70 minutes)*

OVERVIEW

Students will develop and communicate an action plan to support their case study population from this ecosystem.

ASSESSMENT

In this section, the instructor may find it useful to focus on the following critical thinking skills, defined in more detail in the *Student Learning Assessment Tool* located in the **Support Materials** page for this investigation.

- **Problem Finding:** Propose relevant ideas and articulate the need for further information to evaluate the idea.
- **Flexible Thinking**: Keep mind open to multiple ideas until all data is evaluated.

	STUDENT ACTION	TIPS FOR SUPPORTING CRITICAL THINKING
STEP 14 *(45-60 minutes, Varies)*	• Design and communicate a plan to support the population you studied. • What can you do to identify and protect ecosystems at risk for faster-than-normal change? Make a list of action items that you can do to help protect the ecosystem and the population you studied. *Will you write a letter to your local representative? Will you plant more food sources? Develop shelters? Educate your community? Something else?* Be creative and use your talents. *RESEARCH ASSISTANT NOTEBOOK (RAN): page 7*	• Encourage students to reference the evidence they collected in the previous steps. • What can they do to help support this or other chosen ecosystem? Is it realistic?
STEP 15 *(5 minutes)*	• Watch the video on Step 14 of the investigation. (4:02 min)	• Direct students' attention to the following before beginning the video: *In this video you'll learn about how limiting factors affect populations in different ways. Listen for what resources every living organisms needs to survive.*