STORYLINE: 6.4.4 Stability of Ecosystems	
Strand 6.4 STABILITY AND CHANGE IN ECOSYSTEMS The study of ecosystems includes the interaction of organisms with each other and with the physical environment. Consistent interactions occur within and between species in various ecosystems as organisms obtain resources, change the environment, and are affected by the environment. This influences the flow of energy through an ecosystem, resulting in system variations. Additionally, ecosystems benefit humans through processes and resources, such as the production of food, water and air purification, and recreation opportunities. Scientists and engineers investigate interactions among organisms and evaluate design solutions to preserve biodiversity and ecosystem resources.	**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 components in an ecosystem affect populations in that ecosystem. Examples could include Utah ecosystems such as mountains, Great Salt Lake, wetlands, or deserts. (LS2.C) *NGSS Correlation: MS-LS2-4*
Phenomena Statement: Nonnative rabbits have affected the ecosystems of Australia.	
Expected Student Explanation: Students' arguments should recognize that the stability of populations is affected by living and nonliving components in an ecosystem.	

Science & Engineering Practices (SEP)	Crosscutting Concepts (CCC)	Disciplinary Core Ideas (DCI)

Engaging in Argument from Evidence: Students construct an argument with evidence that the stability of populations is affected by changes to an ecosystem. **Students do and use this Science and Engineering Practice (SEP) by:** ● Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. ● Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. ● Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. ● Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.	Stability and Change: Use evidence to identify that the stability of a system can be affected by changes in that system. **Students think and connect through this Crosscutting Concept (CCC) to reason that:** ● Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. ● Small changes in one part of a system might cause large changes in another part. ● Stability might be disturbed either by sudden events or gradual changes that accumulate over time. ● Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.	(LS2.C): Ecosystem Dynamics, Functioning and Resilience **Students know and apply the Disciplinary Core Idea (DCI) of (LS2.C) Ecosystem Dynamics, Functioning and Resilience in their thinking and reasoning to communicate that:** ● Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological components of an ecosystem can lead to shifts in all its populations. ● Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.
Storyline Narrative		**Documents for Storyline**

6.4.4 Storyline Narrative SEEd Standard 6.4.4 asks students to **construct an argument supported by evidence** that the stability of populations is affected by both living and nonliving components causing changes to an ecosystem. To address this standard, our storyline is focused on the phenomenon that the stability *of populations is affected by changes to an ecosystem*. We will begin by engaging students with **evidence** from an article about the effects of nonnative rabbits introduced to the Australian ecosystem. Students will **construct an argument** that the stability of the ecosystem was affected by the nonnative rabbits. Students will then explore the effects one population of animals can have on the stability of an ecosystem. Students will **gather evidence** about sea otter populations and their effect on the stability of the kelp forest ecosystem. Students will **construct an argument supported by evidence** that sea otters are a keystone species in the kelp forest ecosystem and that they directly affected the growth of kelp forests and then indirectly affected resource availability for many other organisms. Next, students will participate in and explain a simulation of two wolf populations where they will raise a pack of wolves under 2 different conditions—without human interference and with human interference. They will collect data for each part of the simulation and **interpret the data** to **construct an explanation supported by evidence** from the simulation of the factors affecting the stability of wolf populations. Students will then elaborate as they **analyze data** of the Kaibab deer population and identify causes for the fluctuations in the stability of the deer population. Students will use their understanding of other ecosystems and what they learned from the simulation to help them make sense of the data. Finally, to evaluate their understanding, students will research living and nonliving components that affect populations in Utah ecosystems. Students will **obtain information** about a native Utah endangered species and the factors that have affected the stability of its population. After groups have presented their findings to the class, students will look for common factors that affect the stability of populations. Finally, students will be assessed on their ability to **construct an argument** supported by evidence as they examine evidence about the decline in the desert tortoise population. They will use the evidence to **construct an argument** that both living and nonliving components have affected the stability of the desert tortoise population in the southeastern deserts of the United States.	Review and/or print out the following documents for this storyline. To edit the following documents you must open, then make your own copy. Links: Storyboard Slides - episode instructions are in the slide notes Storyline Matrix Student Journal or composition notebook Summative Assessment

STORYLINE: Episode Matrix 6.4.4

Episode	Phenomenon	Episode Descriptions & Student Performance Prompts	Conceptual Understandings	
			What We Figured Out	Next Questions or Steps
Episode 1 **Engage** Time: 60 minutes	**Phenomenon: Nonnative rabbits have affected the ecosystems of Australia.**	Nearpod lesson link: https://share.nearpod.com/e/XBfUTjPoYcb **Gather** 1. Students will **obtain information** from an article for the effect rabbits have on Australia's ecosystems. *Teacher suggestions: Have students read an article individually, in a group or as a class about the effects of nonnative rabbits in Australia.* *Teacher Questions:* ● *Why were rabbits brought to Australia in the first place?* ● *What made Australia such a good environment for rabbits to survive and grow in number?* ● *How did the rabbit population grow so quickly?* ● *What living parts of the ecosystem were affected by the growing rabbit population?* ● *What nonliving parts of the ecosystem (like soil or climate) helped rabbits survive and spread?* ● *How did the removal of plants by rabbits change the land?* ● *What are some effects of rabbits eating young plants and seedlings?* ● *How did rabbits change the food web in Australia?* ● *How did rabbits affect native animals like the bilby and the burrowing bettong?* ● *What happened when predators like cats and foxes had more rabbits to eat? How did that change the ecosystem?* ● *Do you think people should have brought rabbits to Australia? Why or why not?* ● *What could people have done differently to protect the ecosystem?*	Nonnative species can cause destructive changes affecting the stability of an ecosystem.	How can one population of animals affect the stability of an ecosystem?

		● *Can you think of other examples where introducing a new species changed an ecosystem?* ● *How does this story help us understand the importance of keeping an ecosystem balanced?* ● *What does this story teach us about how connected all living things are in an ecosystem?* ● *Why is it important to think about how both living and nonliving things interact before making changes to an environment?* *See Student Science Journal page 2* *Humans in Australia have attempted many different solutions to help control the rabbit population. Students may choose to look at this design solution in 6.4.5 E2. If more information is needed/wanted for a richer class discussion on this topic: https://www.amusingplanet.com/2016/04/the-rabbit-proof-fence-of-australia.html* **Reason** 2. In groups, students will **argue from evidence** the effect rabbits have on the stability of Australia's ecosystem. *Teacher suggestions: In groups, have students discuss how rabbits have affected Australia's ecosystems. The group should then construct an argument that is supported by evidence to explain the effect.* *See Student Science Journal page 2* **Communicate** 3. Individually, students will **construct a written explanation** for the effect rabbits have on the stability of Australia's ecosystems. *See Student Science Journal page 3*		

		Formative Assessment *Students' explanations should reflect an understanding that the rabbits have had a negative impact on Australia's ecosystems in many different ways (Rabbits have caused many problems in Australia's ecosystems. They eat a lot of plants, especially young ones, which stops new plants from growing. This leaves the land bare and causes the soil to wash or blow away. Rabbits also take food away from farm animals and native animals by eating too much grass and plants. They move into burrows that belong to other animals like the bilby, making it hard for those animals to survive. Because there are so many rabbits, predator animals like foxes and cats have more to eat. These predators also hunt native animals, which causes more to disappear. All of this has made the ecosystem less healthy and less balanced).*		

Episode 2 **Explore** Time: 60minutes	**Phenomenon: Sea otter populations affect the growth of kelp forests.**	Nearpod lesson link: https://share.nearpod.com/e/kYwYFxQoYcb **Gather** 1. Students will **obtain information** about how sea otters affect the stability of the kelp forest ecosystem. *Teacher suggestions: Have students watch a video and read an article in the student science journal to obtain information about how sea otters affect the stability of the kelp forest ecosystem. Have students fill out the graphic organizer in the students science journal while watching the video and reading the article.* *See Student Science Journal pages 4-5* Video with article: Otters vs. Climate Change Video only: https://www.youtube.com/watch?v=XHOmbAMkCJs&feature=emb_logo https://www.youtube-nocookie.com/embed/XHOmbAMkCJs https://safeshare.tv/x/ss5ff5d7e31d14a *Teacher Questions:* ● *What is an ecosystem?* ● *What is a kelp forest?* ● *What types of organisms live in a kelp forest?* ● *Why do kelp forests need otters?* ● *What happens if there are no predators around to eat sea urchins?* ● *What was the result when otters discovered sea urchins in the Strait of Juan de Fuca?* ● *Why is it important to conserve kelp forests?* ● *How do sea otters help to combat climate change?* ● *What is a keystone species?*	Otters are a keystone species in the kelp forest ecosystem. Fluctuating populations of otters directly affect kelp forests and the organisms that rely on that ecosystem.	What factors can affect populations in an ecosystem?

		Reason and Communicate 2. In groups, students will **argue from evidence** how sea otters affect the stability of the kelp forest ecosystem. *Teacher suggestions: Have students gather evidence from the video and article and develop a group presentation arguing how sea otters are a keystone species affecting the stability of the kelp forest ecosystem. Presentations might include an oral presentation, poster, opinion letter, PowerPoint, etc.* **Formative Assessment** *Students' explanations should reflect an understanding that the sea otters are a keystone species and directly affect the stability of the kelp forest ecosystem.*		
Episode 3 **Explain** Time: 60 minutes	**Phenomenon: Wolf populations are affected by different factors.**	Nearpod lesson link: https://share.nearpod.com/e/Kh3jtmRoYcb **Gather** 1. Students will **obtain information** about the effect of human actions on the stability of ecosystems. *Teacher suggestions: Have students participate in a simulation where they will "raise" a pack of wolves under two different conditions—without human interference and with human interference. They will collect data for each part of the simulation.* *Simulation Instructions* *A. Divide the class into groups of 2-3.* *B. Give each group two dice, an instruction sheet, and the data table simulation 1.* *C. Groups start with two adult wolves and three pups to equal five total wolves.* *D. Each roll of the dice represents the passage of 1 year. After rolling, groups will look at the Without Human Interference information sheet to see what happened to the pack during the year.* *E. Each year add three wolves to the pack (due to reproduction and mature pups leaving the pack).*	The stability of wolf populations can be affected by human interference in the ecosystem.	What can cause fluctuations in populations?

		F. *Fill in the information on the wolf record table and adjust the number of wolves.* G. *Repeat 15 times to model 15 years of time.* H. *Repeat the simulation using the With Human Interference data table simulation 2.* *See Student Science Journal pages 7-9* 2. Students will **ask questions** and **define problems** for the <u>cause and effect</u> of human actions on the <u>stability</u> of ecosystems. *Teacher suggestions: Pose the following question to students and have them brainstorm in groups. Have each group share their thoughts with the class.* *Q. How can human actions change and affect the stability of ecosystems?* *Possible points to cover/student answers:* ● *Humans can introduce new species to an environment, like rabbits in Australia, which can cause problems for native plants and animals.* ● *Hunting or removing certain animals, like sea otters, can cause other populations (like sea urchins) to grow too much and harm the ecosystem.* ● *Pollution can damage air, water, and soil, which makes it hard for plants and animals to survive.* ● *Cutting down forests or destroying habitats for buildings or farming can make animals lose their homes and food sources.* ● *Overfishing can remove important species from the food web and unbalance ocean ecosystems.* ● *Climate change, caused by burning fossil fuels, can make temperatures rise and affect where animals and plants can live.* ● *Helping protect species through conservation or laws can also help restore balance to ecosystems, like when sea otters were protected and helped kelp forests recover.* **Reason** 3. Students will **analyze and interpret data** about the <u>effect</u> of human actions on the <u>stability</u> of ecosystems.		

		Teacher suggestions: Have pairs graph their data on a double bar graph. X-axis will be the year, Y-axis will be populations with or without human interference. They will then look at the data and draw some conclusions about the effect of human actions on the wolf pack population. Then have the students compare their graph to several other pairs in the class and see if their conclusions changed or stayed the same. See Student Science Journal pages 10-11 4. Students will **develop arguments from evidence** about the <u>effect</u> of human actions on the <u>stability</u> of ecosystems. Teacher suggestions: After the students compare their results to other members of the class, have them return and discuss with their partners the evidence they found for or against their original argument and refine their evidence. Then bring the class back together for a discussion. *Questions to Ask:* *Q. What happened to the stability of the pack of wolves **<u>without</u>** human interference?* *Q. How did the stability of the pack change over the years?* *Q. Was the pack population stable? Support your reasoning with data.* *Q. What happened to the stability of the pack of wolves with human interference?* *Q. How did the stability of the pack change over the years?* *Q. Was the pack population stable? Support your reasoning with data.* *Q. What was the difference in the stability of the populations between the two simulations?* *Q. What differences in stability can be seen among the different wolf packs in the classroom?* *Q. What would account for these differences?* *Q. How does this simulation relate to the stability of actual ecosystems?* **Communicate**		

		5. Individually, students will **construct an argument from evidence** about the effect of human interference on the stability of the wolf pack population in their ecosystem. *Teacher suggestions: Have students communicate how the stability of the wolf pack population was affected by human interference. Their argument should include evidence from the simulation and analysis of data. Students should also think about how the simulation relates to stability of actual ecosystems.* *See Student Science Journal pages 7-11* **Formative Assessment** *Students' arguments will demonstrate an understanding that stability of populations is affected by living and nonliving components in the ecosystem.*		
Episode 4 **Elaborate** Time: 60 minutes	**Phenomenon: The Kaibab deer population rose and decreased dramatically over a period of 10 years.**	Nearpod lesson link: https://share.nearpod.com/e/I9ipKFToYcb **Gather** 1. Students will **ask questions and define problems** about the stability of the deer population in the Grand Canyon. *Teacher suggestions: Pose the following scenario to students:* *It is the early 1900s, and you are a scientist. You have just learned that a protection plan was implemented to protect around 4,000 deer that live on the Kaibab plateau near the Grand Canyon. The plan involved removing all predators from the area and banning hunting. You examine the data and see that within a few years, the deer population increased from 4,000 to 100,000 deer. Then a few years later, the population decreased to a very small number.* *As a class, facilitate a discussion about the living and nonliving components in an ecosystem. In the discussion, help students to identify the components that affect the deer population. Examples could include vegetation, predators, competition, bacteria causing illness, humans, water, erosion, temperature, shelter. Have students record the*	The removal of predators affected the stability of the deer population.	What can cause species to become endangered?

		components in their student science journal. *Possible Teacher Questions* ● *What living things do deer need to survive in their ecosystem?* ● *What nonliving things do deer depend on?* ● *What might happen to the deer if there is less vegetation available? Why?* ● *How could the presence of predators affect the deer population?* ● *How do deer compete with other animals for food or space?* ● *What kinds of diseases or bacteria could affect deer, and how might that change their population?* ● *How might a drought or lack of water affect deer?* ● *In what ways can humans affect deer populations—both positively and negatively?* ● *How does erosion or loss of shelter affect deer?* ● *How might temperature or seasonal changes impact deer survival and behavior?* *See Student Science Journal page 13* *After the discussion, have students discuss in groups explanations for the tremendous increase in the deer population and the sharp decrease that followed.* *Possible Teacher Questions* ● *What conditions in the environment might have allowed the deer population to grow quickly at first?* ● *Were there enough resources (like food, water, and shelter) to support the larger population? For how long?* ● *What role might predators or the lack of predators have played in the population increase?* ● *Could the increase in deer have caused changes to their own habitat? How?*		

		● *What might have caused the deer population to decrease so quickly afterward?* ● *How could a high deer population affect the availability of vegetation and water?* ● *Do you think disease or competition played a role in the population drop? Why or why not?* ● *How might changes in the nonliving environment—like a drought, fire, or cold winter—have affected the deer?* ● *What evidence from our discussion or learning can support your explanation?* ● *How could this pattern (increase followed by sharp decrease) affect other living things in the ecosystem?* 2. Students will **obtain information** about the <u>stability</u> of the deer population in the Grand Canyon. *Teacher suggestions: Have students read the article in the student science journal to obtain information about the methods that were used by humans to stabilize the deer population in the Grand Canyon.* *See Student Science Journal page 12* **Reason** 3. Students will **analyze data** about the <u>stability</u> of the deer population and create a graph to make sense of the change in deer population. *Teacher suggestions: Have students create a graph of the data for deer population numbers. Students should then use both the graph and the article to answer the questions in the student science journal to make sense of the human interference on the stability of the deer population.* *See Student Science Journal page 12-15 (It may be a good idea to only have students complete either pg. 14 OR 15, depending on your time).* 4. In groups students will determine if conservation methods were successful in <u>stabilizing</u> the deer population and **construct**		

		an argument supported by evidence for how the stability of the population was affected by human actions. *Teacher suggestions: Put students in groups and have them decide whether the conservation methods were effective or not. They should construct an argument together and back their argument with evidence from the graph and article.* *See Student Science Journal page 16* **Communicate** 5. Individually, students will **construct an explanation** for what caused the deer populations to change and how the stability of the population was affected by human actions. *Teacher suggestions: Using evidence from the article, graph and group discussion, have students write their own explanation for the cause of the change in the deer population. Students should also write about how human interaction affected the stability of the population.* *See Student Science Journal pages 16* **Formative Assessment** *Students' arguments should demonstrate an understanding that the stability of the deer population was negatively affected by the removal of predators from the habitat.*		
Episode 5 **Evaluate** Time: 60 minutes	**Phenomenon: Animal populations can become endangered through a variety of factors.**	Nearpod lesson link: https://share.nearpod.com/e/Td8uqCSoYcb **Gather** 1. Students will **obtain information** from a video about extinct animals. *Teacher suggestions: Have students watch a video about Extinct Animals. Take time to discuss as a class.* *Teacher questions:* ● *What might have happened to these animals?* ● *What factors could have caused their extinction?* ● *What role might humans have played in their extinction?*	The stability of populations in an ecosystem is affected by many different living and nonliving components.	Can I construct an argument supported by evidence that the stability of populations is affected by changes to an ecosystem.

		2. In small groups, students will **gather information** about a native Utah species and factors that have affected the stability of that population. *Teacher suggestions: Have students research a native Utah species that is endangered. They will look for the factors that led to their endangerment and record them in their student science journal. The following are examples of Utah species that students can research: Bighorn sheep, American beaver, American pika, bison, North American river otter, burrowing owl, peregrine falcon, bald eagle. Students should then present their findings to the class. These presentations could be posters, powerpoints, tables, charts, videos, etc. All class members should record the findings from the presentation in their student science journal.* *See Student Science journal page 17* *Also, the following website has a list of endangered Utah species: Utah Endangered Species Search Website Have link to website available to students through Canvas or other platform.* *Optional Resource: PDF Utah Sensitive Species List* **Reason** 3. Students will **evaluate** the different factors that affected the stability of native Utah animal populations to look for common patterns in the causes of decreased populations. *Teacher suggestions: Now that students have a collection of information, have them evaluate it and look for common factors that impact the stability of a species population.* **Communicate** 4. Individually, students will **construct an argument** using examples from the class presentations of how living and nonliving components in an ecosystem can affect the stability of populations in that ecosystem. *See Student Science Journal page 18 (14 for living and non living*		

		components) **Formative Assessment** *Students' arguments should recognize that the stability of populations is affected by living and nonliving components in an ecosystem.*		
Summative Assessment	6.4.4 SEED storylines assessment			
USBE FORMATIVE ASSESSMENT	6.4.4 Formative Assessment-R			