Ecosystems Interactions & Dynamics

DEVELOPER: OpenSciEd

GRADE: 9–12 | **DATE OF REVIEW:** January 2023

Ecosystems Interactions & Dynamics
EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E

TOTAL SCORE: 8

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	3	3

Click here to see the scoring guidelines.

This review was conducted by NextGenScience using the EQuIP Rubric for Science.

CATEGORY I CRITERIA RATINGS			CATEGORY II CRITERIA RATINGS			CATEGORY III CRITERIA RATINGS		
A.	Explaining Phenomena/ Designing Solutions	Adequate	A.	Relevance and Authenticity	Extensive	A.	Monitoring 3D Student Performances	Adequate
B.	Three Dimensions	Adequate	B.	Student Ideas	Extensive	B.	Formative	Adequate
C.	Integrating the Three Dimensions	Adequate	C.	Building Progressions	Adequate	C.	Scoring Guidance	Adequate
D.	Unit Coherence	Adequate	D.	Scientific Accuracy	Extensive	D.	Unbiased Tasks/Items	Extensive
E.	Multiple Science Domains	Adequate	E.	Differentiated Instruction	Adequate	E.	Coherence Assessment System	Extensive
F.	Math and ELA	Extensive	F.	Teacher Support for Unit Coherence	Extensive	F.	Opportunity to Learn	Adequate
			G.	Scaffolded Differentiation Over Time	Adequate			

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully crafted, and it has many strengths including student opportunities to engage with the phenomenon/problem in authentic, relevant ways that allow them to make real world connections. Additionally, students were provided with multiple opportunities to surface their ideas and new understandings about this learning.

During revisions, the reviewers recommend modifying the phenomena and problem claimed in the unit. Although students are presented with a real-world problem, there is a mismatch between what the lesson sequence claims is the anchoring phenomena and what drives learning. Changing some of these claims and revising some of the sections of the lesson sequence could help increase sense-making and problem solving throughout the unit.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met, and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes. In these cases, the criterion *was* met. The purple text is simply not part of the argument for that Extensive rating.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that learning is driven by students making sense of phenomena or designing solutions to a problem. Students' ideas and questions consistently drive the instruction throughout the unit. However, while an anchoring problem is somewhat presented to the students, designing a solution to this problem does not always seem to be the focus of the learning.

On page 12 of the Teacher Edition, guidance is provided which states, "In the anchoring phenomena, students explore conservation in the context of the 30 by 30 Initiative which aims to conserve 30 percent of US lands and waters by 2030." While conservation is not a phenomenon as defined by the NGSS, determining how to best implement the 30 by 30 Initiative does serve as an anchoring problem that students return to in some of the lessons.

- Lesson 1, Section 1: Students are introduced to the 30 by 30 Initiative. Students watch a video in which Secretary of the Interior Deb Haaland explains how the initiative addresses "issues related to protecting species." Students create a notice/wonder chart that they fill in as they watch the video and read a compilation of articles about the initiative.
- Lesson 1, Section 2: Students work in small groups to brainstorm criteria for conserving land or water.
- Lesson 1, Section 4: Students work as part of a whole group to generate a consensus list of criteria to be considered when planning to conserve an area of land or water.
- Lesson 1, Section 5: Students are asked to if they can think of any places, lands, or water that they "have visited, read about, or heard about that have been conserved or protected." Students are then given a Home Learning activity where they are tasked with locating examples in their local communities of land or water conservation "by talking to family members, friends, or neighbors about lands and waters that they know about that have been conserved or that people might be motivated to conserve."
- Lesson 1, Section 7: Students work in small groups explore specific examples of "conservation profiles," such as the Everglades, Great Lakes, Hoh Rainforest, or Saguaro National Park, to identify specific information about the "system, components, interactions, and decisions" in their profile.

- Lesson 1, Section 8: Students develop initial models of the conservation profiles to show how the "system, components, interactions, and decisions" work together.
- Lesson 1, Sections 10 and 11: Students respond to an Exit Ticket and the teacher identifies patterns in responses from that assignment. Students then revise their initial models considering these "patterns or themes."
- Lesson 1, Section 14: Students are asked to respond to the following question, "What common elements did you notice across all of the cases that can help us figure out how to protect ecosystems more generally?"
- Lesson 1, Section 18: Students engage in group discussions to determine next steps after they generate questions for the Driving Question Board (DQB) and identify investigations. Students are asked, "How can we learn how to protect new lands and waters that have not had protection?"
- Lesson 2: Students make sense of the Serengeti National Park as an ecosystem that has seen a variety of conservation attempts.
- Lesson 5, Section 10: Students are asked to update their Progress Tracker. This three-column document provides the following prompts to students, "What did I figure out about the Serengeti? What in my profile connects to ideas we figured out about the Serengeti? What information do I need/questions do I have about how to protect ecosystems?" While the final prompt may motivate students to reconnect with the anchoring phenomena/problem, the provided responses indicate that students will apply what they have figured out from the Serengeti case study to their chosen conservation profile.
- Lesson 6: Students complete an African Wild Dog Transfer Task. Students are told that they will connect what they know to a different scenario about an endangered animal that needs protecting. However, students are applying what they have figured out about limiting factors and carrying capacity and they are not engaging with the claimed anchoring phenomena/problem.
- Lesson 8, Section 8: Students are asked to return to their Progress Trackers. While the prompts included on this document may motivate students to reconnect with the anchoring phenomena/problem, it is more likely that students will apply what they have figured out from the Serengeti case study to their chosen conservation profile.
- Lesson 8, Section 10: Student are asked to identify questions they have answered and generate additional questions. While students may have additional questions that relate to the anchoring phenomena/problem, it is more likely that they will ask additional questions to help them make sense of the Serengeti ecosystem and how it operates.
- Lesson 9, Section 5: Students are told they will, "use what they have learned about how the [Serengeti] works to understand how humans decided to protect it." Students then use a "Conservation Plan Evaluation Tool" to evaluate the Serengeti Conservation Plan. However, there is no evidence that students will use this evaluation to ultimately help them design solutions to the 30 by 30 Initiative.
- Lesson 10, Section 2: The students revisit the conservation plans originally used in Lesson 1. Teachers are provided with the following suggested prompt, "To respond to the 30 by 30 initiative, we need to know if the conservation plan was successful so we can think about protecting more lands and waters. How will we know the conservation plan was successful?" However, there is no evidence that students are ultimately making connections to the 30 by 30 Initiative as they evaluate the conservation plans.
- Lesson 11: Also referred to as Transfer Task #2, has students investigate the American Prairie Reserve which includes a reading that explains that plan as attempting "to bring together 3.2 million acres of land by working with public, private, and Indigenous interest holders. By adding

additional protected lands, this conservation plan has the potential to contribute to the goals of the 30 by 30 initiative." However, the task does not specifically support students to deepen their understanding of the 30 by 30 Initiative.

Students have opportunities to ask questions that are used to motivate sense-making in the unit. However, student questions are not always connected to the unit anchoring phenomena or problem.

Some examples include:
- Lesson 1, Section 16: Students collaborate to build a DQB for the class to address unanswered questions related to ecosystems and how they are protected. However, the teacher is only guided to revisit the DQB in Lessons 2, 6, 8, and 10.
- Lesson 2, Section 2: Students are told to return to the DQB to, "remind themselves of what they wanted to learn at the end of Lesson 1." Students are then told, "they wanted to learn more about the conservation of ecosystems to answer their questions." While students do generate ideas for investigations at the end of Lesson 1, it is unclear if they would be able to generate this idea. Additionally, there are no suggestions for teachers to guide them in doing so.
- Lessons 2–5 focus on learning about the Serengeti National Park and making sense of investigative phenomena related to wildebeest populations and migration patterns within the park. While student questions are generated and used to drive these lessons, there are no connections made to the anchoring phenomenon/problem. Consequently, it is likely that students will spend these lessons learning about ecosystems and their interactions and not figuring out solutions to the 30 by 30 Initiative.
- Lesson 6, Section 10: Students return to the DQB to identify questions they have answered and to generate new ones based on their experiences. Students are reminded that the unit question is, "how ecosystems work and how understanding them helps us protect them." However, the sample student responses indicate that students are focused more on how ecosystems work and are not figuring out how to protect the ecosystems.
- Lessons 7–8 continue to investigate the Serengeti National Park ecosystem using agent-based modeling of predators to understand the impact of additional components in the system. While student questions are generated and used to drive these lessons, there are no connections made to the anchoring phenomenon/problem.

Suggestions for Improvement
- Consider making the 30 by 30 Initiative connection to the different lesson sets clearer. For example, there is no mention of the 30 by 30 Initiative after Lesson 2 until Lesson 10. It may be unclear to students how their learning is helping them explain or understand the claimed anchoring phenomenon unless it is explicitly revisited.
- Consider making the connection between ecosystem dynamics and designing solutions to ecosystem conservation clearer. As currently written, students may not make the connection that the purpose for studying the Serengeti National Park is because it contains years of data that can help identify the strengths and weaknesses of the conservation plan over time.
- Consider revisiting the DQB more frequently to support students to feel that they are driving the learning sequence.
- Consider providing additional guidance for teachers to draw out student experiences related to conservation or their prior knowledge about the topics.

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I.B. THREE DIMENSIONS

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. Provides opportunities to *develop and use* specific elements of the SEP(s).

ii. Provides opportunities to *develop and use* specific elements of the DCI(s).

iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Students have opportunities to develop and use some, but not all, of the claimed SEP, DCI and CCC elements at the grade-appropriate level.

Science and Engineering Practices (SEPs) | **Rating: Adequate**

The reviewers found adequate evidence that students can use or develop the SEPs in this unit. The materials provide opportunities for students to develop and use most of the claimed SEP elements. However, some claimed SEP elements are not developed at the grade-appropriate level or not fully developing the claimed high school elements.

Asking Questions and Defining Problems
- *Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.*
  - Claimed in Lesson 1:
    - Lesson 1, Section 1: Students complete a Notice and Wonder chart after the introduction of the anchoring phenomenon through slides, a video, and a reading. As they do so, students are engaging with the claimed SEP. However, the student questions generated are not always used to clarify or seek additional information throughout the unit.
    - Lesson 1, Section 9: The teacher is told to ask students to, "write down one thing they figured out and one question they still have about their conservation profile." As they do so, they are engaging with the claimed SEP. While it is possible that students may return to these questions in later lessons as they return to their conservation profiles, there is no evidence that they will use these questions to clarify or seek additional information.
    - Lesson 1, Section 16: Students engage with this element as they develop a DQB. The teacher is told to display a slide which clarifies that questions should "help us explain the phenomenon", and "learn more about the phenomenon."
    - Lesson 1, Section 17: The teacher is told to use slide AA to support students in connecting their questions from the DQB to future class investigations.

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Developing and Using Models

- *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
  - Claimed in Lesson 1:
    - Lesson 1, Section 8: Students develop initial models to explain interactions between components within the conservation profiles and how those change over time. As they do so, students are using the claimed SEP.
    - Lesson 1, Section 11: Students revise their initial models in response to patterns surfaced from their Exit Tickets. As they do so, students are revising the models they developed in Section 8.
    - Lesson 1, Section 12: Students work in small groups to develop models of their conservation profiles. Students then engage in a gallery walk to identify similarities and differences in their models. As they do so, they are engaging with the claimed SEP.
  - Claimed in Lesson 3:
    - Lesson 3, Section 9: Students engage in group discussions to develop a consensus model about wildebeest migration. As they do so, students are engaging with the claimed SEP.
  - Claimed in Lesson 4:
    - Lesson 4, Section 20: Students engage in a group discussion to revise the consensus model they developed in Section 9. As they do so, they are engaging with the claimed SEP.
  - Claimed in Lesson 9:
    - Lesson 9, Section 4: Students work collaboratively to revise the class consensus model developed in Lesson 8 to incorporate humans and their interactions. As they do so, they are engaging with the claimed SEP.
- *Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.*
  - Claimed in Lesson 5:
    - Lesson 5, Sections 2–3: The students through the processes of creating a kinesthetic model of the Serengeti system to simulate what is happening with the wildebeest population and food. Students evaluate the kinesthetic model to determine how it is similar and different from the real world. However, students are not developing the claimed SEP; rather, they are engaging with the Grade 9–12 element, "~~Develop, revise, and/or~~ use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system" along with the following Grade 3–5 element from this same SEP, "Identify limitations of models."
- *Develop a complex model that allows for manipulation and testing of a proposed process or system.*
  - Claimed in Lesson 8:
    - Lesson 8, Section 3: Students use SageModeler to create a model of the Serengeti ecosystem using components and interactions students have previously modeled. As they do so, they are using the claimed SEP.
    - Lesson 8, Section 6: Students use the SageModeler program to simulate disturbances within the Serengeti ecosystem. As they do so, they are using the claimed SEP.

- *Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.*
  - Claimed in Lesson 7:
    - Lesson 7, Section 9: Students use a model of the Serengeti ecosystem in the form of a board game to collect data related to predator/prey interactions. Students are told (Lesson7, Section 2) that the game uses mathematics and numbers as rules for game play. In Section 12, students analyze the data they generated when using the model.

Analyzing and Interpreting Data
- *Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.*
  - Claimed in Lesson 4:
    - Lesson 4, Sections 5 and 12: Students use the CODAP program to generate graphs of annual rainfall data (Section 5) and wildebeest population (Section 12). Students analyze these graphs to generate data to support claims that wildebeest migration is or is not tied to rainfall. As they do so, students are using the claimed SEP.

Using Mathematical and Computational Thinking
- *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
  - Claimed in Lesson 4:
    - Lesson 4, Section 5: Students complete Data Excursion #1 where they use the CODAP program to generate graphs of data. They use this data to respond to questions in the Investigating Rainfall handout. As they do so, they are using the claimed SEP.
    - Lesson 4, Section 12: Students complete Data Excursion #2 where they use the CODAP program to generate graphs of data. They use this data to respond to the *Wildebeest and Rainfall* questions. As they do so, they are using the claimed SEP.
  - Claimed in Lesson 5:
    - Lesson 5, Section 4: Students construct graphs to communicate what occurred during their Serengeti Kinesthetic Model activity. As they do so, they are engaging with the following Grade 6–8 element of the claimed SEP, "*Use mathematical representations to describe and/or support scientific conclusions and design solutions.*"
    - Lesson 5, Section 5: Students work collaboratively to create algorithms for the purpose of making sense of the Serengeti Kinesthetic Model activity. As they do so, they are engaging with the claimed SEP.
  - Claimed in Lesson 6:
    - Lesson 6, Section 3: Students complete the African Dog Transfer Task activity. Within that activity, students are asked to create and use graphs to support their claims and explanations. As they do so, they are using the claimed SEP.
  - Claimed in Lesson 7:
    - Lesson 7, Section 12: Students complete the Data Analysis handout after completing the Serengeti game. Students are expected to, "develop algorithms

to help explain patterns in data.*" As they do so, they are engaging with the claimed SEP.

- o Claimed in Lesson 8:
    - ▪ Lesson 8: Students use SageModeler to complete the *Serengeti Component Interactions* document. Students use the information collected when using SageModeler to write if/then statements and develop graphical representations of the data they collected. The final question of the document asks students to, "describe and explain the cause for the interaction you modeled in your graph." As they do so, they are using the claimed SEP.

Constructing Explanations and Designing Solutions

- *Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*
    - o Claimed in Lesson 2:
        - ▪ Lesson 2, Section 10: *S*tudents engage in group discussions about the Information Scavenger Hunt to develop an explanation for why people decided to protect the Serengeti and how they decided what to protect. The sources students use to collect information are provided to students as handouts and include maps, images, short readings, and quotations. While not specifically identified in the suggested prompts, it is likely that students will engage with the idea that the natural world operates today as it has in the past when explaining how and why the Serengeti National Park was established. However, students are not supported in developing or revising their own initial explanations. Students are supported in developing a consensus explanation.
- *Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.*
    - o Claimed in Lesson 9:
        - ▪ Lesson 9, Section 8: Students review several proposals for roads that will impact the Serengeti ecosystem. Three road proposal cards are reviewed by students and then the teacher is directed to say, "Now you have had a chance to investigate evidence and hear about all three road proposals. You will choose one proposal to evaluate and then you will explain your evaluation." Students complete a Road Proposal Evaluation sheet which includes prioritizing criteria from various points of view. Students are directed to use, "other resources you have developed throughout the unit" for this activity.
    - o Claimed in Lesson 10:
        - ▪ Lesson 10, Sections 3 and 4: Students use the Evaluating Conservation Plans handout as they review a provided conservation plan for their conservation profiles. However, the evaluation students complete does not include explicit discussion of prioritized criteria or tradeoff considerations.
    - o Claimed in Lesson 11:
        - ▪ Lesson 11, Section 1: Students complete a transfer task where they read about the Great Plains Prairie Ecosystem and the American Prairie Reserve proposed conservation plan. However, student evaluation of the proposed solution does

not require the use of student-generated sources of evidence and does not include tradeoff considerations.

Obtaining, Evaluating, and Communicating Information

- *Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.*
  - Claimed in Lesson 1:
    - Lesson 1, Section 1: Students are introduced to a reading about the 30 by 30 Initiative. While students are reading a compilation for the purpose of obtaining scientific and/or technical information about the Initiative the resources used to develop the reading are informational in nature and are not pieces of scientific literature that have been adapted for classroom use. Consequently, students are not engaging with the claimed SEP and are instead engaging with the following 3–5 element, "*Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.*"
  - Claimed in Lesson 2:
    - Lesson 2, Section 3: Students are assigned the "*A Brief History of the Serengeti*" reading. Students discuss this reading in Lesson 1, Section 4. As they do so, they are using the following portion of the claimed SEP, "*Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information ~~to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms~~*." While a research study is referenced as a source for this reading, most of the resources are informational rather than scientific. Consequently, it may be that students are only engaging with this element in minimal ways.
    - Lesson 2, Section 5: Students engage in the Scavenger Hunt activity where students rotate through multiple stations for the purpose of obtaining additional information about the Serengeti. However, the resources students use are informational documents and are not pieces of scientific literature that have been adapted for classroom use. Consequently, students are not engaging with the claimed SEP and are instead engaging with the following 3–5 element, "*Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.*"
  - Claimed in Lesson 7:
    - Lesson 7, Section 3: Students read about their assigned "agent" as a part of the orientation of the game. Students are provided with a compilation of information related to either wildebeests, lions, or hyenas.
- *Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.*
  - Claimed in Lesson 3:
    - Lesson 3, Section 7: Students create "data displays" in which they orally and graphically communicate ideas related to patterns of wildebeest migration. As they do so, they are not using the claimed SEP element. However, students are

using the following element from the claimed SEP, "*Communicate scientific ~~and/or technical~~ information or ideas (e.g., about phenomena ~~and/or the process of development and the design and performance of a proposed process or system~~) in multiple formats (including orally, graphically, textually, and mathematically)."*

Disciplinary Core Ideas (DCIs) | Rating: Adequate

The reviewers found adequate evidence that students can use or develop the DCIs in this unit because students are supported to build toward grade appropriate DCIs.

LS2.A: Interdependent Relationships in Ecosystems
- *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.*
  - Lesson 3: This element is claimed. Students are instructed to organize their Wildebeest Data Cards and look for patterns in the data. They are instructed to use the Analyzing Wildebeest Data Cards handout to support their thinking. As students complete part 4 of that document, answering questions such as "Which of the factors that you investigated are likely to support or limit the size of the population?" they are building toward the following portion of the claimed DCI, "*These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.*"
  - Lesson 4: Students analyze graphs to determine if there is a correlation between annual rainfall and wildebeest populations. As they do so, they are engaging with the following portion of the claimed DCI, "*These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.*" As students complete question #8 on the Wildebeest and Rainfall handout, they are engaging with the claimed portion of the DCI element.
  - Lesson 5: Students begin building toward an understanding of part of this element as they engage with the "Serengeti Kinesthetic Model" activity. They are asked "If the simulation were to carry on for 50 rounds, representing 50 years, what would happen to the wildebeest population if other conditions, such as the grass population remained stable?" Later during the Building Understandings Discussion, the prompts provided support students in developing an understanding of carrying capacity. The teacher is told to say "During the discussion, students will likely bring up the idea that there can only be so many wildebeest in the system due to the amount of grass. When that happens, add that we hear that scientists call this idea carrying capacity". Students then add key terms to their personal glossaries, including carrying capacity.
  - Lesson 6, Section 3: Students complete the African Wild Dog Transfer Task. As they do so, students are engaging with the claimed DCI.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- *A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or*

physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), ~~as opposed to becoming a very different ecosystem~~.

- o Lesson 8: Students use the SageModeler program to simulate the effects of disturbances (rain, disease, fire) on the Serengeti Ecosystem. Students are asked "What do you predict will happen to your component, the wildebeest, or the whole system if you add a disturbance?" They therefore are building toward the following portion of the DCI element: "*If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient)*". Later, the class co-constructs the definition of resilience.
- o Lesson 10: Students are provided with data packets for their individual conservation profiles to support their evaluation of the conservation plan for those areas. They then examine complex sets of interactions within an ecosystem, and therefore begin to build toward this high school level element.

- *Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation,* ~~and climate change~~—*can disrupt an ecosystem and threaten the survival of some species.*
  - o Lesson 2, Section 3: Students complete a reading of the "History of the Serengeti National Park." Included in that reading is a section that details concern that overhunting would occur which prompted the need to conserve the land to prevent this from happening. In Section 4, the teacher is directed to lead a class discussion of the reading. If those prompts are followed it is likely that students will engage with the claimed DCI.
  - o Lesson 9, Section 3: Students watch a video that shares information related to human interactions in the Serengeti. In Sections 8 and 9, students investigate different proposals for a road that would go through the Serengeti National Park. As they complete these activities, they are engaging with the claimed DCI.
  - o Lesson 11: Students complete the American Prairie Transfer Task. As they do so, they are asked to analyze data and respond to the following prompt, "Based on the information presented in the graph, what are three ways human activities may have impacted the bison population?" Additionally, they are asked to explain how overexploitation of bison changed the ecosystem. As they do so, they are engaging with the claimed DCI.

LS2.D: Social Interactions and Group Behavior
- *Group behavior* ~~has evolved because~~ *membership can increase the chances of survival for individuals and their* ~~genetic~~ *relatives.*
  - o Lesson 7: After participating in the Serengeti Agent Model game, students analyze their data using the Data Analysis handout. The Lesson 7 Where We are Going and Not Going section specifically states that the evolutionary component is not addressed in the lesson. Students are asked "When an agent was successful, how could their success impact the rest of the group?" Example student responses include: "If a wildebeest survived it would stay with the group and then help protect the rest of the herd." And "If a lion or a hyena was successful and got food it would bring it back to the group and they would all eat and that helps them survive". Students therefore begin to build toward this high school-level element.

LS4.D: Biodiversity and Humans
- *Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation,*

overexploitation, habitat destruction, pollution, introduction of invasive species, ~~and climate change.~~ Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

- o Lesson 11, American Prairie Reserve Transfer Task: Students read about biodiversity and are told that it is an important part of conserving an ecosystem. Students also describe the priorities valued by residents and tourists of the American Prairie Reserve. As they do so, they are most likely engaging with the following portion of the claimed DCI, "*Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through ~~overpopulation,~~ overexploitation, habitat destruction, ~~pollution, introduction of invasive species, and climate change~~. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value*."

ESS3C: Human Impacts on Earth Systems
- *The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.*
  - o Lesson 1:Students are introduced to a reading about the 30 by 30 Initiative. Students engage with this reading compilation for the purpose of obtaining scientific and/or technical information about the Initiative. As they do so, they are using the claimed DCI. In Section 7, students complete conservation profiles where they look at the system, the components of the system, the interactions within the system, and impacts [human] decision making have had on the system. As they look at the impacts of human decision making, it is likely that students are using the claimed DCI element. In Section 8, a suggested teacher feedback prompt is "Does your system have high biodiversity? Why is this important to humans?"
  - o Lesson 2: Students share the information they have gathered during the scavenger hunt in small groups as they complete a graphic organizer. As they do so, students are engaging with the claimed DCI.
  - o Lesson 9, Section 8: Students investigate the potential environmental impact of several proposed roads within the Serengeti National Park. As they complete the investigation/evaluation they are engaging with the claimed DCI.

ETS1.B: Developing Possible Solutions
- *When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.*
  - o Lesson 9, Section 9: Students review the different proposals for the road through the Serengeti. As they review the proposals, they complete the Road Proposal Organizer, in which they consider various criteria and constraints in relation to their priorities to different interest holders (tourists, conservationists, Elipkea Urio youth leader, etc.). Students therefore may be building toward an understanding of this element.
  - o Lesson 11, American Prairie Reserve Transfer Task: Students are asked to identify priorities and predict potential consequences of proposed conservation plans. As they do so, they are using the following portion of the claimed DCI, "*When evaluating solutions it is important to take into account a range of ~~constraints~~ including cost, ~~safety, reliability~~ and aesthetics and to consider social, cultural and environmental impacts.*"

Crosscutting Concepts (CCCs) | Rating: Adequate

The reviewers found adequate evidence that students can use or develop the CCCs in this unit. However, there are some mismatches between the elements the unit claims and the elements that students use or develop in the unit.

Patterns
- *Mathematical representations are needed to identify some patterns.*
  - Lesson 7, Section 12: Students complete the Data Analysis handout which asks specific questions to support them as they make sense of the data generated during the Serengeti game. Specifically, students are asked, "How do the algorithms for all three agents help you identify a pattern?" As they answer this question, students build toward an understanding of this element.
- *Empirical evidence is needed to identify patterns.*
  - Lesson 3: Students are told that the population data that Dr. Mduma shared in the video is empirical evidence and add this definition to their personal glossaries. As they do so, they are building toward an understanding of the claimed CCC.

Cause and Effect
- *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*
  - Lesson 4: This element is claimed. Students analyze graphs created with the CODAP program to determine if there is evidence for the claim that wildebeest migration is related to rainfall patterns. The teacher is also told "Students use empirical evidence collected from observations of wildebeest occupancy and rainfall. Remind them that they used empirical evidence in Lesson 3 when they investigated mortality patterns. Here, students begin to distinguish between *correlation,* that rainfall pattern and wildebeest location are related, and *cause,* that the rainfall pattern causes wildebeest migration."
- *Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.*
  - Lesson 1, Section 7: Students complete conservation profiles where they look at the system, the components of the system, the interactions within the system, and [human] decision making. As they do so, they are engaging with the claimed CCC.

Scale, Proportion, and Quantity
- *The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.*
  - Lesson 4, Section 15: The following teacher prompt is provided to support students as they share ideas about the relationships they have observed in the CODAP graphs, "What can these relationships at the scale of the region tell us about wildebeest, rain, and food across the whole Serengeti?" Students are therefore supported to begin building toward an understanding of this element.
  - Lesson 6, African Dog Transfer Task: Students are presented with the following question in 8c, "To date, the reintroduction of the African wild dogs to Liwonde National Park is seen as a success story. Many people would like to replicate this project at the scale of the African continent and reestablish wild dog populations in the countries they used to live in. What recommendations would you make to help them

accomplish this?" As they answer this question, it is likely that they will use the claimed CCC to support their thinking. Note, however, there is no evidence that students are required to do so and it may be that students will rely on an element of Cause and Effect when answering.

- *Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.*
  - o Lesson 4, Section 2: This element is not claimed. Students are presented with the prompt that states, "Today, scientists can measure food by fencing off a small area and studying it. What might make it hard to measure food directly even today across the whole Serengeti? As students respond to the prompt, they are using this element.
  - o Lesson 4, Section 3: This element is not claimed. The following guidance is provided for teachers, "*Since we have this idea that rain can help us figure out how much food there is, I found some data from the rain gauges around the Serengeti. Even with rainfall, we have to select a few carefully chosen locations to measure rainfall, because the scale of the Serengeti is so big. These locations were chosen because they look very different from one another but all have wildebeest at some times in the year.*" Students are therefore supported to engage with this element.

Systems and System Models
- *Systems can be designed to do specific tasks.*
  - o Lesson 7, Section 12: Question #4 of the Data Analysis handout states "Our game was designed to model interactions in the Serengeti system. How well did our design of the game support that goal? What recommendations would you make to revise the game system?" As students answer the question, they are using the claimed CCC.
- *Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.*
  - o Lesson 5, Section 7 students are asked, "How did the scale of the wildebeest population and time (the number of rounds we simulated) limit our understanding of the system? .... What data would help our understanding of the system at the scale of the Serengeti ecosystem over long periods of time?" As students answer these questions, they are using the claimed CCC.
- *Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.*
  - o Lesson 7: Students engage with a game that models the Serengeti ecosystem where they collect data. Later, students analyze the data using the Data Analysis Handout. As students complete question 5 of that document, they have to identify the assumptions and limitations of the model. As they do so, they are using the claimed CCC.
  - o Lesson 8, Section 6: Students use the SageModeler program to simulate the effects of disturbances (rain, disease, or fire) on the Serengeti ecosystem. A teacher follow up question states "What is missing from the model?" In the class discussions, students are inherently building toward the claimed CCC. However, students may not be using this CCC element to support their sense-making.

Stability and Change
- *Much of science deals with constructing explanations of how things change and how they remain stable.*
  - o Lesson 1, In the Conservation Profile Organizer handout, students are asked "How have the lands, waters, species, and kinds in the area been affected by human activity and

human decision-making, and how are they being affected now? What decisions were made about the land? Will those decisions make the system more stable?" Students might therefore begin to build an understanding that science includes considering why things change and why they remain stable.

- o Lesson 2: Students share the information they have gathered during the scavenger hunt in small groups as they complete a graphic organizer. Students are asked "How have these relationships changed and/or stayed the same over time?" They therefore might implicitly be building toward an understanding that science often involves answering questions like this.
- o Lesson 4, Sections 6 and 10: Students engage in discussions about patterns they have uncovered when analyzing the data displays they created in the CODAP program. As they do so, they may be approaching the claimed CCC, but students are most likely using the following Grade 6–8 element in their sense-making about the changes in grass growth and in wildebeest location, "*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.~~*"
- o Lesson 8, Section 7: Students engage in consensus discussions in which they discuss, "predictions and the effects on components and the system." The suggested prompts, such as "Why is the Serengeti ecosystem resistant to these disturbances?" support students in implicitly building toward an understanding that science often asks these kinds of questions. However, it is likely that students are using the following Grade 6–8 elements to support their sense-making:
  - ▪ *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~~.*
  - ▪ *Stability might be disturbed either by sudden events or gradual changes that accumulate over time.*
- o Lesson 9, Section 5: Students engage in discussions about the Serengeti Conservation Plan and are asked "What data do we have that can support claims about the stability of the wildebeest population over time?" In the Road Proposal Evaluation students are asked "How will the Serengeti ecosystem be impacted by this decision? Use words and/or pictures to predict impacts to the wildebeest migration and ecosystem. Consider which components will change and which will stay the same". Students are therefore building toward an understanding of this element.
- o Lesson 10, Section 9: Students present an evaluation of their conservation plan to their classmates. Students respond to prompts such as "The 30 by 30 Initiative set a goal of conserving 30% of US lands and waters by 2030. How can what we figured out help us make progress on that?" As they do so, they may be using the claimed CCC element.
- *Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.*
  - o Lesson 5, Section 8: Students analyze data about wildebeest populations and compute rates of change for these populations. As they do so, they inherently using the claimed CCC. However, it is likely that this CCC element will be subsumed under the SEP **Using Mathematical and Computational Thinking** so it may not be clear to students that they are using this element to support their sense-making.
- *Systems can be designed for greater or lesser stability.*
  - Lesson 2, Section 5: Students engage in an Information Scavenger Hunt to find out more about the Serengeti National Park and why it was established. In Section 8,

students share what they have learned by completing a graphic organizer. The teacher is told to "Point out to students that the entire ecosystem has a different boundary than the park system".

Suggestions for Improvement

Science and Engineering Practices
- None

Disciplinary Core Ideas
- Providing students with more opportunities to engage deeply with grade-appropriate DCI elements could strengthen the evidence for this criterion.

Crosscutting Concepts
- Consider choosing a smaller number of CCC elements as learning targets in the unit.
- For elements intended to be fully developed during the unit, consider including opportunities for students to learn about the elements and how to use them, and prompting educators to explicitly facilitate students to fully develop and use the claimed elements. For example, providing explicit instruction related to the targeted CCC elements would help ensure that all students could develop understanding.

I.C. INTEGRATING THE THREE DIMENSIONS

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena or designing solutions to problems. Students have several opportunities to use multiple dimensions together in service of sense-making. However, they often use elements in these performances that are from the middle school grade-level.

Some examples include:
- Lesson 2, Sections 3 and 5: Students gather information about the Serengeti National Park through a series of readings. They share this information in small groups in Section 8. Students develop and use the following elements:
  - SEP: *Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.*
  - DCI: ***ESS3C:*** *The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.*

- o CCC: Students use a Grade 6–8 element. *Stability might be disturbed either by sudden events or gradual changes that accumulate over time.*
- Lesson 3, Section 9: Students engage in a group discussion to create a consensus model to explain wildebeest migration. Students develop and use the following elements:
  - o SEP: *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
  - o DCI: ~~*Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.*~~ *These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ~~Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.~~*
  - o CCC: Students use a Grade 6–8 element. *Patterns can be used to identify cause and effect relationships.*
- Lesson 4, Section 11: Students are introduced to COPAD data containing information related to region, total annual rainfall, and wildebeest percentages and record their observations. In Section 12, students analyze the graphs that they have generated using the CODAP program to determine if there is a correlation between annual rainfall and wildebeest populations. Students develop and use the following elements:
  - o SEP: *Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.*
  - o DCI: **LS2A**: ~~*Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.*~~ *These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ~~Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.~~*
  - o CCC:
    - ▪ Students are implicitly using the element, "*Mathematical representations are needed to identify some patterns.*"
    - ▪ Students are most likely explicitly using an unclaimed element of **Cause and Effect,** "*Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*"
- Lesson 5, Sections 3–5: Students engage with the Serengeti Kinesthetic Model activity. In Section 9, they engage in whole group discussions about the kinesthetic Model activity. Students develop and use the following elements:
  - o SEP: Students are using an unclaimed element from **Developing and Using Models**, "~~*Develop, revise, and/or*~~ *use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*"
  - o DCI: **LS2A**: *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are*

finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

- o CCC: Students use a Grade 6–8 element of **Systems and System Models**, *"Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems."*

- Lesson 6: Students engage in the African Wild Dog Transfer Task to demonstrate their understanding of limiting factors and carrying capacity in ecosystems. Students develop and use the following elements:
  - o SEP: *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
  - o DCI: *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.*
  - o CCC: Students demonstrate understanding of a Grade 9–12 **Stability and Change** element, *"The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs."*

- Lesson 9, Section 4: Students work collaboratively to revise the class consensus model developed in Lesson 8 to incorporate humans and their interactions. They engage in a class discussion about this in Section 5. Students develop and use the following elements:
  - o SEP: **Developing and Using Models**: *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
  - o DCI: **LS2C**: *Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, ~~and climate change~~—can disrupt an ecosystem and threaten the survival of some species.*
  - o CCC: *Much of science deals with constructing explanations of how things change and how they remain stable.*

Students engage in some two-dimensional performances. However, these performances are often identified as three-dimensional. For example, in Lesson 11, students engage in the American Prairie Reserve Transfer Task to demonstrate their learning from the entire unit. This activity is claimed in the Teacher Edition to integrate all three dimensions.

- o DCI: Students use and understand portions of the targeted elements from **LS2.C**, **LS4.D**, and **ETS1.B**.
- o SEP: Students engage with a grade 9–12 **Constructing Explanations and Designing Solutions** element. However, students are not actually required to demonstrate knowledge of the entire element.
- o CCC: Students engage with a grade 9–12 **Stability and Change** element, *"Much of science deals with constructing explanations of how things change and how they remain stable."* However, it is unclear how students address this specific element within this task.

Suggestions for Improvement

- See suggestions for I.B to provide students with more opportunities to engage with grade-appropriate DCI and CCC elements.

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that lessons fit together coherently to target a set of performance expectations. The materials are arranged in such a way as to allow students to see the connections in learning from one lesson to another and students are supported in building proficiency in most of the targeted learning goals. However, students are often engaging with elements of the CCCs that are below grade level.

Related evidence includes:
- Students are given numerous opportunities to ask questions, track their learning progress related to those questions, and collaborate to develop new questions.
  - Lesson 1, Section 16: Students work collaboratively to create the DQB.
  - Lesson 2, Section 1: Students return to the DQB to remind themselves of what they wanted to learn after Lesson 1.
  - Lesson 2, Section 12: Students generate questions about the Serengeti National Park on their Progress Trackers and add those questions to the DQB.
  - Lesson 6, Section 10: Students return to the DQB to identify questions that they have answered and add new questions to the DQB.
  - Lesson 8, Section 10: Students return to the DQB and are prompted to, "celebrate the progress they have made." Students are given additional opportunities to add to the DQB.
  - Lesson 10, Section 13: Students evaluate which questions, or portions of questions, have been answered on the DQB.
- Coherent links are made throughout the unit. Some examples include:
  - Lesson 2, Section 11: Students are introduced to the Ecosystem Progress Tracker to keep track of their learning related to ecosystems and the 30 by 30 Initiative. Students update the Progress Tracker in Lesson 5, Section 10; Lesson 6, Section 1; Lesson 8, Section 8; and Lesson 10, Section 3.

o   Lesson 2, Section 10: Students work collaboratively to create a consensus model about conservation of the Serengeti National Park. Students update the Serengeti consensus model in Lesson 3, Section 9; Lesson 4, Section 20; and Lesson 9, Section 4.

Students are supported in building proficiency in most of the targeted PEs. However, students do not have opportunities to develop and use a majority of the grade-appropriate CCC elements from the PEs. Evidence of CCCs that are not developed at the grade-appropriate level can be found in Criterion I.B. Claimed PE targets are below:

- **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- **HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
- **HS-LS4-6** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- **HS-ESS3-3** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Suggestions for Improvement
- Consider reducing the number of PEs that are claimed as targets in the unit.
- Consider providing students with opportunities to explicitly engage with grade-level appropriate elements of the CCCs. See suggestions in I.B and I.C.
- Consider more explicitly connecting each lesson to the 30 by 30 Initiative or providing ways teachers can address the 30 by 30 Initiative when providing students with opportunities to update the DQB or their Ecosystem Progress Trackers.

I.E. MULTIPLE SCIENCE DOMAINS

When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

    i.   Disciplinary core ideas from different disciplines are used together to explain phenomena.

    ii.   The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that links are made across the science domains when appropriate because students are supported to understand the connections between multiple science domains, Earth and space science (ESS), and life science (LS), while making sense of the anchoring phenomenon. However, students are not supported in explicitly using elements from CCCs to make connections across the two domains and student use of the CCCs is often below grade level.

Related evidence includes:
- Explaining how human impacts on the environment can cause disruptions that ultimately require humans to responsibly manage natural resources can be accomplished using grade-appropriate elements from the targeted LS and ESS domains.
- Student use of the CCC elements is not always grade appropriate and students are not supported to see how CCC elements can be used across scientific domains.

Suggestions for Improvement
Consider supporting students in explicitly using grade-appropriate elements of the CCCs to make connections across science domains. See suggestions in I.B and I.C.

I.F. MATH AND ELA

Ecosystems Interactions & Dynamics
EQuIP RUBRIC FOR SCIENCE EVALUATION

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.	
Rating for Criterion I.F. Math and ELA	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics, English language arts (ELA), history, social studies, or technical standards. In addition to specific CCSS being claimed and used by the students, there are multiple opportunities for students to speak and listen to their peers and they are provided with reading materials that go beyond the textbook.

Related evidence includes:
- Lesson 1: CCSS.**ELA-Literacy.RST.11-12.2** *Determine the central conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.*
  - Students read the 30 by 30 Initiative reading and then, "After students have had a few minutes to individually record their noticings and wonderings, ask them to turn and talk to a partner to share their ideas. Each partner should share for one minute while the other student listens, and then they should switch. Call on a few pairs to share their ideas. Consider asking students to summarize in the whole group what their partner shared with them" (Teacher Edition, page 29).
- Lesson 2: **RST.11-12.1** *Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.*
  - This standard is claimed for Lesson 2 and the Additional Teacher Guidance on page 61 suggests that this will be met through evidence collected through *Peat and Permafrost* but the reviewers were unable to locate this resource in the provided materials.
- Lesson 3: CCSS.**Math.Content.HSS-IC.3** *Recognize the purpose of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*
  - Students review data from observational studies about wildebeests and the changes among populations throughout the migration season. Students recognize and use the differences among the samples to support their ideas for why wildebeest migrate.
- Lesson 5: CCSS.**Math.Content.HS.F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate rate of change from a graph.*
  - "Students use historical data from the graph on Wildebeest Population Data to calculate the rate of change for the wildebeest population at three specified time intervals to deepen their understanding of limiting factors and carrying capacity in the Serengeti" (Teacher Edition, page 128).
- Lesson 6: CCSS.**Math.Content.HS.N-Q1** *Use units as a way to understand problems and to guide the solution of multi-step problems, choose and interpret units consistently in formulas, choose and interpret the scale and the origin in graphs and data displays.*
  - "Students will interpret the scale of multiple graphs and choose the appropriate scale to build two graphs to answer questions in African Wild Dog Transfer Task" (Teacher Edition, page 142).

- Lesson 7: **RST.11-12.7** *Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.*
  - "Students use information from a reading, summarized from scientific literature, and data from their own investigations to answer questions about predator and prey interaction in the Serengeti" (Teacher Edition, page 158).
- Lesson 7: CCSS.**Math.Practice.MP2** *Reason abstractly and quantitatively.*
  - "Students develop algorithms in words and numerals to reason about their data and how it provides evidence to answer their question" (Teacher Edition, page 158).
- Lesson 8: CCSS.**Math.Practice.MP4** *Model with mathematics.*
  - "Students develop mathematical representations using computer-based models that include direction, magnitude, and graphical representation of relationships" (Teacher Edition, page 182).
- Lesson 9: **WHST.9-10.7** *Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.*
  - Students evaluate different options for roads through provided road proposal readings to determine the possible impact of each road on the Serengeti National Park ecosystem.
- Lesson 10: **RST.9-10.8** *Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.*
  - "Students read about a specific conservation plan from their conservation profile. Students will look at the data from a data packet to use as evidence to evaluate if the conservation plan is successful" (Teacher Edition, page 214).

Suggestions for Improvement
None

OVERALL CATEGORY I SCORE: 2	
Unit Scoring Guide – Category I	
Criteria A-F	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students have opportunities to experience phenomena and problems as directly as possible and the unit includes suggestions for how teachers can help connect instruction to students' lives.

Students experience the anchor phenomena/problem directly.
- Lesson 1: Students are introduced to the 30 by 30 Initiative through a reading and a video.
- Lesson 2: Students are introduced to the Serengeti National Park through videos, maps, and readings.
- Lesson 3: Students are introduced to wildebeest migration patterns through maps and videos.

Suggestions for how to connect to students' lives and communities are provided. Some examples include:
- Lesson 1: Students are asked to share "lands or waters" that they have "visited, read about, or learned about that have been conserved."
- Lesson 1: In the Conservation Home Learning activity students connect the concepts of conservation to their own experience "by talking to family members, friends, or neighbors about lands and waters that they know about that have been conserved or that people might be motivated to conserve" (Teacher Edition, page 32). Later the teacher is told, "Organize students into small groups of 3-4 and ask them to share what they discovered through their home learning. Call on a few group members to share one example they heard from their group. Keep a public record of student contributions on the whiteboard" (Teacher Edition, page 33).
- Lesson 4: Students are supported in using personal or everyday examples to understand correlations between events. The Additional Guidance for this lesson states, "If your students need additional scaffolding in interpreting mathematical representations, draw on everyday examples by asking them to think about two things that increase or decrease together" (Teacher Edition, page 99).

- Lesson 4: Students review graphs of rainfall data from the Serengeti National Park. "To help students make sense of the rainfall data, consider asking them about local seasonal rainfall patterns where you live" (Teacher Edition, page 90).
- Lesson 5: Students begin to develop algorithms to understand and analyze collected data. The teacher is told, "Draw on students' prior knowledge from middle school, their mathematics classes, and their everyday lives. In middle school, they may have engaged in mathematics and computational thinking (SEP 5) by creating algorithms as a series of ordered steps to solve a problem (NGSS Appendix F). In their everyday lives, students may be familiar with algorithms that determine what posts they see in their social media feed or which songs they hear in a playlist in a music app. Remind them that these algorithms are based on data generated by the components of a system (them!)" (Teacher Edition, page 116).
- Lesson 9: Students are supported to brainstorm ways that humans interact with the Serengeti National Park Ecosystem. The Additional Guidance for this section tells the teacher, "Support students in using these personal examples to draw connections to the Serengeti. Students might share some of the following interactions: keeping things like mold, or insects or other pests out of where they live, keeping predators away from their livestock or pets, visiting protected spaces for recreation, people working and even sometimes living in a protected space. Help students make connections between their experiences and experiences people living, working or visiting the Serengeti might have" (Teacher Edition, page 189).

Suggestions for Improvement
None

II.B. STUDENT IDEAS

Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas.

Students have multiple opportunities to express, clarify, justify, and represent their ideas. Some examples include:
- Lesson 1, Section 1: Students are given opportunities to turn and talk to share their initial notices and wonderings.
- Lesson 1, Section 3: Students are guided to develop Community Agreements to support class discussions. These Community Agreements are revisited in Lessons 2, 5, 6, 7, 8, and 10.
- Lesson 1, Section 8: Students develop initial models in small groups. Students complete a gallery walk of the initial models to share their ideas with their peers.

- Lesson 1, Section 15: Students share patterns that they have observed across the conservation profiles. These are then shared with the whole class.
- Lesson 2, Section 10: Students develop a consensus model through a Scientist Circle. The teacher is told, "Your role is to help students see where they agree and where they still disagree" (Teacher Edition, page 55).
- Lesson 3, Section 8: Students share data in a Stand Up, Hand Up, Group Up activity. Students are directed to record the similarities, differences, and any questions they may have because of this activity.
- Lesson 3, Section 9: Students engage in whole-class discussions after receiving the Analyzing Wildebeest Data Cards activity. Later in the discussion the teacher is supplied with suggested prompts to elicit student ideas and follow-up questions designed to support students justifying their responses.
- Lesson 4, Sections 4 and 5: Students work in small groups to generate graphs of data using the CODAP program. Students then engage in whole group discussions about their findings using their data to support their ideas. The teacher is given guidance to, "invite students to share conclusions and claims and push them to support their conclusions and claims with evidence" (Teacher Edition, page 91).
- Lesson 4, Section 16: Students are given an opportunity to revise their initial answer to their Wildebeest and Rainfall document after participating in group discussions.
- Lesson 4, Section 20: The class revises the Serengeti consensus model. Students then turn and talk to their partners to share their ideas.
- Lesson 5, Section 7: Students are directed to turn and talk about the provided questions.
- Lesson 6, Section 3: Students work in pairs to complete the transfer task. Teacher guidance is provided that states, "Before students move into pairs, revisit the agreements your class wrote for group work – for example, our commitment to an equitable classroom community where everyone's participation and ideas are valuable – and discuss productive ways to complete the transfer task together. It is important to involve both partners in writing all answers rather than dividing up the questions between them because the transfer task is a story that builds. Before writing an answer, they should discuss their strategy or intention with their partner. If they are making a calculation, they can write it down to show their partner what they are trying to do, so the other person can check the work and discuss alternatives. They might assign one person to read and one person to write. The person who reads could also be sure to reread the question once the answer is 'complete' to make sure they answered all portions of the question and supported the answer as appropriate" (Teacher Edition, page 135).
- Lesson 7, Section 5: Students make sense of the game rules in small groups before playing the Serengeti Board Game simulation. Students "summarize/paraphrase" the rules and discuss them in small groups.
- Lesson 8, Section 2: Students read articles about the Serengeti. They are then assigned to small groups where they share, and receive, information from the articles with their peers.
- Lesson 9, Section 8: Students engage in a Turn and Talk activity to discuss a proposed road which would go through the Serengeti National Park. Groups of students then share their ideas with the whole group.
- Lesson 10, Section 6: Students engage in a Turn and Talk activity to discuss the Conservation Evaluation Tool and to share their ideas for next steps.
- Lesson 10, Section 13: Students revisit the DQB to determine the group progress on the questions they originally developed.

Students have multiple, structured opportunities to receive and respond to peer feedback. Students have opportunities to receive teacher feedback. However, guidance for the feedback students should provide to peers or the teacher should provide to students is often not present. Some examples include:

- Lesson 1, Section 7: Teacher guidance is provided to take up the Conservation Profile Graphic Organizer and "provide written feedback" to students.
- Lesson 1, Section 8: Teacher guidance is provided to collect the individual student models and provide written feedback that students can use later when they revise their models (Section 11).
- Lesson 3, Section 4: Teacher guidance is provided to collect Analyzing Wildebeest Data Cards from each student and provide written feedback, using the prompts on the key as guidance. The key provides guidance for what the teacher should look for in student responses, which could also provide some guidance for the teacher on the feedback they can provide. However, this guidance is implicit for teachers.
- Lesson 4, Section 16: Guidance is provided to pair struggling students and have them share their feedback.
- Lesson 5, Section 2: After students complete a Turn and Talk activity with a partner to share ideas about what else needs to be investigated, the teacher is told to say, "I heard many of you say we need a way to simulate what is happening in the Serengeti with wildebeest and food. If we were to do this, what are all the parts of the system we would want to include to help us figure out how the wildebeest population can be so big? Listen for students to identify wildebeest and grass as components. Record these on whiteboard or chart paper" (Teacher Edition, page 112).
- Lesson 6, Section 8: Students provide peer feedback following a transfer task. Students are then provided with time to, "independently to incorporate the peer feedback into a revision of their original answer to question 8."
- Lesson 9, Section 10: Teacher guidance is provided to collect student work and provide feedback. In Section 13, students are provided with time to revise their thinking in response to the feedback they have received.

Suggestions for Improvement
None

II.C. BUILDING PROGRESSIONS

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

Ecosystems Interactions & Dynamics
EQuIP RUBRIC FOR SCIENCE EVALUATION

Rating for Criterion II.C. Building Progressions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because prior student learning expected for the dimensions is identified in the materials and a learning progressions chart is included. However, the materials do not identify the expected level of proficiency students should have for each element of the three dimensions. Additionally, while the materials do point out how each lesson fits with the one that immediately preceded it and the one that follows, there is no guidance provided for teachers regarding how elements of each dimension are explicitly built upon from one lesson to the next.

Related evidence includes:
- The Teacher Edition identifies the DCI elements that students should have prior knowledge of from previous grade bands (page 15) and states, "This unit uses and builds upon disciplinary core ideas (DCIs) and other science ideas that students should have previously developed in OpenSciEd Middle School or another middle school science program" (Teacher Edition, page 15).
- The Teacher Edition identifies SEPs and CCCs "that students should have previously developed in OpenSciEd Middle School or another middle school program." (page 16). The Teacher Edition states the specific OpenSciEd units where students should have developed the SEPs and CCCs and which lessons in this unit students will continue to develop those SEPs and CCCs. However, individual elemental level of prior proficiency is not included.
- The Teacher Edition states, "Students will come into the unit with many ideas about conservation and ecosystems derived from previous classroom experiences, intuitive understandings of the way the world works, everyday experiences with nature, and the conversations they have had with parents, friends, and family members." There are also several lesson specific concepts that students may already hold which are explained (Teacher Edition, page 16).
- The Teacher Edition includes information related to prior learning in mathematics concepts. "This unit does not assume students are fluent with the mathematical practices listed below, but that students develop these practices as part of the sense-making. Thus these standards are not so much prerequisites, as co-requisites. If students are simultaneously developing the skills and vocabulary in math class, you can help by making explicit connections to the mathematical standards below" (Teacher Edition, page 17).
- Lesson 1: In the Additional Guidance section of Lesson 1, teacher guidance is provided regarding student's prior experiences with the OpenSciEd Unit 7.5. Additionally, guidance is provided if students have not had this specific prior experience (Teacher Edition, page 28).
- Lesson 3: In the Where We Are Going portion of the lesson it states that, "(HS-LS2.A.1) Students engage in a portion of this DCI element as they explore and explain why wildebeest are migrating. Students will build out the rest of this DCI element in the following lessons. Here students build on middle school-level understanding of different ecosystem interactions (MS-LS1.B.3 and MS-LS2.A.2)" (Teacher Edition, page 66).
- Lesson 4: In the Where We Are Going portion of the lesson it states, "Students also use stability and change to look at seasonal changes over time to recognize patterns that repeat each year. They build on middle school use of this crosscutting concept, in which they examine changes over time and at different scales and build on their prior use in this unit. Students worked with

stability and change in Lessons 2 and 3 to make sense of changes over time and instances of stability in the Serengeti system" (Teacher Edition, page 87).

- Lesson 5: In the Where We Are Going portion of the lesson it explains, "In Lessons 3-4, they made sense of limiting factors and how they might affect the population of migrating wildebeest. Here they build on the idea of limiting factors as they figure out how they impact carrying capacity." Additionally, it explains, "Students should be familiar with using graphs, algorithms, and rates from middle school practice as well as mathematical representations in the form of graphs in Lesson 4 to support conclusions about the relationship between variables. Here they use these aspects of the mathematics and computational thinking practice to support their explanations" (Teacher Edition, page 111).
- Lesson 6: In the Where We Are Going portion of the lesson it explains, "In this lesson, students build on what they figured out in Lessons 2–5 about limiting factors and carrying capacity to explain the interactions between wildebeest and their predators in the Serengeti, specifically, disciplinary core idea HS LS2.D.1: Group behavior membership can increase the chances of survival for individuals and their genetic relatives. This DCI explains the mechanism behind outcomes that result from interactions between wildebeest and their predators in the Serengeti. Students build on a middle school understanding that animals engage in characteristic behaviors that increase the odds of reproduction (MS LS1.B)" (Teacher Edition, page 147).
- Lesson 8–10: The Where We Are Going portion of the lesson provides details explaining links to prior DCIs, SEPs, and CCCs that have been introduced and how the lesson builds upon prior learning.

Suggestions for Improvement
- Consider revisions which explicitly state the expected level of proficiency students should have for all elements of the three dimensions, including SEPs and CCCs.
- Consider revisions to the Where We Are Going sections that would clearly describe for teachers how all three dimensions progress from one lesson to the next.

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials use scientifically accurate and grade-appropriate scientific information because students . All science ideas and representations are accurate, students have access to real world data, and the materials have resources which ensure the teacher has access to scientifically accurate information.

Suggestions for Improvement
None

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

i. Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because there is evidence of strategies to explicitly support students who are struggling with learning targets, read below grade level, or are multilingual learners. However, there is no guidance provided for adaptations should a student enter the lesson with prior learning proficiency levels significantly above or below those expected for the lesson. Additionally, there are limited supports for students who have already met the performance expectations or have a significant interest in the subject matter.

Related evidence includes:

Some strategies are provided to address the needs of needs of multilingual learners, learners with disabilities and those who read below grade level. Some examples include:

- Lesson 1: When students are developing their Notice and Wonder chart there is a callout included with the following support, "Students should be encouraged to record their ideas using linguistic (e.g., written words) and nonlinguistic modes (e.g., photographs, drawings, tables, graphs, mathematical equations, measurements). This is especially important for emergent multilingual students because making connections between written words and nonlinguistic representations helps students generate richer explanations of scientific phenomena" (Teacher Edition, page 28).
- Lesson 1: The following support is suggested for students during a discussion, "Allow and encourage students to speak using both content-specific and everyday words and phrases when expressing their ideas. This helps students fully express themselves, allowing others to question, evaluate, and build off their ideas. Switching back and forth between different

registers is especially important for emergent multilingual students because it helps them draw on their full range of meaning-making resources" (Teacher Edition, page 32).

- Lesson 2: "Alternative strategies for recording this information in different modalities for students with disabilities or multilingual learners could include voice memos or taking photos of key ideas to review later. Students who need more time to process or translate information before writing can review these recordings and fill in Scavenger Hunt Notes at home before the next class" (Teacher Edition, page 53).
- Lesson 3: "When developing new vocabulary, strategies that may benefit emergent multilingual learners are to use student-friendly definitions, make connections to cognate words when possible, and encourage students to include a visual representation of the word. Use these strategies throughout the unit for both 'definitions we co-construct' and 'definitions we encounter'" (Teacher Edition, page 68).
- Lesson 3: "It can be very helpful for all students, and particularly emergent multilinguals, to provide some context, purpose, and support in how to share and discuss the data displays. Remind students that our goal is to observe and record the similar and different patterns that connect to our ideas and predictions about wildebeest migration. While there are some physical similarities and differences in how different groups chose to display their patterns, we want to focus and record the patterns that connect to wildebeest migration. To further help students discuss these patterns, provide them with the following sentence starters" (Teacher Edition, page 73). Several sentence frames are then included in the Attending to Equity sidebar.
- Lesson 5: "It is helpful to intentionally group emerging multilingual students with certain peers. Sometimes this could be peers who know the same languages as them, while other times it could be peers whose English language development is slightly more advanced. It is important that this grouping be thoughtful and that it varies throughout the course of a unit so that students benefit from working with different peers" (Teacher Edition, page 119).
- Lesson 5: "Throughout this unit, there will be instances in which the students immediately engage in whole-group discussion. Insert a partner talk prior to the whole-group discussion if you believe this would benefit your students' ability to communicate and express their ideas" (Teacher Edition, page 121).
- Lesson 7: "Before students engage in whole class discussions, it can be helpful to first provide them with the opportunity to work with others - either in pairs, triads, or small groups - on ideas related to their reasoning. These smaller group structures can be especially helpful for emerging multilingual students because they offer students a chance to engage in sensemaking with their peers and also offer them the space to use their linguistic and nonlinguistic resources to express their ideas (and learn from other students' uses of these resources too)" (Teacher Edition, page 148).
- Lesson 8: "Encourage students to record their ideas using linguistic (e.g., written words) and/or nonlinguistic modes (e.g., photographs, drawings, tables, graphs, mathematical equations, measurements). This is especially important for emergent multilingual students because making connections between written words and nonlinguistic representations helps students generate richer explanations of scientific phenomena. Have students use the literacy strategies in place in your school, such as close reading, graphic organizers, read aloud, or partner reading" (Teacher Edition, page 166).

Some options are provided that could help students who are struggling to meet the learning targets. However, some of the differentiation strategies do not specify the student groups they are targeted for. Some examples include:

- Lesson 1: While developing the DQB, the following support is suggested, "If students struggle to identify questions, encourage them to revisit their notes from the lesson and their initial models. Ask students to recall the things they have done so far in the lesson to refresh their memories about what questions they had" (Teacher Edition, page 39).
- Lesson 4: "If your students need additional scaffolding in interpreting mathematical representations, draw on everyday examples by asking them to think about two things that increase or decrease together" (Teacher Edition, page 99).
- Lesson 4: Students are grouped together to work on Data Excursion Part 2: The teacher is told to, "Organize students into small groups of 2-4; consider drawing on the Exit Ticket responses to form heterogeneous groups based on students' abilities to support claims with adequate evidence" (Teacher Edition, page 97). However, it is unclear if this ability grouping is based only on Exit Ticket responses or the teacher's general knowledge about student ability.
- Lesson 5: "To increase access, you can print the slide of the mapping tool and provide it as a handout to students who may need more scaffolding in developing and using models" (Teacher Edition, page 113).
- Lesson 5: "If students struggle to use mathematical and computational thinking to analyze their data, support them by helping them visualize the data numerically or with words. Have students use various groupings, like breaking down the graph into 5-year spans. Once students have identified the change during those five years, have them write it directly on their graphs and move on to the next 5-year span. Alternatively, you could have students explain orally, and you could scribe their thinking for them" (Teacher Edition, page 120).
- Lesson 7: "If students struggle with a passage from the reading, ask them to point at the words or segments that are not clear to them. Encourage them to reword difficult sentences, and if there are terms they are not familiar with, help them define these in their own words. The use of both content-specific and everyday vocabulary to express ideas is an effective strategy for supporting emerging multilingual learners" (Teacher Edition, page 150).
- Lesson 7: "Not all students will be ready to write numeric algorithms. Consider pairing up students who are working on written algorithms and those that are working on numeric. They will have different data, but can support each other in structuring the algorithm and placing the correct evidence. Students working on written algorithms only can also work on developing system models that include the percentages for the outcomes" (Teacher Edition, page 155).
- Lesson 8: "Support students as they work in their small groups. If students are struggling with identifying the interactions between components, refer students back to their articles. Push students to identify particular information from their article that mentions interactions. If students struggle to create a graph (mathematical representations) or if/then statement, refer back to the thinking they did in Lessons 4 and 5. Additionally, ask questions that will get students to think about the mechanism for what might be causing those interactions, such as Why do you think that is happening? or What evidence is in the articles or previous lessons that would make you think that these two components interact in this way?" (Teacher Edition, page 166).

Some options are provided that could help students who have specific learning needs. However, some of the differentiation strategies do not specify the student groups they are targeted for. Some examples include:
- Lesson 3: Students collaborate to sort and review data cards to locate evidence. An Additional Guidance note states, "To support the diverse learners in your class, it may be helpful to guide groups to sort the data based on complexity" (Teacher Edition, page 71).

- Lesson 5: "Allowing students to express their ideas using multiple modalities supports student ownership of their learning by giving students choice, access, and control in navigating their own understanding around the science ideas. Consider agreeing on a set of non-verbal signals to use as a class (e.g., head nods, thumbs up, ASL signs) for signaling nonverbal agreement, disagreement, and wondering/questioning as a way to ensure equitable participation by giving students additional modalities with which to express themselves" (Teacher Edition, page 112).
- Lesson 5: "If it is something familiar to your students or part of their education plans, consider allowing students to use a digital graphing tool such as a graphing calculator or spreadsheet software to help them create their graphs. Students can take the data table and enter it into graphing software. Allowing alternatives for use of tools such as a calculator can remove barriers for students in expressing their understanding by keeping the focus on the learning goal. Use of such tools can help provide a match between a student's abilities and the demands of the task" (Teacher Edition, page 116).
- Lesson 6: In an Attending to Equity callout for Section 2, there is a suggestion for students with accommodations suggesting that teachers could provide a copy of their partner's answers to support their work on the task during the next lesson.

Some options are provided that could help students who are struggling readers. However, some of the differentiation strategies do not specify the student groups they are targeted for. Some examples include:
- Lesson 2: "Provide students with a reading strategy that builds community and teaches students to work together to understand a challenging reading. The Reading for Gist comprehension strategy is well-suited to A Brief History of the Serengeti. A description of the Reading for Gist method can be found in the OpenSciEd Teacher Handbook: High School Science and is described as follows:
    - Encourage students to read the text together. They can stop after each paragraph to paraphrase what they understood and identify items to write in the 'Notice' column of their notebooks. If they have questions as they read, they should ask their group members. If no one knows the answer, it would be a good candidate for the 'Wonder' column of their notes" (Teacher Edition, page 49). However, it is unclear if the inclusion of this support is for all students or targeted for students needing reading support.
- Lesson 8: "The Serengeti Component Articles are written at different reading levels and vary in length. You may wish to allow students to select readings based on interest before dividing them into groups. Or, at your discretion, count students into random groups 1-8, or assign them into intentional, mixed-ability reading groups with the students who need more reading support along with students who do not need the extra support" (Teacher Edition, page 165).

Some options are provided that could help students who have already met the performance expectation. However, these options do not explicitly address specific learning targets and are instead generalized instructional moves for the teacher. Some examples include:
- Lesson 4: "For students who quickly grasp the idea of positive and negative relationships between variables in graphs, you can prompt them to consider how the slope of a best fit line differs between graphs and how they could interpret that difference" (Teacher Edition, page 98). However, this suggestion only provides an extension for students on a single element.

Suggestions for Improvement
- Consider providing supports to assist teachers with presenting abstract content in small incremental steps to support students with varying abilities.

- Consider providing strategies that help students meet the targeted expectations for all three dimensions. Consider explicitly identifying these strategies with the student group that they can help support.
- Consider offering extensions that focus on the SEPs and/or the CCCs in conjunction with the DCIs for students who have already met the performance expectation.

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

Supports teachers in facilitating coherent student learning experiences over time by:

i.   Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence	Extensive (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time because teachers are provided with guidance and routines that establish and reinforce coherence from a student's perspective, although it is not clear if students will understand how their learning in all three dimensions progresses.

Related evidence includes:
- The Teacher Edition includes a Unit Storyline document which provides a brief overview of each lesson in the unit. This Unit Storyline also includes a statement explaining how to navigate to the next lesson with key learning listed.
- Each lesson includes a section at the beginning of the lesson that summarizes what the student will do in the current lesson and the next lesson (e.g., page 23). Additionally, each lesson provides an overview of each component of the lesson (e.g., page 24).
- Each lesson includes a document which summarizes Where We Are Going and NOT Going. This document provides clarification on elements which DCI, SEP, and CCC elements are being approached and often includes specific language explaining middle school units which may support current targets. This document also provides clarification about what the lesson materials are not attempting to develop (e.g., page 27).
- Students frequently use Exit Tickets at the end of specific classes which are then used to open the following class with discussions. This takes place within Lessons 1, 2, 4, 8, and 9.
- Lesson 1: Teachers are instructed to develop a DQB. They are given guidance for how to organize the DQB and how to collect student ideas. This DQB is revisited by students in Lessons 2, 6, 8, and 10.
- Lesson 1: The Teacher Edition suggests that students begin the unit with a science notebook. "Keeping a science notebook allows students a space in which to reflect and communicate their

developing understandings about science ideas and to track changes in their understandings. Each student should have a binder that will serve as their 'science notebook' for the course. Students can use large dividers to indicate the start of a new unit."

- Lesson2: Students are introduced to the Progress Tracker. Guidance is provided that the Progress Tracker will support students in showing how their understandings have increased over time and will provide a way for them to capture questions that they have (Teacher Edition, page 59). Students return to the Progress Tracker in Lessons 5, 6, 10, and 11.

Suggestions for Improvement
- Consider including explicit teacher guidance and strategies for supporting students to see how their learning in all three dimensions connects to their sense-making and problem solving.
- Consider providing some guidance and strategies for teachers to support students in seeing how their grade-appropriate CCC earning contributes to problem solving.

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time. Although scaffolding for some SEP elements is introduced across different lessons, the scaffolding is not always reduced over time in a logical way that supports students in using the elements more independently over the course of the unit. Additionally, the supports provided are not explicit in how they would support students with diverse needs and abilities.

The What Elements of the NGSS are being Developed section (Teacher Edition, page 13) clearly states which SEP elements are being intentionally developed in the unit. However, the initial scaffolding of the targeted SEP elements is unclear, and the scaffolds are not always reduced gradually over time.

Related evidence includes:
- There is evidence of supports being adjusted over time for the following SEP element: *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system* throughout the unit. For example:
  - Lesson 1, Section 8: Students develop their initial models of ecosystems in small groups on paper. The teacher is told, "While each student should develop their own model, encourage them to talk with their group members to share and build on each others' ideas. Remind students that there is no one correct way to develop a model and we should celebrate a diversity of different representations" (Teacher Edition, page 34).

- Lesson 2: Students create a class consensus model of the Serengeti National Park on chart paper or a whiteboard. This class consensus model is updated later in Lesson 4 to include additional evidence students collected during class investigations. It is revisited a final time in Lesson 10.
- Lesson 8: Students use the SageModeler software to use a more sophisticated model to predict the relationships between various components of the Serengeti National Park ecosystem.

Suggestions for Improvement
- Consider including progressively reduced teacher scaffolds for all targeted SEP elements so that students can use the elements more independently or deeply by the end of the unit.
- Consider providing students with multiple opportunities to engage in the targeted SEP elements throughout the unit and adjusting scaffolds for developing and using the SEP elements over time such that the teacher can clearly see the progress a student is making toward independence.

OVERALL CATEGORY II SCORE: 3	
Unit Scoring Guide – Category II	
Criteria A-G	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

Ecosystems Interactions & Dynamics
EQuIP RUBRIC FOR SCIENCE EVALUATION

III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena and/or design solutions. Students produce artifacts that require them to use more than one dimension in service of problem solving or sense-making. However, not all targeted learning is evident and there is considerable mismatch between what is intended to be assessed and what is actually assessed.

Some evidence includes:
- Lesson 1, Section 8: Students develop individual models in their science notebooks to explain how components interact within their conservation profile. As they do so, students are most likely using:
    - DCI: An unclaimed Grade 6–8 element **of ESS3C: Human Impacts on Earth Systems:** *Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.*
    - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
    - CCC: An unclaimed Grade 6–8 element of **Cause and Effect:** *Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems.*
- Lesson 1, Section 12: Students work in small groups to develop models of their conservation profiles. Students then engage in a gallery walk to identify similarities and differences in their models. As they do so, students are most likely using:
    - DCI: An unclaimed Grade 6–8 element **of ESS3C: Human Impacts on Earth Systems:** *Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.*
    - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
    - CCC: **Stability and Change:** *Much of science deals with constructing explanations of how things change and how they remain stable.*
- Lesson 3, Section 7: Students work collaboratively to create data displays to communicate patterns students notice as they worked on their Analyzing Wildebeest Data Cards activity. As they do so, students are most likely using:

- o DCI: Unclaimed Grade 6–8 elements of **LS2A: Interdependent Relationships in Ecosystems:**
  - ▪ *In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.*
  - ▪ *Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. ~~Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.~~*
  - o SEP: An unclaimed element from **Obtaining, Evaluating and Communicating Information:** *Communicate scientific ~~and/or technical~~ information or ideas (e.g. about phenomena ~~and/or the process of development and the design and performance of a proposed process or system~~) in multiple formats (including orally, graphically, textually, and mathematically).*
  - o CCC: An unclaimed Grade 6–8 element of **Patterns:** *Patterns can be used as evidence to support an explanation.*
- Lesson 4, Section 7: Students construct an explanation to support a provided claim in their science notebooks as part of an Exit Ticket assignment. As they do so, students are using:
  - o DCI: An unclaimed Grade 6–8 elements of **LS2A: Interdependent Relationships in Ecosystems:** *Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors*
  - o SEP: An unclaimed Grade 6–8 element of **Constructing Explanations and Designing Solutions:** *Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.*
  - o CCC: **Stability and Change:** *Much of science deals with constructing explanations of how things change and how they remain stable.*
- Lesson 4, Section 13: Students construct an explanation to support claims made as part of the Exit Ticket assignment. As they do so, students are most likely using:
  - o DCI: An unclaimed Grade 6–8 elements of **LS2A: Interdependent Relationships in Ecosystems:** *In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.*
  - o SEP: An unclaimed Grade 6–8 element of **Constructing Explanations and Designing Solutions:** *Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.*
  - o CCC: **Patterns:** *Mathematical representations are needed to identify some patterns*
- Lesson 5, Section 8: Students complete the Wildebeest Population Data handouts to help them figure out what is causing changes in the wildebeest population over time. As they do so, students are using:
  - o DCI: Students are possibly using elements from **LS2A:** *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for*

the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. However, it is more likely that they are relying heavily on an unclaimed Grade 6–8 elements of **LS2A: Interdependent Relationships in Ecosystems:** *In any ecosystem, organisms and populations with similar requirements for food,* ~~*water, oxygen, or other resources may*~~ *compete with each other for limited resources, access to which consequently constrains their growth and reproduction.*

- o SEP: **Using Mathematics and Computational Thinking:** *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
- o CCC: An unclaimed Grade 6–8 element of **Cause and Effect:** *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*

- Lesson 5, Section 12: Students answer questions on an Electronic Exit Ticket. As they do so, students are using:
  - o DCI: **LS2A: Interdependent Relationships in Ecosystems:** *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.*
  - o SEP: **Using Mathematics and Computational Thinking:** *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
  - o CCC: **Stability and Change:** *Much of science deals with constructing explanations of how things change and how they remain stable.*

- Lesson 7, Section 12: Students create algorithmic representations of interactions between two "agents" in the Serengeti ecosystem. As they do so, students are using:
  - o DCI: Students are using an element of **LS2D: Social Interactions and Group Behavior:** *Group behavior has evolved because membership can increase the chances of survival for individuals and their* ~~*genetic*~~ *relatives.* However, some students may be using a 3–5 element of **LS2.D**: *Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size*
  - o SEP: **Using Mathematics and Computational Thinking:** *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
  - o CCC: An unclaimed Grade 6–8 element from **Patterns:** ~~Graphs~~, charts, ~~and images~~ can be used to identify patterns in data.

- Lesson 9, Section 10: Students work in small groups to complete the Road Proposal Evaluation. As students do so, they are using:
  - o DCI: **LS2C: Ecosystem Dynamics, Functioning, and Resilience:** *Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species* and an unclaimed element from **ESS3C. Human Impacts on Earth Systems:** *The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.*

- o SEP: **Constructing and Designing Solutions:** *Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.*
- CCC: An unclaimed Grade 6–8 element from **Stability and Change:** *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.*
- Lesson 10, Section 9: Students prepare and present their evaluations of their conservation plans. As they do so, students are using:
  - o DCI: **LS2C: Ecosystem Dynamics, Functioning, and Resilience:** *Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species* and an unclaimed element from **ESS3C. Human Impacts on Earth Systems:** *The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.*
  - o SEP: **Constructing and Designing Solutions:** *Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.* And an unclaimed element from **Obtaining, Evaluating, and Communicating Information.**
  - o CCC: **Stability and Change:** *Much of science deals with constructing explanations of how things change and how they remain stable.*

Formal assessment tasks in the materials are driven by phenomena and require students to use the three dimensions. However, students are not always using grade-level appropriate elements. For example:

- Lesson 6: African Wild Dog Transfer Task: Students construct explanations about factors that affect the carrying capacity of ecosystems. As they do so, they are using:
  - o DCI: **LS2A: Interdependent Relationships in Ecosystems:** *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.*
  - o SEP: **Constructing Explanations and Designing Solutions**
  - o CCC: An unclaimed Grade 6–8 element from **Cause and Effect:** *Cause and effect relationships may be used to predict phenomena in natural or designed systems* rather than the claimed element from **Scale, Proportion and Quantity**.

Suggestions for Improvement

- Consider providing three-dimensional performance opportunities for all students to show an understanding of all the targeted learning.
- Consider making revisions to address the mismatch between what is claimed and what students are actually doing in the lessons.

III.B. FORMATIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction. Formative assessments opportunities are identified throughout the unit and some guidance for what to look for in student answers and how to modify instruction is provided. However, many of the formative assessment opportunities occur in whole group settings and there are few explicitly structured opportunities for teachers to collect formative assessment data from individual students. Consequently, instructional decisions about how to modify instruction could be made based on a few students rather than patterns generated by individual student responses.

Related evidence includes:
- Lesson 2, Section 4, *Assessment Opportunity*: Teacher guidance is provided as to what to look/listen for as students engage in the class discussion about the history of the Serengeti. Specific elements are identified and some guidance for "what to do" is provided. However, this is a whole group formative assessment opportunity and there is no guidance provided to support teachers in discerning individual student understandings.
- Lesson 2, Section 6: Teacher guidance is provided that the Exit Ticket can serve as a formative assessment. Teachers are told to, "check for individual students' ability to summarize information concisely and accurately to consider how to support students with more strategies in future lessons." Additionally, the teacher is told, "Use the Exit Tickets as a way to group students for day 2 of the lesson, creating groups of students who investigated different questions and can share complementary information." However, guidance for how to modify instruction is not provided.
- Lesson 2, Section 11: Teacher guidance is provided that states, "Progress Tracker can be a valuable tool for formative assessment." While guidance is provided regarding the importance of not grading the Progress Tracker, no guidance is provided for how to use this document as a formative tool or how to modify instruction based on student responses.
- Lesson 3, Section 4, *Assessment Opportunity*: Teacher guidance is provided as to what to look/listen for as students engage with the Analyzing Wildebeest Data Cards. Specific elements are identified, and guidance is provided for teachers to use the answer key to provide feedback to students. However, guidance for how to modify instruction is not provided.
- Lesson 3, Section 8, *Assessment Opportunity*: Teacher guidance is provided as to what to look/listen for as students compare data displays. Specific elements are identified, and guidance is provided for additional prompts that teachers can use to support the discussions. However, guidance for how to modify instruction is not provided.

- Lesson 3, Section 4, *Assessment Opportunity:* Teacher guidance is provided as to what to look/listen for as students engage with the Analyzing Wildebeest Data Cards activity. However, guidance for how to modify instruction is not provided.
- Lesson 4, Section 13, *Assessment Opportunity*: Teacher guidance is provided as to what to "look/listen" for as students discuss the Wildebeest and Rainfall activity. Teachers are provided with some guidance on what to do in response to this formative assessment. However, the guidance for how to modify instruction is focused on the SEP and not the other dimensions.
- Lesson 4, Section 16, *Assessment Opportunity*: Teacher guidance is provided as to what to "look/listen" for as students revise their responses to the question 7 Wildebeest and Rainfall activity. Teachers are told to take up the document and provide feedback to students. A strategy is provided to support students who may struggle with the assignment but guidance for how to modify instruction is not provided.
- Lesson 5, Section 5, *Assessment Opportunity*: Teacher guidance is provided as to what to "look/listen" for as students develop algorithms to describe the wildebeest population. Some teacher guidance for how to modify instruction is provided.
- Lesson 7, Section 10, *Assessment Opportunity:* Students complete an Exit Ticket. Teacher guidance about "what to look/listen for" is provided. Some guidance on how to modify instruction is provided.
- The Teacher Edition contains a section titled *Assessment System Overview* which explains the formative assessment philosophy for teachers. While this overview does include a table that identifies the types of assessments within a lesson and where they occur, it does so at large grain size and does not include element level assessment targets or guidance for how to modify instruction.

Suggestions for Improvement
- Consider allowing opportunities for students to develop and use grade-appropriate SEP and CCC elements. See Criterion I.B.
- Consider adding support for how teachers could modify instruction based on student responses. Providing sample student responses along with how to tailor instruction based on the responses could strengthen the evidence for this criterion.
- Consider providing additional guidance to teachers and students about how to address gaps and misconceptions.

III.C. SCORING GUIDANCE

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions. Scoring guidance is provided to interpret student progress in relation to the learning targets. However, the teacher guidance does not always provide support for targeted, ongoing feedback to individual students and there is no guidance for students in interpreting their own progress towards mastery of targeted elements.

Related evidence includes:

- Expected student responses are provided for the suggested discussion prompts which are also provided in the slides that are displayed to students. Several of these discussions include *Assessment Opportunities* in which individual elements are identified as evidence to "look/listen for". This evidence is presented as if it will occur in an integrated manner although there is no evidence that students will respond in this manner. Additionally, this evidence is identified using a numbering system which may result in teachers being unsure as to which element should be assessed.
- Answer keys are provided for some student handouts that provide sample student responses. Answer keys can be found for student handouts in Lessons 1, 5, 7, 8, 9, and 10. However, these answer keys do not always identify the targeted elements being assessed or provide a range of student answers. Additionally, there is no evidence of feedback guidance for teachers or evidence that students will receive feedback that they can use to assess their own progress.
- Lesson 6: A rubric is supplied for the transfer task which links individual questions to specific DCI, SEP, and CCC elements. A general answer key is provided for the overall assessment along with sample student answers. Differentiated sample student responses, based on level of proficiency, are provided for the final question/task within the assessment. Specific teacher feedback for students is provided at each level for that one question. However, the feedback suggestions do not support teachers in providing on-going, targeted feedback and there is no evidence that students will be able to use this feedback to interpret their own progress towards learning targets.
- Lesson 6: A rubric is provided for peer and self-assessment. The rubric provides insight into how the teacher will interpret their work for all dimensions on one question/task. However, the rubric does not provide guidance for the feedback the peers can provide on their classmate's performance for students to reflect on and improve their learning.
- Lesson 9: A rubric is supplied for the How do Humans Interact with the Serengeti ecosystem handout. Elemental targets of SEP, CCC, and two DCIs are identified within the rubric. Differentiated sample student responses, based on level of proficiency, are provided and suggested teacher feedback for each level of proficiency is provided. However, the feedback suggestions do not support teachers in providing on-going, targeted feedback and there is no evidence that students will be able to use this feedback to interpret their own progress towards learning targets.
- Lesson 11: A rubric is supplied for the Prairie Transfer Task. Elemental targets of SEP, CCC, and three DCIs are specifically linked within the rubric. A general answer key is provided for the overall assessment along with sample student answers. Differentiated sample student responses, based on level of proficiency, are provided for the final question/task within the assessment. Specific teacher feedback for students is provided at each level for that one question. However, the feedback suggestions do not support teachers in providing on-going, targeted feedback and there is no evidence that students will be able to use this feedback to interpret their own progress towards learning targets.

Suggestions for Improvement
- Consider revisions which would support students in interpreting their own progress towards mastery of the targeted elements and the learning performance.
- Consider revisions which would support teachers in providing targeted feedback to students at all levels of proficiency.

III.D. UNBIASED TASK/ITEMS

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples.

Related evidence includes:
- The representations are fair and unbiased.
  - Lesson 2: The teacher is provided with guidance for teaching a potentially difficult topic. The teacher is direct to say, "Before we break into small groups to read, I want to let you know that there was and still is quite a bit of controversy over the conservation of the Serengeti ecosystem. You will be reading about some events that happened over a century ago, and you may not agree with the behaviors, actions, or decisions people made".
- Throughout the unit, students are given a mix of text, visuals, and data tables.
- Throughout the unit, students are asked to respond in a variety of ways: talking about their learning with groups and the class, writing their answers, modeling using a computer software, constructing graphs, and engaging in gallery walks.
- Throughout the unit, students are provided flexibility in the modality with which they complete and communicate their understandings.
  - Lesson 2, Section 5: Students complete an information scavenger hunt. In a callout labeled Attending to Equity, it states, "Alternative strategies for recording this information in different modalities for students with disabilities or multilingual learners could include voice memos or taking photos of key ideas to review later. Students who need more time to process or translate information before writing can review these recordings and fill in Scavenger Hunt Notes at home before the next class" (Teacher Edition, page 53).
  - Lesson 5, Section 1: Students are tasked with sharing their thoughts from supplied prompts. In a callout labeled Attending to Equity, it states, "Allowing students to express their ideas using multiple modalities supports student ownership of their

learning by giving students choice, access, and control in navigating their own understanding around the science ideas. Consider agreeing on a set of non-verbal signals to use as a class (e.g., head nods, thumbs up, ASL signs) for signaling nonverbal agreement, disagreement, and wondering/questioning as a way to ensure equitable participation by giving students additional modalities with which to express themselves" (Teacher Edition, page 112).

- o Lesson 5, Section 5: Students are tasked with developing algorithms to demonstrate population changes among the wildebeest. In a callout labeled Attending to Equity, it states, "Allowing students to express their ideas using multiple modalities supports student ownership of their learning by giving students choice, access, and control in navigating their own understanding around the science ideas. Wildebeest Kinesthetic Model Key provides some different ways students could express their algorithm" (Teacher Edition, page 116).
- o Lesson 9, Section 4: Students add components to a class consensus model of the Serengeti National Park ecosystem. In a callout labeled Attending to Equity, it tells teachers to, "Provide students the option of using SageModeler to revise the consensus model. Allowing students to express their ideas using multiple modalities supports student ownership of their learning by giving students choice, access, and control in navigating their own understanding around the science ideas" (Teacher Edition, page 190).

- Throughout the unit, students are provided with appropriate text and vocabulary in the supplied readings for scientific and non-scientific terms.
  - o Readings are provided that have been adapted from scientific texts to include grade-level appropriate texts in Lessons 1, 2, 6, 7, 8, and 10.
  - o Students are supported in developing personal glossaries throughout the unit. The Teacher Edition explains, "The definitions we co-construct and encounter in this unit are listed in this document and in each lesson to help prepare and to avoid introducing a word before students have earned it. They are not intended as a vocabulary list for students to study before a lesson, as that would undermine the authentic and lasting connection students can make with these words when they are allowed to experience them first as ideas they're trying to figure out" (Teacher Edition, page 21). Lesson materials explicitly call out when to support students in the development of their personal glossaries in Lessons 1, 2, 3, 4, 5, 7, 8, and 9.

Suggestions for Improvement
None

III.E. COHERENT ASSESSMENT SYSTEM

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Ecosystems Interactions & Dynamics
EQuIP RUBRIC FOR SCIENCE EVALUATION

Rating for Criterion III.E. Coherent Assessment System	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. All assessment types are included in the unit, and the materials provide guidance for how assessments can be used to support students in meeting three-dimensional learning goals. Additionally, the materials explain how different assessment types work together to provide a coherent assessment system. However, guidance which will support feedback to students to inform instruction is not always present.

The teacher materials include an *Assessment System Overview* which explains, "Each OpenSciEd unit includes an assessment system that offers many opportunities for different types of assessments throughout the lessons, including pre-assessment, formative assessment, summative assessment, and student self-assessment. Formative assessments are embedded and called out directly in the lesson plans. Please look for the 'Assessment Icon' in the teacher support boxes to identify places for assessments" (Teacher Edition, page 222).

Multiple examples of each type of assessment occur throughout the unit. Evidence of at least one example of each type is provided below.

Pre-assessment
- Lesson 1: The *Assessment System Overview* in the Teacher Edition states, "The initial model developed on day 2 of Lesson 1 is a good opportunity to pre-assess student understanding of how students define and identify the important components and interactions of the system they investigate in their Conservation Profiles" (Teacher Edition, page 222).
- Lesson 1: The DQB is identified as an opportunity to pre-assess student understanding of questions. The teacher is told, "note any close-ended questions and use navigation time throughout the unit to have your students practice turning these questions into open-ended questions when they relate to the investigations underway" (Teacher Edition, page 222).

Formative Assessment
- See evidence under Criterion III.B.

Summative Assessment
- Lesson 5: The Electronic Exit Ticket is listed as a potential summative *Assessment Opportunity*. However, the reviewers were unable to access the resource.
- Lesson 6: Students complete a transfer task to demonstrate their understanding of **HS-LS2-1** through the phenomenon of the relocation of African wild dogs. The summative task includes grade-appropriate elements of the three dimensions to make sense of the African wild dogs phenomenon.
- Lesson 10: The *Assessment System Overview* states that students will revisit the DQB to identify questions answered during the unit and to determine what questions require further research. However, no grade-appropriate elements of the three dimensions are specifically identified for this task.
- Lesson 11: Students complete the end of unit transfer task to demonstrate their understanding using the American Prairie Preserve phenomenon. The summative task includes grade-

appropriate elements of the three dimensions to make sense of the American Prairie Preserve phenomenon.

Self-Assessment
- Lessons 2, 5, 6, 8, and 10: The *Assessment System Overview* states that students will revisit their Progress Trackers "to figure out how to prioritize and use those discoveries to develop a model to explain Phenomena" (Teacher Edition, page 226). However, three-dimensional assessment targets are not provided to students.
- Lesson 2, Section 9: Students use the *Self-Assessment for Obtaining and Communicating Information* to reflect on their ability to record what they learned from the scavenger hunt and share that information with their peers when they worked together to complete Graphic Organizer for the Scavenger Hunt.
- Lesson 6, Section 4: Students self-assess "how they felt" after completing the first part of the transfer task.

Suggestions for Improvement
- For improving formative assessments, see suggestions for Criterion III.B.
- Consider revisions which would provide feedback that will explicitly inform teachers of instruction and students of learning.

III.F. OPPORTUNITY TO LEARN

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Rating for Criterion III.F. Opportunity to Learn	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCCs. Students have many iterative opportunities to demonstrate their learning in the SEP, CCCs, and DCIs; but often they are doing so at below grade-level. Additionally, while students have opportunities to use peer feedback to improve on their performance of tasks, there are no opportunities for them to use teacher feedback to improve on their performance.

Related evidence includes:
- Students have opportunities to use the following SEP elements several times over the course of the unit demonstrating their growth. For example:
  - *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
    - Lesson 1, Section 8: Students develop initial models. Students then revise those models in Section 11.

- Lesson 1, Section 12: Students develop individual models, then they work collaboratively in a group to develop a model which they share with the class, then they use the similarities and differences that they observed from their classmates' models to revise their group model.
        - Lesson 2: Students work collaboratively to create a class consensus model. Students return to this model and revise it in Lessons 3, 4, and 9.
- Students have opportunities to use some DCI elements several times iteratively during the unit, demonstrating their growth. For example:
    - Students have multiple opportunities to engage with a claimed **ESS3.C** element, and **LS2.C** element. However, student use of these elements is often below grade level.
        - **LS2C**:
            - Lesson 8, Section 6: Students use the SageModeler program to simulate the effects of disturbances (rain, disease, fire) on the Serengeti Ecosystem. As they do so, they are using a middle school element of this DCI.
            - Lesson 8, Section 7: As students engage in the consensus discussion it is likely that students will be told the claimed DCI as the teacher summarizes the discussion and tells students that increased biodiversity can lead to a resilient ecosystem. There is no evidence that this understanding is being developed.
            - Lesson 10, Section 4: Students are provided with data packets for their individual conservation profiles to support their evaluation of the conservation plan for those areas.
        - **ESS3.C**:
            - Lesson 1, Section 1: Students are introduced to a reading about the 30 by 30 Initiative. Students engage with this reading compilation for the purpose of obtaining scientific and/or technical information about the initiative.
            - Lesson 1, Section 7: Students complete conservation profiles where they look at the system, the components of the system, the interactions within the system, and impacts [human] decision making have had on the system. As they do so, they continue to build their understanding of this element.
            - Lesson 9, Section 8: Students investigate the potential environmental impact of several proposed roads within the Serengeti National Park. While students are using this element, it is unlikely they have developed any deeper understandings of it as compared to earlier uses.
- Students have multiple opportunities to use portions of an **LS2.A** and **LS4.D** element but neither are fully developed in this unit and students are often using below grade level elements.
    - **LS2.A**:
        - Lesson 3, Section 9: Students engage in group discussions to create a consensus model about wildebeest migration based on what they have figured out from the Analyzing Wildebeest Data Cards. However, students are using a middle school element in this activity.
        - Lesson 4, Section 13: Students construct an explanation to support claims made as part of the Exit Ticket assignment. However, students are using a

middle school element in this activity, and they are not developing or growing in their proficiency of this element.

- Lesson 6, Section 3: Students complete the African Wild Dog Transfer Task. As they do so, they are using the claimed high school element for this DCI.

- **LS4.D**:
  - Lesson 2, Section 8: Students share the information they have gathered during the scavenger hunt in small groups as they complete a graphic organizer.
  - Lesson 2, Section 10: Students engage in a consensus discussion for the purpose of developing a consensus model. The *Assessment Opportunity* "provides guidance for teachers to 'listen for' this element" (identified as **LS4.D.1**). While it is likely that students are developing their understanding of this element, there is no guidance for what portion(s) of the element to listen for during this discussion.
  - Lesson 11, American Prairie Reserve Transfer Task: Students read about biodiversity and are told that it is an important part of conserving an ecosystem. As they do so, students are using the following portion of the DCI, *Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through ~~overpopulation~~, overexploitation, habitat destruction, ~~pollution, introduction of invasive species, and climate change~~. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. ~~Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value~~.*

- Students have multiple opportunities to use a CCC element from **Stability and Change** CCC in the unit. However, students often use below grade-level elements of this CCC.
  - *Much of science deals with constructing explanations of how things change and how they remain stable.*
    - Lesson 1, Section 12: Students work in small groups to develop models of their conservation profiles. Students then engage in a gallery walk to identify similarities and differences in their models.
    - Lesson 4, Sections 6 and 10: Students engage in discussions about patterns they have uncovered when analyzing the data displays they created in the CODAP program. However, students are most likely using a Grade 6–8 element
    - Lesson 8, Section 7: Students engage in a consensus discussion in which they discuss "predictions and the effects on components and the system." While the suggested prompts may allow students to approach the claimed element, it is likely that students are using a middle school element.
    - Lesson 9, Section 5: Students engage in a discussion about the Serengeti Conservation Plan and then use the Conservation Evaluation Tool to evaluate that plan. However, it is likely that students are using a middle school element.

- Students have some opportunities to apply feedback from their peers to improve their performance. There is no evidence that students have opportunities to explicitly apply teacher feedback for the purpose of improving their performance.
  - Lesson 1, Section 8: Students develop initial models in small groups. Students complete a gallery walk of the initial models to share their ideas with their peers. Students then revise those models based on the feedback they have received in Section 11.
  - Lesson 1, Section 12: Students develop individual models, then they work collaboratively in a group to develop a model which they share with the class, then they use the

similarities and differences that they observed from their classmates' models to revise their group model.

- o Lesson 4, Section 16: Students are given an opportunity to revise their initial answer to their Wildebeest and Rainfall document after participating in group discussions.
- o While specific guidance is not provided to teachers, it is likely that students might use teacher feedback provided during whole group discussions and the development of the consensus models to improve their performance.

Suggestions for Improvement
- Consider establishing a feedback cycle at several points in the unit through which students can receive and respond to teacher and peer feedback for the CCCs in addition to the SEPs and DCIs.
- Consider revisions which would have students building grade-level appropriate elements of each dimension throughout the unit.

OVERALL CATEGORY III SCORE: 3	
Unit Scoring Guide – Category III	
Criteria A-F	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

Scoring Guides for Each Category

Unit Scoring Guide – Category I (Criteria A-F)	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Unit Scoring Guide – Category II (Criteria A-G)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Unit Scoring Guide – Category III (Criteria A-F)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

	OVERALL SCORING GUIDE
E	**Example of high quality NGSS design—**High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)
E/I	**Example of high quality NGSS design if Improved—**Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)
R	**Revision needed—**Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)
N	**Not ready to review**—Not designed for the NGSS; does not meet criteria (total 0–2)