CORPS
Central Oklahoma Rural Partnership For Science

PHENOMENON-BASED INSTRUCTIONAL TASK | **GRADE LEVEL:** High School Biology

DON'T BOX ME IN

TARGETED DCI AND/OR ASSOCIATED PE

PE

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 biodiversity.

DCI

Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep the ecosystem's numbers and types of organisms relatively constant over long periods of time under stable conditions.
- If a modest biological or physical disturbance occurs to an ecosystem, that ecosystem may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem.
- Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
- Anthropogenic changes (induced by human activity) in the environment can disrupt an ecosystem and threaten the survival of some species.

Biodiversity and Humans *(secondary to HS-LS2-7)*

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- 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.
- 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.

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.

POSSIBLE DRIVING PHENOMENA

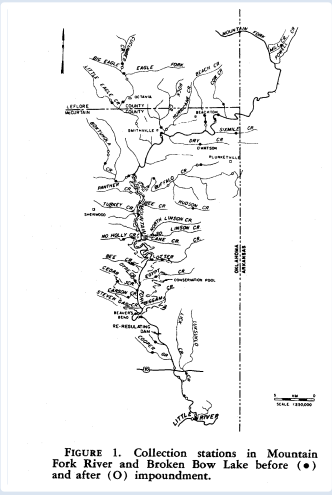

FIGURE 1. Collection stations in Mountain Fork River and Broken Bow Lake before (●) and after (O) impoundment.

Student observation or initial interaction:
Students analyze data* relating to the species present in different sections of Mountain Fork River in southeastern Oklahoma before and after Broken Bow dam was built. Students ask questions about how this change to the environment could influence the aquatic organisms in the river. Students analyze and interpret this data to collect evidence to construct explanations for how the dam has and could continue to influence life in the Mountain Fork River. **Data from Research Article: "A comparison of pre- and post-impoundment fish populations in the Mountain Fork River in Southeastern Oklahoma" Rex Eley, James Randolph and John Carroll (1981). Data included in appendix.*

Student observation or initial interaction:
Students observe images both of original unbroken wilderness as it once existed, and of now-fragmented wilderness. Students make observations and ask questions about how these changes to the environment may influence organisms that live in and migrate through these ranges. Students investigate proposed solutions and evaluate their effectiveness. **resources can be found by searching "Wildways" and "Wildlife Corridors"*

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Phenomenon explanation for teachers:
In 1961, Broken Bow Dam was built on the Mountain Fork River. The dam began operation in 1968 and impounded the river (controlled the water flow) to create a reservoir. Surveys of the fish species present were conducted at three areas—the upper section, the middle section (lake), and the lower section of the river. Fish surveys were conducted on the river before and after the dam was built. The building and placement of the dam on the river caused the numbers, types, and diversity of fish species to change over time in the different sections of the river. Building the dam caused some species of fish to decline in parts of the river, decreasing diversity. In other parts of the river, some fish species increased even as overall diversity decreased. The dam restricts the movement of fish species along the river and impacts their access to the different niches in the river ecosystem that they may need in order to find food and shelter and to mate/spawn.

Phenomenon explanation for teachers:
As humans continue to develop land for commercial and residential use, development (highways, housing, agriculture, and commercial construction) encroaches on natural ecosystems. As this encroachment occurs, animal habitats and ranges are, in a sense, being divided up into separated patches of wild spaces by man-made structures. Many animals require large areas to serve as their territory, over which they migrate and roam during the course of a year in order to find food, shelter, and to mate. Because of this, many animals more frequently encounter man-made structures that they must cross in order to travel between patches of wild spaces in their territory. As a result, many organisms' population sizes are impacted as animals are injured or otherwise negatively impacted by these encounters. Many scientists are studying the use of various types of wildlife corridors that can serve as natural byways for animals to travel between patches of wild space.

HOW DOES THE PHENOMENON CONNECT TO THE DCI OR PE?

Adaptation is the primary mechanism by which changes in biodiversity occur. These phenomena allow students to engage in investigations and generate evidence to defend and critique claims for how changes in genetic diversity can affect the increase or decrease of populations, and emergence or extinction of species. Using data sets, simulations, and case studies, students construct explanations about how different environmental conditions affect populations. Those organisms that are anatomically, behaviorally, and physiologically well-suited to a specific environment will survive and reproduce. Through synthesis of this information, students engage in argument from evidence about the origins of adaptations and predict the effects on survival and reproduction. In order to truly understand adaptations, students must first understand the cause and effect relationship between change in genetic frequency and overall reproduction or survival success in a population. By analyzing evidence, students understand how the selection of beneficial traits (natural selection) causes adaptations in populations. Because these adaptations have the effect of increasing an individual's ability to survive and reproduce, the gene(s) for the beneficial trait may increase and thus alter the genetic frequency of that trait in the population. Students also use evidence to engage in argumentation, predicting how changes in environmental conditions (such as habitat destruction, invasive species, etc.) can affect fitness of the population, which can lead to changes in biodiversity. Students evaluate the connections between selection pressures, adaptations, and populations in order to both analyze and communicate the changes in biodiversity on earth.

GATHERING AND REASONING IN ORDER TO CONSTRUCT AND REFINE EXPLANATIONS:

How could students gather evidence using SEPs and CCCs that will help them construct or refine a supported explanation of the phenomenon?

1. INITIAL ENGAGEMENT WITH THE PHENOMENON:

Students can analyze the data presented (e.g. Mountain Fork Data Tables or Wilderness Maps) to identify patterns that may emerge. Students can ask questions about the data and begin to propose explanations for these patterns as they relate to adaptation and biodiversity.

GUIDING QUESTIONS:

- What patterns do you notice in the data presented in the (table/images)?
- How is the population of organisms in the described ecosystem changing over time?

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2. CONTINUING EXPLORATION:

- Students can research the ecosystem and the organisms within it to develop an understanding of the needs and behaviors of the species that live within the ecosystem.
- Students can obtain and synthesize additional research data related to the concept of restriction of organisms' movements in both aquatic and terrestrial ecosystems and analyze the resulting impact on the populations of species in the ecosystem. Students can use the research to make claims supported by evidence about how restricting the movement of organisms in an ecosystem could affect both the ecosystem and the organisms living in the described ecosystem.
- Students can be given different scenarios in which an ecosystem undergoes either a natural or a human-induced change. Students can use models to gain a better understanding of how organisms' movements and population frequently might be affected by both natural and human-induced changes to ecosystems.
- Students can begin to design solutions to mitigate effects of anthropogenic changes to ecosystems. Students can use models and data to make claims about the effectiveness of each design solution.

- What do you predict will happen in the future to these populations of organisms if this change occurs?
- What are the key parts to the described ecosystem?
- What are the properties of the environment that allow populations of organisms living in it to survive?
- What is it about the structures of the organisms that allow them to survive in the described ecosystem?
- How do you think _____ will respond to the described change in the ecosystem?
- What will stay the same in the ecosystem?
- What might change in the ecosystem?
- How was this ecosystem affected by/how might this ecosystem be affected by _____?

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COMMUNICATE FINAL EXPLANATION OF THE PHENOMENON

How might students communicate their understanding of the targeted DCI or PE in an explanation supported by evidence?

Students will construct and communicate explanations for how the frequency and behavior of organisms change over time in a given ecosystem as it undergoes change (natural or human-induced).

Possible formats for constructing explanations of this phenomenon

- Students can construct models (e.g. drawings, diagrams, tables, physical models, analogies) to represent and communicate how the changes to the ecosystems have affected the populations of organisms in each ecosystem.
- Students can communicate their understanding of ecosystem dynamics and how populations respond to change through a multimedia presentation.
- Students can construct a written or oral argument with supporting evidence from their investigations for how populations of organisms are affected by changes in ecosystems.
- Students can propose and/or evaluate design solutions to impacts on populations of organisms from disruptions in ecosystems.

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