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# K-12 Partnership Lesson Plan

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# *Where the Wild Things Are*

# *How rainfall drives food web interactions*

## Overview

Every organism, large and small, is affected by weather. Some organisms like plants are affected directly by rainfall. Others are impacted through their food chain relationships. In the hot-dry tropics found in some parts of Africa, seasonal patterns of rainfall drive one of the most impressive animal migrations in the world. This activity uses the great African migration to review the water cycle and emphasize how food webs are strongly impacted by rainfall patterns through a hands-on activity. The food web portion of this exercise can be used independently as a hands-on alternative to pen-and-paper models to review food webs, food web vocabulary, or the importance of biodiversity in ecosystems. The food web exercise also contains additional scenarios that explore: 1. The importance of taking food webs and animal behavior into account when planning wildlife reserves, 2. How human-animal conflicts can change with rainfall, and 3. What happens when key species go extinct.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Explain how changes in the water cycle cause the wet and dry season in Africa
* Understand/review water cycle and food web vocabulary
* Illustrate how every animal ultimately depends on rainfall/water availability using an African food web as an example
* Illustrate how rainfall changes result in changes in the African food web
* Explain how these food web changes can lead to changes in behavior (migration, increased conflict between carnivores, etc.)
* Explore how human-caused changes can strongly impact food web patterns

**Length of Lesson**

Full lesson: 60 min class period

Food web activity only (MS/HS): 20-40min (depending on how many scenarios are used)

Food web activity only (EL): 20-30min (depending on how many scenarios are used)

**Grade Levels**

Middle school and lower high school version

Upper elementary version (material labeled ELEM)

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Elementary School*

* **3-LS4-3**: construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all
* **3-ESS2-2**: obtain and combine information to describe climates in different regions of the world
* **5-LS2-1**: develop a model to describe the movement of matter among plants, animals, decomposers, and the environment
* **5-ESS2-1**: develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact

*Middle School*

* **MS-LS2-1:** analyze and interpret data to provide evidence for the effects of resource availability on organisms and population of organisms in an ecosystem
* **MS-LS2-4**: construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect population
* **MS-LS2-2**: construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems
* **MS-ESS2-6**: develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates

*High School*

* **HS-LS2-6:** evaluate the claim, 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-LS4-5**: evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
* **HS-ESS2-4**: use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate

Cross Cutting Concepts:

* Patterns
* Cause and effect
* System and system models
* Energy and matter in systems
* Stability and change of systems

Science and Engineering Practices

* Developing and using models
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **S.RS.00.11/07.15**: demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activites
* **S.RS.07.17**: describe the effect humans and other organisms have on the balance of the natural world
* **E.ES.07.11**: demonstrate, using a model or drawing, the relationship between the warming by the sun of the Earth and water cycle as it applies to the atmosphere (evaporation, water vapor, warm air rising, cooling, condensation, clouds)
* **E.ES.07.12**: describe the relationship between the warming of the atmosphere of the Earth by the sun and convection within the atmosphere and oceans
* **E.ES.07.13**: describe how the warming of the Earth by the sun produces winds and ocean currents
* **E.ES.07.41**: explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface
* **E.ES.07.81/E4.P1A**: explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff, ground water, and absorption occur within the cycle
* **E2.1B**: analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth
* **E2.1C**: explain using specific examples, how a change in one system affects other Earth systems
* **L3.P2A**: describe common relationships among organisms and provide examples of producer/consumer, predator/prey, and parasite/host relationship
* **L3.P2B**: describe common ecological relationship between and among species and their environments (competition, territory, carrying capacity, natural balance, population, dependence, survival, and other biotic and abiotic factors)
* **L3.P3D**: predict how changes in one population might affect other populations based upon their relationships in a food web
* **B3.2C**: draw the flow of energy through an ecosystem. Predict changes in the food web when one or more organisms are removed

**Materials**

* One set of animal cards per group (groups of 9 MS/HS, groups of 7 EL) – online
* 6 pieces of yarn/string per player(roughly arms length), 1 color for each animal in the group
* Rule sheet- to be used by the instructor to narrate the activity or a responsible student
* Student worksheet – online
* Power point - online

**Background**

 Why would a wildebeest risk crossing a crocodile-infested river? Why does the African Serengeti have a wet and dry season? This lesson uses the African Serengeti to examine how weather patterns explain these two seemingly unconnected phenomena.

**The Water Cycle in Africa**

The annual amount of rainfall varies considerably from place to place. In North America, rainfall varies from very high in wet areas such as Juneau, Alaska, which receives an average of 90 inches of precipitation per year, to extremely low in areas such as in Death Valley, which only receives 2.36 inches. Lansing, Michigan falls somewhere in-between, with an average of 31 inches of rainfall per year. In Africa, rainfall is also varied. Sixty percent of Africa is covered by arid land, and rainfall is particularly low in desert regions (like in Cairo, Egypt which gets 1 inch per year). Our focus will be in the Serengeti ecosystem, a tropical savanna which receives much more rain annually than desert regions, but experiences high seasonality in rain patterns. The Serengeti ecosystem includes the Masai Mara National Park in Kenya, which receives ~ 45 inches of rainfall per year in its northwest section, and stretches down to the southwestern Serengeti plains in Tanzania, which receive less than 20 inches annually.

The African Serengeti, like other regions in the tropics, has an annual rainfall cycle instead of an annual temperature cycle. During the wet season, the warm waters of the Indian Ocean evaporate and condense into clouds. At this time of year winds blow from the southeast, carrying these clouds to the Serengeti and Masai Mara located in Tanzania and Kenya in Eastern Africa (see powerpoint) where the rain falls. During the dry season, the trade winds instead blow from the northeast carrying the moist Indian Ocean clouds to South Africa instead. Clouds are still formed locally over Lake Victoria near the Masai Mara providing more regular rain to this area while the Serengeti becomes dry. While this part of Africa still receives clouds formed further to the northeast over the continent of Asia, these are not the moist ocean clouds of the wet season. The trade-winds shift because of the tilt of the earth (NOTE: this section is likely beyond what most students need to know). As the sun heats the atmosphere over the equator most intensely, the warm air rises and pulls in cool air to take its place. During the wet season, the Northern hemisphere is tilted towards the sun causing the winds (i.e. the “cool air”) to blow out of the southeast. During the wet season, the Southern hemisphere is tilted towards the sun causing the winds to blow out of the northeast.

**The African Migration**

Every year 1.3 million wildebeest, 200,000 zebra, and 300,000 Thompson’s gazelle migrate roughly 1,500 miles from the African Serengeti in Tanzania to the Masai Mara in Kenya and back again. These giant herds migrate to follow the rains. The migration is initiated by the zebras that can consume tougher vegetation. The wildebeest follow, feeding preferentially on the new growth of the recently grazed plants. The herds spend the peak of the dry season in the Masai Mara that still receives periodic rains from the nearby Lake Victoria and move back to the Serengeti when the wet season comes. Scientists think the herds bother to move back because of the quality of the grass. The grasses of the Serengeti are rich in phosphorous while the grasses of the Mara are relatively phosphorous poor. Phosphorous is important in supporting wildebeest pregnancies. The wildebeest have their babies in the Serengeti during the wet season.

**The Food Web Activity: “Six-Degrees of Separation”**

There is a saying that any two humans on earth are only 6 or fewer connections away from each other. In this game students will play African animals that are each within 6 degrees of separation from the seasonal rains. Students will physically build these connections using a string to create a network of living food chains. Each student group will have a wildebeest herd, a zebra herd, an impala, a cheetah, a spotted hyena, a lion, a vulture, a honey badger (MS/HS only), and an African savanna hare (MS/HS only). More information on these animals is available in the notes on the PowerPoint presentation.

*Scenario One*

This scenario explores the food web relationships in the wet season and the dry season and asks students to think about how and why they change. This is the best scenario to use if you want a short activity practicing food web relationships.

*Scenario Two: Walls around Wildlife Reserves*

This scenario explores a fictional scenario where a small walled reserve is placed in the Serengeti. As students will discover in this activity, this set-up prevents animals from migrating and has disastrous consequences. The scenario is designed to help students realize effective conservation involves understanding the behavior of the animals you’re trying to protect. In reality the Serengeti National Park does not have permanent boundaries for this very reason. In recent years there has been controversy over plans to construct a highway cutting across the park, which pose similar problems for the migration.

*Scenario Three: Human-Animal Conflicts (MS/HS only)*

This scenario explores how human-animal conflicts increase as reduced food supply puts more pressure on the local carnivores. Many predators in and around the park are killed by local people. Many of these people depend on cattle herds for their living, and kill predators to protect these herds or in retaliation for livestock loss. This human-animal conflict may increase as ecological factors force predators to hunt livestock as an extra food source.

*Scenario Four: The Extinction of the Cheetah*

This scenario explores how the food web changes if the cheetah is driven to extinction. This may be a reality in Africa’s future. Larger predators frequently steal kills from cheetahs and the majority (~ 70%) of cheetah cubs die from predation. Human disturbance has put even more pressure on this species, leaving their populations vulnerable to extinction. This scenario can be used to teach about the importance of biodiversity and the conservation of key species. In reality the extinction of the cheetah would not have such dramatic results, as there are other medium carnivores in the African ecosystem that can fill the cheetah’s ecological role. During this scenario, students can discuss the importance of biodiversity and how it may buffer ecosystems from the effects of one species going extinct.

### Activities of the session

1. Introductory power point (see notes sections on slides for further information)

*Start here if doing food web activity ONLY*

1. Introduce the “cast of characters” using the slides at the end of the power point. This section starts with the slide entitled “Large Carnivore: Spotted Hyena”.
2. Pass out an animal card and 6 lengths of string to each student in each group. Each animal should have its own unique color. When the web is fully connected, each student should have at least one continuous set of connections going through the food chain all the way to a source of rain.
3. Use the Rules sheet for more specific game instructions.
4. Results and answers to the questions are recorded on the student worksheet.
5. Scenario one can stand alone. If you plan to use the other scenarios, you should do scenario one first so students can clearly see the difference.

**Resources**

* A powerpoint with detailed notes, student worksheet, teacher guide to the worksheet, rule sheet, and animal cards are all provided on the “Where the Wild Things Are” lesson page on the KBS GK-12 website

**Extensions and Modifications**

This lesson can be performed in full, but the food web activity can also stand alone. The food web activity contains several scenarios to illustrate how various human-caused changes can alter food webs. Some or all of the additional scenarios can be removed depending on your learning objectives (see background information).

**Assessment**

This activity contains a student worksheet with follow-up questions at the end of each scenario that can be used to assess student understanding.