NATIONAL GEOGRAPHIC

TEACHING WITH SAFARILIVE

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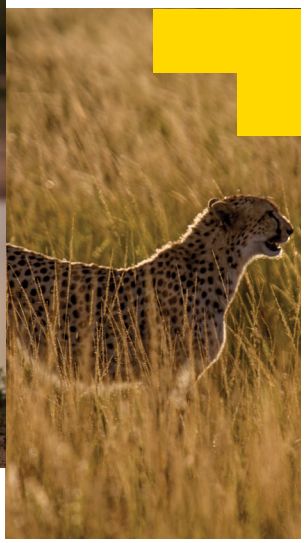


ABOUT SAFARILIVE

Experience the African bush through safariLIVE, a program that takes your classroom on a safari live from savannas and forests in Africa. Learn about local ecosystem dynamics, current wildlife research, and threats to biodiversity from resident guides as they track elusive leopards, travel amongst herds of wildebeest, and listen to the trumpets of elephants. safariLIVE allows students to experience African ecosystems from the classroom and engage with guides in the field in real time.

TO THE TEACHER: USING THIS EDUCATOR GUIDE

This guide provides resources to support students' engagement and learning as they interact with safariLIVE. The guide includes optional discussion questions and activities that can be used before, throughout, and after the safari to individually address specific topics, or as a comprehensive unit. The pre-safari resources are intended to motivate student engagement and facilitate construction of new understandings beforehand, while the post-safari resources are meant to facilitate the application of students' new learning. The resources developed for use during the safari are designed to engage students in scientific practices and promote active engagement with the activity. safariLIVE currently operates from Kruger National Park and Maasai Mara National Reserve, but the guide references other parks so students can learn about a wider variety of areas in Africa. Many activities within the guide require the use of computers or personal devices to perform Internet research, and some activities incorporate the use of a "field notebook" while on safari. A field notebook is not included with this guide but can be created by students as a craft project or provided by the facilitator. This guide includes learning objectives, background vocabulary, common misconceptions, facilitator tips, additional resources for further investigation, and connections to national curriculum standards and principles.

INTRODUCTION TO AFRICA

The second largest continent on Earth, Africa is home to roughly sixteen percent of the world's population or 1.2 billion people. The continent gave rise to humanity, evidenced by the DNA of the San, who are likely to be the oldest population on Earth and direct descendants of the early human ancestors from which all other African groups originated. Cultural diversity now spans the continent, from the Egyptian pharaohs entombed in the north to the urban residents bustling through Nairobi in the east, and the ochre-covered Himba in the southwest.

Diverse assemblages of flora and fauna also spread across African lands, including national parks and game reserves. Within Kenya's Maasai Mara National Reserve, plant diversity ranges along grassland, swamp, riverine forest, and more, while over 470 bird species have been documented in the 1,510 km² (583 miles²) area. More than a million wildebeest (*Connochaetes taurinus*) and thousands of plains zebra (*Equus quagga*) take part in an annual migration between the reserve and Tanzania's Serengeti National Park, its border to the south. Toward the southern end of the continent, Kruger National Park sprawls across 19,633 km² (7,580 miles²) of South Africa, making it the country's largest national park. Animals great and small traverse the area, including endangered wild dogs (*Lycaon pictus*) and critically endangered black rhinos (*Diceros bicornis*). Directly adjacent to Kruger National Park lies Sabi Sand, a 650 km² (251 miles²) privately owned game reserve. Animals are able to travel between the park and reserve, while over 300 species of trees can be found throughout the general area, including baobabs.

Teacher Tip

The appendix includes a vocabulary section that covers key terms used in this guide. Review these terms with students by creating a web centered on ecology, science, or wildlife, to which students connect related terms. Students can also designate symbols to represent each term within the web.

The diversity of Africa is ultimately a result of differences in climate. Changes in precipitation, temperature, ocean currents, and varying elevations, among other factors, produce variations in climate across the continent. In turn, differences in climate, along with variations in geology and soil, enable specific assemblages of plants and animals to thrive, referred to as biomes. Within each biome exist many ecosystems at different scales. Across Africa, these ecosystems can range from tropical forest to desert, shrubland to grassland, and savanna in between. Each ecosystem represents an area of interrelated and interacting abiotic (nonliving) and biotic (living) factors.

Did You Know?

Food chains represent isolated snapshots of a more complex food web. A food web provides a more realistic representation of organisms within an ecosystem in part because it allows organisms to exist at more than one trophic level.

Organisms within an ecosystem can be categorized according to their method of obtaining energy (autotroph vs. heterotroph) and role within the system (producer, consumer, decomposer, or detritivore), which indicates their trophic level within the food web. Interactions between species in a community, or interspecific interactions, can be classified as competitive, predator-prey, or symbiotic, which includes mutualism, commensalism, and parasitism. Taken together, these characteristics represent the organism's niche, or unique role and space within an ecosystem.

Plants, for example, are considered producers, and so make up the first trophic level of a food web. Giraffes (*Giraffa camelopardalis*) consume plants such as *Acacia* trees and therefore occupy the second trophic level. Giraffes themselves may be a source of food for large predators, like lions or hyenas, which occupy higher trophic levels. When these predators pursue the same prey or attempt to occupy the same space, they are competing for available resources. Giraffes may also interact with parasitic organisms, such as ticks, or benefit from mutualistic interactions, as with the yellow-billed oxpeckers (*Buphagus africanus*) that remove and consume ticks attached to giraffes.

Ecologists are scientists who study the interactions between organisms and their relationships to the environment. As scientists, ecologists engage in the scientific method of making observations, asking questions, developing hypotheses, designing appropriate methods to test theories, and drawing justifiable conclusions based on accurate, reliable data. Ecological studies may focus on the impact of herbivores on vegetation, population dynamics of predators, or species diversity, among other topics. In order to collect data, ecologists use a variety of methods and tools. Depending on the goals of the study, it may be appropriate to quantify populations using satellite technology, track movement using radio collars, or walk transects to collect seeds or fecal samples.

Through scientific research, over 15,000 plant and animal species have been found in the Democratic Republic of Congo alone, contributing to its status as one of the most biologically diverse African countries. Ecologists continue to document and assess biodiversity across Africa, while also researching how species are impacted by human activity and proposing solutions that promote conservation. Many species, such as African elephants (*Loxodonta africana*) and giraffes (*Giraffa camelopardalis*), are at risk of extinction due to human activity such as poaching, deforestation, civil unrest, and development that results in habitat loss and fragmentation. Climate change compounds these stressors brought by human activity and can increase the rate of species extinctions.

Ecologists across Africa are working to document, understand, and conserve the continent's biodiversity, from the far reaches of the Sahara to the coast of Cape Town, but success will require global participation.

GRADE LEVEL

For use with grades 6–8

GUIDING QUESTION

How can scientific research be used to document and conserve biodiversity across Africa?

LEARNING OBJECTIVES

The learning objectives are aligned with individual discussion questions and activities, and can be achieved using one or more of the resources. Therefore, the number of learning objectives met depends on which resources are used. Student learning can be assessed using the end products of activities or the responses to the discussion questions.

1. Engage in the scientific process by making reliable observations, developing pertinent research questions, selecting appropriate data collection methods, and drawing relevant conclusions from data.

2. Investigate biodiversity by analyzing and comparing the major components of different ecosystems.

3. Explain how human activities impact African ecosystems and predict how these impacts will change as human population increases and climate change progresses.

4. Evaluate the strengths and limitations of conservation initiatives based on ecological and social considerations.

ROLE OF THE FACILITATOR

BEFORE THE DRIVE

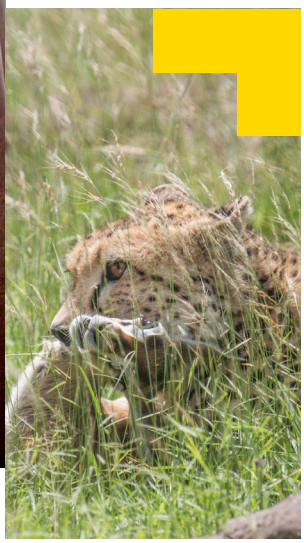
Prior to the classroom drive, facilitators should provide an introductory discussion that encourages students to share their existing background knowledge and understanding of Africa, ecosystems, and scientific research in order to build interest in the topics and identify any misconceptions to be addressed. A list of pre-safari discussion questions is included in this guide, which can be used to elicit background information related to ecology, ecosystem dynamics, biodiversity, and conservation. After the introductory discussion, facilitators can choose to delve deeper into these topics by engaging students in one or more of the pre-safari activities.

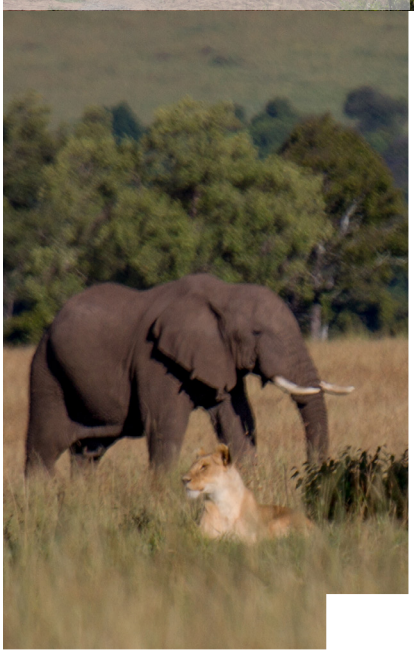
DURING THE DRIVE

Throughout the classroom safari, facilitators should circulate among students to monitor engagement and encourage students to develop questions to be submitted directly to the guides. Asking students to describe unique features of the environment or explain the behaviors and interactions between organisms can prompt students to connect previous discussions and activities with their current experiences. Activities intended to engage students in the scientific process are included in this guide and can be carried out during the safari.

AFTER THE DRIVE

After the classroom drive, facilitators should have students reflect on their personal experience in a short journal entry or as part of a class discussion. Facilitators can probe students' experiences to elicit any conflicts between preconceptions and what they learned or noticed, and then work to dispel existing misconceptions. A list of post-experience discussion questions and activities included in this guide can be used to help students place their new learning in the context of ecology and to begin understanding how they can help conserve biodiversity.





BEFORE SAFARILIVE

Use these discussion questions and activities prior to participating in safariLIVE. These questions and activities will motivate student engagement with safariLIVE by providing an introduction to ecology and background knowledge of African ecosystems.

DISCUSSION QUESTIONS

Ecologists represent a type of scientist who investigates the relationships organisms have to each other and to their environment.

- *Why is studying ecology important?*
- *How do humans benefit from the study of ecology?*
- *Is it necessary that humans benefit in order to perform ecological studies? Why or why not?*

Ecologists collect data about the organisms they are studying.

- *What methods might ecologists use to collect data about organisms, their interactions with each other, or their relationship to their environment?*
- *Considering differences in populations and environments, what are some advantages and disadvantages of those data collection methods?*
- *How can technology influence the type or quality of data that is collected?*

An ecological niche is the role and space of an organism within an ecosystem, including its interactions with other organisms.

- *What types of interactions exist between organisms in Africa?*
- *How are these interactions influenced by biotic and abiotic factors?*
- *How are these interactions similar or different from the interactions between organisms near your home?*

Teacher Tip

Any of the discussion questions or activities can be tailored to be more personal or geographically relevant to students, or modified for older or younger students.

Predator-prey relationships represent a type of interaction found in ecosystems throughout Africa.

- *What characteristics or behaviors would benefit predators in their hunt for prey?*
- *What characteristics or behaviors would benefit prey as they attempt to evade predators?*
- *How do these characteristics and behaviors relate to or stem from natural selection?*

Human activity influences biodiversity.

- *How does human activity, directly and indirectly, influence biodiversity? (e.g, Poaching reduces populations of the target species but may also impact food webs to which the target species belongs.)*
- *How might cultural differences among humans influence their impact on biodiversity?*
- *How might your behaviors at home impact the biodiversity of another country or continent?*

ACTIVITIES

ONE

Engage: Introduce students to endangered African wild dogs (*Lycaon pictus*) using this video. Explain that, in the future, ecologists may need to reintroduce captive packs into the wild to help conserve the species, but they can only do so in areas with a suitable climate and geographical characteristics.

Teacher Tip
Introduce or review how to read elevation and topographic maps by focusing on a well-known mountain range and its surroundings, noting how the features of the map change as elevation increases.

Explore: In order to be prepared, ecologists must understand how abiotic factors vary across Africa so they can identify potentially suitable areas for reintroduction. Students will use MapMaker Interactive to explore differences in precipitation, temperature, and elevation in the northern, central, and southern regions of Africa. Use the Terrain base map and add the layers for "Winter and Summer Surface Air Temperatures," "Precipitation & Rainfall," and "Surface Elevation" to explore the abiotic factors. Students will record their findings in a chart divided into each region.

Explain: Students will analyze their findings to compare the general temperature, precipitation, and elevation of each region and identify any trends or patterns between the abiotic factors. Using their analysis, students will draw general conclusions about the climate in each area. Then facilitate a discussion in which students share their conclusions and provide evidence from the map to support their claims. Conclude that abiotic factors such as temperature, precipitation, and elevation produce a region's climate.

Elaborate: Explain to students that wild dogs are adapted to a broad range of abiotic factors, including mountains, but ecologists do not think they can live in extreme desert climates. Students will use their maps to identify areas in Africa that are likely deserts, and therefore not suitable for wild dog reintroduction.

Evaluate: Students will compare their conclusions to the "Climate Zones" map layer and provide suggestions for any discrepancies.

Extend: Prompt students to consider how the surrounding ocean may cause climatic differences between the western and eastern portions of southern Africa, and therefore the suitability of habitat for wild dogs.

TWO

Engage: Students will brainstorm answers to the following: Why would researchers, especially ecologists, be interested in understanding local cultures? In what ways does culture influence how a community interacts with the environment?

Explore: A lion has recently killed several cows owned by the Maasai. The Maasai want to terminate the lion to prevent more cows from being killed. As conservationists, students are being asked to meet with the elders of the Maasai to discuss the issue. To understand their perspective, students will need to research the culture of the Maasai, focusing on their dependence and interactions with the environment.

Explain: After researching the Maasai, divide students into groups to develop arguments in favor of conserving the lion or destroying the lion. Facilitate a discussion in which students will share their arguments, making sure both sides are acknowledged. Then challenge students to develop possible compromises allowing the Maasai and lions to co-exist.

Elaborate: Students will watch National Geographic Explorer Laly Lichtenfeld explain how she works to prevent this conflict. Facilitate a discussion regarding the importance of understanding local cultures while studying ecosystems. Students will consider how the characteristics of their culture could be changed to improve interactions with or impacts on local ecosystems.

Evaluate: Use a rubric to evaluate writing.

Extend: Present a photo gallery of rock art engraved by San hunter-gatherers over at least 2,000 years ago and have students consider the significance of the rock art, noting the prevalence of wildlife-based art. Compare the rock art to examples from other cultures around the world within the context of wildlife significance.

THREE

Engage: UNESCO is an organization responsible for designating World Heritage sites of outstanding universal value, including significant biodiversity. Designated sites, like Botswana's Okavango Delta, benefit from global recognition and funding. As scientists, students must prove why their park or reserve is worthy of recognition as a World Heritage site based on our current understanding of its biodiversity and the potential for future research.

Teacher Tip
Review how to write research questions that reference the independent and dependent variables under study.

Explore: Divide students into teams, with each student assuming the role of a scientist, such as a botanist, zoologist, or ecologist. Students will be randomly assigned to research the ecology of the Maasai Mara National Reserve, Sabi Sands Game Reserve, Kruger National Park, Etosha National Park, or Chobe National Park.

Teacher Tip
Pre-teach vocabulary related to food webs, using local plant and animal species with which students are familiar.

Did You Know?
The arrows within food webs, should depict the flow of energy as it moves from one trophic level to the next, rather than to show who eats whom.

Explain: Students will then select 7 heterotrophs and 3 autotrophs found in their park or reserve for further research. Determine the type of food eaten by the heterotrophs and their potential predators, and determine which heterotrophs feed on the selected autotrophs. Students will use these 10 organisms to construct and annotate a diagram that models the community and its interactions, noting each organism's method of obtaining energy and its trophic level within a food web.

Elaborate: Students will present the diagrams depicting their community during a gallery walk. Facilitate a discussion comparing the biodiversity of the different reserves and parks, highlighting animals that are found in multiple locations across Africa and those that are more unique to certain areas.

Evaluate: Use a rubric that focuses on communication and models.

Extend: Select the park or reserve hosting safariLIVE and review the researched information. Students will use the information to develop a research question specific to the safari location. Practice revising and refining their questions so that they are testable, concise, and detailed.

Teacher Tip
Students can begin their research into the reserve or park for activity three using these websites:

Maasai Mara National Reserve
United Nations Educational, Scientific and Cultural Organization: The African Great Rift Valley – The Maasai Mara
https://whc.unesco.org/en/tentativelists/5512/
Mara Conservancy: Migration – The Greatest Show on Earth
https://www.maratriangle.org/maratriangle/wildebeest-migration/

Kruger National Park
Encyclopedia Britannica: Kruger National Park
https://www.britannica.com/place/Kruger-National-Park
South African National Parks: Kruger National Park
https://www.sanparks.org/parks/kruger/conservation/ff/default.php?p=Kruger

Etosha National Park
Ministry of Environment & Tourism: Etosha National Park
http://www.met.gov.na/national-parks/etosha-national-park/217/
Encyclopedia Britannica: Etosha National Park
https://www.britannica.com/place/Etosha-National-Park

Chobe National Park
National Geographic Traveller: Botswana – On safari in the Chobe National Park
http://www.natgeotraveller.co.uk/destinations/africa/botswana/botswana-on-safari-in-the-chobe-national-park/
Encyclopedia Britannica: Chobe National Park
https://www.britannica.com/place/Chobe-National-Park
United National Educational, Scientific and Cultural Organization: Chobe Linyanti System
http://whc.unesco.org/en/tentativelists/5556/

Did You Know?
Competition between individuals of the same species is referred to as intraspecific competition, while interspecific competition occurs between different species. In both cases, competition is waged over limited resources that might include food, water, space, or potential mates.

FOUR

Engage: Introduce the topic of cheetahs using this video. Then ask students what else they know about cheetah characteristics and their role in the environment.

Explore: Students will research and outline the general niche of cheetahs, including prey species and competitors. Then read about the decline in cheetah populations across Africa. Students will use their previous research to brainstorm three possible impacts of declining cheetah populations on the surrounding environment, including the populations of other species.

Explain: Facilitate a review of the scientific method. Provide students with the following examples of potential research questions and have them work in pairs to develop a corresponding hypothesis supported by scientific reasoning based on their earlier research:

- How will antelope populations be affected if cheetah populations go extinct?
- How will elephant populations be impacted if cheetah numbers continue to decline?
- If cheetahs go extinct, what will be the likely effect on lion populations in areas where cheetahs were once present?
- What will be the short-term impacts on the vegetation in cheetah habitat if cheetahs go extinct?

Students will share their reasoned hypothesis with another student pair.

Elaborate: Highlight the role of hypotheses as scientifically supported predictions of what will occur, noting that they generally incorporate independent and dependent variables. Then explain that cheetahs may use elevated termite mounds as lookout points for potential prey or competitors, as in this photograph. Ask students to hypothesize the ecosystem impacts should termite populations decline.

Evaluate: Students will evaluate and refine one of their scientifically-supported hypotheses based on their new understanding of what a strong hypothesis entails.

Extend: Pairs of students will design an appropriate method to test one of their hypotheses.

Teacher Tip
Demonstrate the interrelated nature of ecosystems by watching this video that explains how conserving jaguars impacts other species within the community.

Teacher Tip
Provide a graphic organizer to help students keep track of the different research methods. The organizer should include distinct sections for the respective advantages, disadvantages, and type of data collected.

FIVE

Engage: Introduce students to African bat research using a photo gallery of rare bats species found in Mozambique and Malawi. Emphasize the importance of bats for pollination and pest control; then ask students why researchers might have difficulty determining if bats are present in an ecosystem.

Explore: Bats are generally small in size and nocturnal in nature, which makes them more difficult to study. As ecologists of Kruger National Park, students are responsible for documenting the different species of bat within the park. Before ecologists can begin documenting bats, they must first learn more about the different methods scientists use to research bats: mist netting, acoustic surveying, field surveying, radio transmission and the citizen-science project, AfriBat.

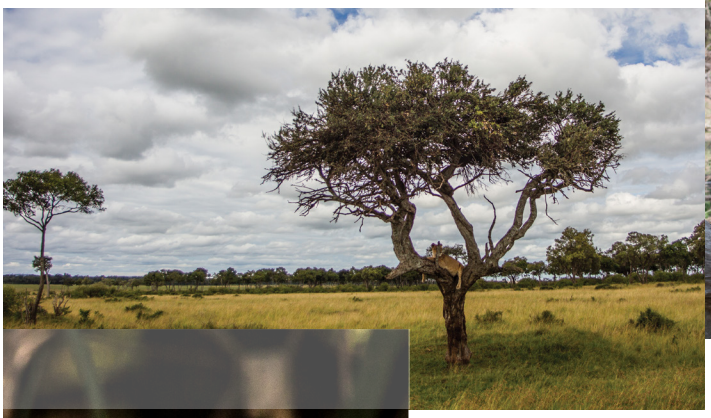
Teacher Tip
Have students read about the research project that investigated bat biodiversity in Mozambique and Malawi and identify the different tools used by the researchers.

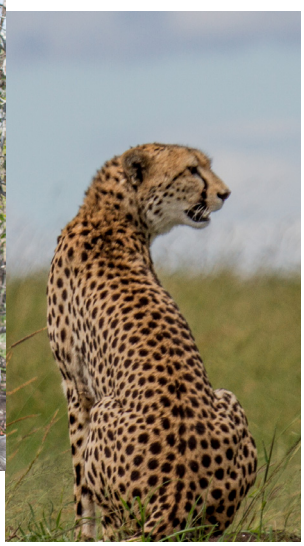
Explain: Students will determine the type of data that can be collected using each research method, and suggest advantages and disadvantages of each method. As part of their evaluations, students should keep in mind that scientific research is often limited by time, feasibility, and monetary restrictions.

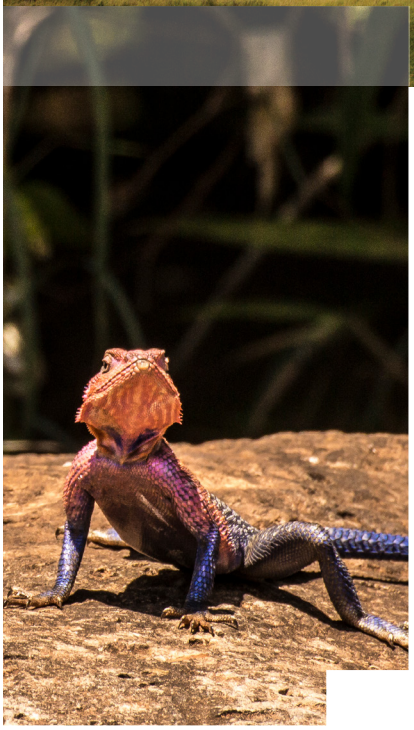
Elaborate: Facilitate a discussion regarding the use of multiple types of tools to research bats, as opposed to only one tool. Challenge students to select and defend the two methodologies they would use to investigate bat communities within Kruger National Park.

Evaluate: Evaluate the choices and rationale of each group during a class discussion or through presentations.

Extend: Students will determine which of these methodologies would be useful in the study of terrestrial mammals, such as zebras, elephants, or cheetahs. Brainstorm additional methods that could be used to research terrestrial mammals, but may not be useful to bat research.







DURING SAFARILIVE

While the main focus for students during safariLIVE is to immerse themselves in the ecosystem and interact with the guides by asking questions, other activities are suggested to help make the most of the classroom drive experience. These activities are designed to engage students in different aspects of scientific research through the lens of ecology. As ecologists, students should create a field notebook that they can add to throughout the safari. Designate the first section of the field notebook for general questions that students would like to ask of the safariLIVE guides. Encourage independent and unscripted use of this section for writing and revising questions throughout the safari and activities. Students can choose to select questions from this section to submit to the guides according to classroom procedures, or they can opt to submit questions developed during the following activities.

ACTIVITIES

ONE

Engage: Designate a section of the field notebook to research questions. Students will begin their section with a list of synonyms for the term "question."

Explore: In order to visualize the art of questioning, students will create a map or cluster of concepts or terms related to the idea of "research question," which should be placed in the center of the cluster. Afterward, connect related terms and concepts using lines. Students will use their brainstorm to determine why it is important for scientists to continually ask questions.

Explain: Students will write down at least five questions during the safari in their field notebook and select one they would like to submit directly to the guides during the classroom drive. Explain to students that their questions may stem from what the guide is discussing or what the students are seeing on screen.

Teacher Tip

Develop a plan for selecting and submitting student questions to the guides during the safari.

Teacher Tip

In order to encourage questions that stem from the safari experience, have students write out their pre-existing questions in the first section of their field notebook prior to beginning this activity and the safari.

Elaborate: After engaging in safariLIVE, have students share some of the questions they developed. Facilitate a discussion connecting the components and content of student questions to the terms from the initial concept map. Highlight their process of developing questions as a major component of the scientific process.

Evaluate: Have students work in groups to evaluate another person's questions and even come up with possible answers. Use a rubric to evaluate the quality of research questions.

Extend: Students can revisit their questions and select the question they find most interesting or one they were unable to ask the guides during the classroom drive. Prompt students to revise or expand upon this question until it is a testable research question that could guide an investigation.

TWO

Engage: Designate a section of the field notebook to observations. Prompt students to make a list of classroom observations in their field notebook and consider why such observations may be important to research.

Explore: Students will make and record 10–15 observations of anything they notice during the safari within the field notebook.

Explain: After safariLIVE has ended, students will share some of their observations in small groups. As a class, practice categorizing some of their observations as abiotic vs. biotic and qualitative vs. quantitative based on students' current understanding of these terms.

Elaborate: Then review the difference between abiotic and biotic factors and qualitative and quantitative data as a class. Model the differences using the initial classroom observations and select examples from the safari. Student groups will categorize the rest of their observations on their own. Facilitate a debate about the usefulness of each type of data, eventually concluding that the usefulness of data depends upon the research question asked.

Evaluate: Informally assess student contributions to the debate.

THREE

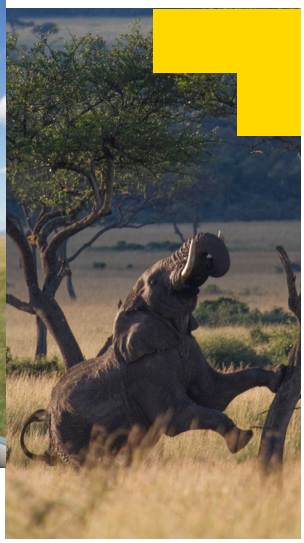
Engage: Designate a section of the field notebook to data collection and analysis. Prompt students to identify the similarities and differences between observations and experiments using a Venn diagram.

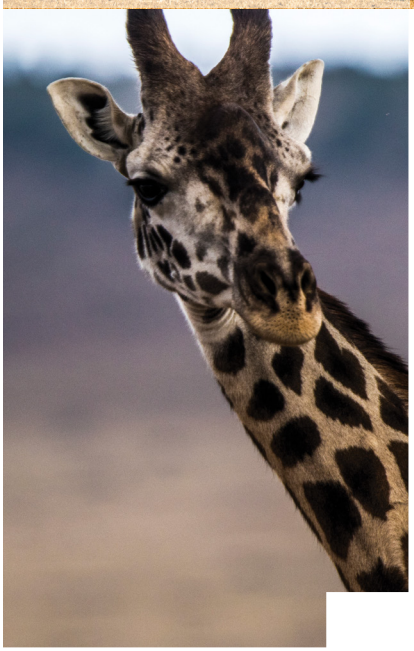
Explore: Facilitate a discussion of observational vs. experimental data, concluding that research data may be experimental, in which the researcher manipulates variables and observes the effects, or observational, in which the researcher has no control over variables. Students will determine which type of data they will be able to collect while engaging with safariLIVE (observational) then brainstorm specific data they may be able to collect (e.g., number of species encountered, number of individuals of a species, behaviors).

Explain: Instruct pairs of students to decide upon the observational data they would like to collect and how best to record it. Students will then collect the relevant data during the classroom drive.

Elaborate: After the safari has ended, students will evaluate their data to determine if it is reliable. Emphasize that a lack of observable data is still a scientific result (so long as it was not due to student error) and should be recorded. Students will then suggest ways to modify and improve data collection in the future.

Evaluate: Assess students' evaluations of their own data as they share their findings with the class.





AFTER SAFARILIVE

Use these discussion questions and activities after participating in safariLIVE. These questions and activities prompt student reflection and facilitate the application of student experiences following safariLIVE.

DISCUSSION QUESTIONS

Ecosystems represent an area in which living organisms in a community interact with each other and with nonliving factors in the environment.

- *How was the ecosystem, including the interactions between organisms, similar or different from what you expected?*
- *What interactions did you observe between biotic and abiotic factors in the ecosystem?*
- *How does this ecosystem compare to your local ecosystem?*

Ecologists may study animal behavior to help understand how an animal adapts and survives within its environment.

- *What types of animal behaviors did you notice?*
- *How did the behavior differ between prey species and predators?*
- *How do these behaviors increase the likelihood that the animal will successfully capture prey or survive?*

Shrinking wildlife habitat means humans and wildlife are coming into increasing contact, which can negatively impact both humans and wildlife. One possible solution to decreasing human-wildlife interactions is to erect fences around national parks and similar wildlife reserves.

- *What are some advantages and disadvantages to fencing a wildlife area?*
- *How could wildlife populations be affected by fencing?*
- *What are some other approaches to reducing unwanted interactions between humans and wildlife?*

Did You Know?

An ecological community is a group of two or more populations living and interacting with each other in the same geographic area, while a population is a group of organisms of the same species interacting with each other in the same geographic area at the same time.

As researchers, guides, and tourists explore and investigate the African bush, their presence impacts the ecosystem.

- *What impacts do these visitors likely have?*
- *Under what circumstances is it acceptable to impact an ecosystem like the one you visited?*
- *How can visitors minimize their impact on ecosystems?*

Conserving biodiversity across Africa will require participation from people all across the world.

- *How can residents of African countries help conserve biodiversity within their own region?*
- *What is something you can do to help conserve biodiversity in your region?*
- *How can we inspire people to conserve local biodiversity and biodiversity in other parts of the world?*

ACTIVITIES

ONE

Did You Know?
Ecosystems are constantly in flux and change over time. While ecosystems may be viewed as "balanced," change within ecosystems does not always result in negative outcomes.

Teacher Tip
The Engage section of this activity includes the use of quantitative data from the classroom drive (e.g., number of species observed and number of individuals of each species). Using the data is optional as the activity can be completed using the wildebeest migration video alone.

Teacher Tip
Integrate art into this activity by creating a collage of still images captured using the different research tools discussed.

Engage: Prior to this activity, record the animal species and the number of individuals encountered during safariLIVE. To begin the activity, watch wildebeest migrate across the Mara River as part of the great migration in and out of the Maasai Mara National Reserve (Warning: includes footage of crocodiles attacking wildebeest). Challenge students to count the total number of wildebeest they see in the different parts of the video. Then create a list of reasons why the number of wildebeest counted and data from the classroom drive may not be accurate or comprehensive (e.g., zebra, because they move in herds and blend together)..

Explore: Each year, ecologists estimate the populations of migrating species such as the wildebeest migration between Maasai Mara National Reserve and Serengeti National Park. Changes in the population may reflect other ecological impacts such as a decrease in predators, disease, or human activity. As ecologists, students are tasked with selecting an appropriate tool to count wildebeest. Students will work in pairs to research tools that could be used to overcome the issues identified earlier in order to obtain reliable data on wildebeest (e.g., drones, satellite imagery, camera traps).

Explain: After researching tools, students will develop an argument for using one over the other to count wildebeest populations. Make sure to outline the advantages and disadvantages of each method. Then facilitate a discussion in which students will share their arguments with a peer(s).

Elaborate: Students will learn how National Geographic Explorer Amy Dickman uses camera traps to document lions and how scientists recently used aerial photography to count populations of elephants. Students will practice counting elephants from aerial images and then compare their results. Facilitate a discussion identifying any potential difficulties that researchers may still face despite advancements in technology.

Evaluate: Use a rubric to evaluate student arguments for which tool is most appropriate to count wildebeest.

Extend: Challenge students to identify other animals or ecosystems in which aerial photography or satellite imagery might be a helpful tool (e.g., inhospitable or inaccessible areas).

Teacher Tip
Advertisements can be in the form of flyer, video (try this paper slide option), or poem.

TWO

Engage: Students will brainstorm answers to the following: How do organizations and governments inspire people to help conserve wildlife and their habitats?

Explore: National Geographic is seeking a new advertisement to promote its wildlife conservation awareness campaign. In order to create an effective campaign, students must first research reasons why wildlife populations may decline. Students will begin by brainstorming reasons and then compare responses with those reasons described under the "Decreasing Biodiversity" section of the biodiversity encyclopedia entry. Facilitate a discussion of these causes that highlights human activity as a major driver of biodiversity loss.

Teacher Tip
Provide students with additional examples of African wildlife if not enough species are observed during the safari. Examples include: African wild dog, black rhinoceros, African elephant, African lion, Cape vulture, puku antelope, leopard, Grevy's zebra, giraffe, lesser flamingo, Cape buffalo, pangolin, Anchieta's dwarf python, oryx, roan antelope, and kudu.

Explain: Introduce the IUCN as an organization responsible for evaluating the conservation status of animal and plant species. In groups, students will select and research a species of animal spotted during the classroom drive to determine their IUCN Red List status and the causes of any threats to their populations.

Elaborate: Students will use their research and understanding of decreases in biodiversity to design an advertisement for National Geographic that educates the audience about threats to the animal's population and encourages a specific action to promote its conservation. Show these advertisements promoting sea turtle conservation from the Houston Zoo and (scroll to the bottom and select the appropriate language) as examples. Have students evaluate each other's advertisements during a gallery walk and vote on the most compelling message. Conclude with the importance of considering all relevant stakeholders when developing conservation campaigns.

Evaluate: Use a rubric to evaluate the advertisements.

Extend: Challenge students by prompting them to consider how they would alter their advertisement if the audience was not an international audience, but instead the newspaper of a community that borders the species habitat.

THREE

Engage: Students will brainstorm answers to the following: What issues might arise from large carnivores living close to human settlements?

Explore: Kruger National Park is home to lions, leopards, and cheetahs. The park is the largest in South Africa and surrounded by wildlife conservancies, villages, and farmland. The park's ecologists are concerned that the big cats may leave the park in search of food, potentially bringing them into conflict with local residents. As

Teacher Tip
Help students begin to comprehend the issue of human-wildlife conflict by asking them to share their own experiences with organisms, such as ants at a picnic, mosquitoes during the summer, or squirrels at the bird feeder.

ecologists, students must propose methods to limit potential conflict, especially with farmers. In order to provide the best recommendation, students will need to research each cat to understand how its and dietary requirements might result in conflict with surrounding communities.

Explain: Students will research and compare the methods used by three programs specifically focused on this issue: Build a Boma campaign, Cheetah Conservation Fund, and N/a'an ku sê Foundation. Students will then propose which methods they think will reduce the most conflict around Kruger National Park. Facilitate a class discussion to review student choices; then prompt students to consider how each program incorporates the needs of local stakeholders and why this is important.

Elaborate: Students will learn about different types of stakeholders in this case study on human-big cat coexistence in the Ruaha landscape of Tanzania. Conclude with a discussion on the importance of using multiple conservation methods that are tailored to the needs of the community to address human-carnivore conflict.

Evaluate: Informally assess students' understanding by evaluating their reasons for selecting certain methods to reduce conflict around the park.

Extend: Students will predict how climate change may influence human-carnivore interactions or research what is being done to limit conflict with large carnivores in your area (e.g., mountain lions in California).

FOUR

Engage: Students will use MapMaker Interactive to locate and explore the country of Namibia. Challenge students to locate Etosha National Park, home to many species of wildlife. Students can make observations of the country in their field notebook.

Explore: The Namibian government is interested in establishing a new national park in a relatively untouched area of the country and seeking proposals for suitable areas. To help inform their proposal, students will first research the locations and surroundings of the Maasai Mara National Reserve and Kruger National Park. Use MapMaker Interactive to locate and mark both locations; then determine the distance from each area to the next town and large city using the "Streets View" base map. Overlay the "Human Population Density" and "Land Cover" layers to explore the relationship between human population density and habitat changes.

Explain: After researching each area, students will draw conclusions about the relationship between human population density and habitat changes. Identify the most common land cover types around the wildlife areas compared to the land cover types near towns and cities. Then facilitate a discussion in which students consider how changes in habitat may influence local biodiversity.

Teacher Tip
Model the use of MapMaker Interactive for the class by altering the transparency of layers to highlight different information on the map.

Elaborate: Students will use their new understanding to develop a proposal identifying and justifying an area in Namibia suitable for a national park (e.g., away from human settlements, where population density is low, and land is not categorized as urban or cropland.) A select group of students will comprise the "Board of Conservation Officials," who will later evaluate each group's proposal. The "Board" will develop its own assessment criteria based on their understanding of national parks and the surrounding environment).

Evaluate: Students' proposals will be evaluated by the "Board of Conservation Officials," who will use their criteria to assess which proposed land area is best suited for a national park and ultimately select a winner.

Extend: Students will predict how increasing human populations will impact Maasai Mara National Reserve and Kruger National Park based on their respective proximities to urban areas.

Teacher Tip
Read the article as a class, pausing to check for understanding at strategic points throughout the text. Encourage students to work with peers as they summarize the main points of the article. Example sentence stems include: "Sometimes, the biggest threat to endangered species is …"; "Scientists created a map to show …"; "Countries in Africa are impacted by countries such as …"; "Examples of threats from human activity include …"; "These maps can help endangered species by …"

Teacher Tip
Review the uses and important components of maps, emphasizing the function of legends.

FIVE

Engage: Students will make a list of five foods or goods they often consume or use and brainstorm how these items might impact animal species in another country (e.g., grown, produced, or derived elsewhere).

Explore: Students will read about a study investigating the effects of international trade on endangered and threatened animals across Africa and engage in informational writing by summarizing the major points of the article. Introduce students to a map of species-threat hotspots linked to consumption in the United States and elicit observations about the map, using student contributions to interpret and explain features of the map.

Explain: Students will compare the maps of the United States and European Union–linked species-threat hotspots to draw conclusions about the relative effect of each hotspot on Africa, citing evidence from the maps to justify their answers. Facilitate a discussion in which students propose ideas for any differences they identify.

Elaborate: Assign groups of students one of the four hotspot maps: United States, European Union, Japan, or China. Each group will analyze the effect of its assigned hotspot's consumption on Kenya, near the Maasai Mara, and South Africa, near Kruger National Park. Students can use Google Maps to locate the corresponding vicinity of each area. Students will then use evidence from the map to create a graph comparing the impact on each location and draw conclusions about the effects of their assigned hotspot, citing evidence from the map and graph to support their claims. Use a jigsaw to share each group's findings and compare the impacts of the four hotspots on Kenya and South Africa. Use student conclusions to facilitate a debate on the relative importance of wildlife conservation initiatives at local, national, and international levels.

Evaluate: Use a rubric to assess student ability to cite evidence from text and maps.

Extend: Students will create a poster to bring awareness to the impact of international trade on wildlife species.

APPENDIX

VOCABULARY

abiotic (adjective)
– characterized by the absence of life or living organisms.

biodiversity (noun)
– all the different kinds of living organisms within a given area.

biotic (adjective)
– having to do with living or once-living organisms.

carnivore (noun)
– organism that eats meat.

climate (noun)
– all weather conditions for a given location over a period of time.

climate change (noun)
– gradual changes in all the interconnected weather elements on our planet.

commensalism (noun)
– relationship between organisms where one organism benefits from the association while not harming the other.

community (noun)
– group of organisms or a social group interacting in a specific region under similar environmental conditions.

competition (noun)
– contest between organisms for resources, recognition, or group or social status.

conservation (noun)
– management of a natural resource to prevent exploitation, destruction, or neglect.

decomposer (noun)
– organism that breaks down dead organic material.

detritivore (noun)
– organism that consumes dead plant material.

ecology (noun)
– branch of biology that studies the relationship between living organisms and their environment.

ecosystem (noun)
– community and interactions of living and nonliving things in an area.

endangered species (noun)
– organisms threatened with extinction.

exploit (verb)
– to use or take advantage of for profit.

fragmentation (noun)
– breaking up of large habitats into smaller, isolated chunks. Fragmentation is one of the main forms of habitat destruction.

habitat loss (noun)
– the reduction or destruction of an ecosystem, making it less able to support its native species.

herbivore (noun)
– organism that eats mainly plants and other producers.

hypothesis (noun)
– statement or suggestion that explains certain questions about certain facts. A hypothesis is tested to determine if it is accurate.

method (noun)
– a way of doing something.

mutualism (noun)
– relationship between organisms of different species, in which both organisms benefit from the association.

niche (noun)
– role and space of a species within an ecosystem.

parasitism (noun)
– relationship between organisms where one organism (a parasite) lives or feeds on the other, usually causing harm.

poach (verb)
– to hunt, trap, or fish illegally.

population (noun)
– total number of people or organisms in a particular area.

predator (noun)
– animal that hunts other animals for food.

prey (noun)
– animal that is hunted and eaten by other animals.

research question (noun)
– query that guides scientific observations and investigations.

species (noun)
– group of similar organisms that can reproduce with each other.

stakeholder (noun)
– person or organization that has an interest or investment in a place, situation or company.

symbiotic (adjective)
– associating with another organism, not always to the mutual benefit of either species.

sustainability (noun)
– use of resources in such a manner that they will never be exhausted.

CONNECTIONS TO NATIONAL STANDARDS AND PRINCIPLES

NEXT GENERATION SCIENCE STANDARDS

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

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

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

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MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

NATIONAL GEOGRAPHIC STANDARDS

Standard 1

Properties and functions of geographic representations

- The advantages and disadvantages of using different geographic representations—such as maps, globes, graphs, diagrams, aerial and other photographs, remotely sensed images, and geographic visualizations for analyzing spatial distributions and patterns
- The acquisition and organization of geospatial data to construct geographic representations
- The use of geographic representations to ask and answer geographic questions

Standard 8

Components of Ecosystems

- Components of ecosystems are interdependent
- Physical processes determine the characteristics of ecosystems

Standard 14

How human actions modify the physical environment

- 3. The physical environment can both accommodate and be endangered by human activities

Standard 16

The changes that occur in the meaning, use, distribution, and importance of resources

- 1. People can have different viewpoints regarding the meaning and use of resources
- 3. Humans can manage resources to sustain or prolong their use

NATIONAL GEOGRAPHIC LEARNING FRAMEWORK

Attitudes

Curiosity

- Youth are curious about philosophical ideas about the natural and cultural world and, specifically, about what they and others can do to make a difference

Responsibility

- Youth are developing complex ways of thinking that allow them to understand and analyze the broader scope of human wants and needs—beyond their immediate surroundings to the broader world.

Responsibility

- Youth identify injustices in the world and problem-solve social and environmental problems.

Skills

Observation

- Youth apply scientific ideas and evidence to explain real-world phenomena.

Communication

- Youth select and use appropriate technology, map types, and other visual media to communicate their message.

Collaboration

- Youth understand the role of multiple points of view in contemporary geographic policies and issues.

Collaboration

- Youth understand the role of multiple points of view in contemporary geographic policies and issues.

Problem Solving

- Youth ask questions that can be investigated in the classroom, outdoors, and in museums and other public places.

Problem Solving

- Youth come up with explanations and solutions based on multiple perspectives and evidence from science and math, and they construct explanations using models, theories, and experiments.

Knowledge

Our Changing Planet

- Youth understand that human activities impact Earth's living things in a variety of ways.

Our Changing Planet

- Youth understand the global interdependent relationships that exist across Earth's ecosystems.

Wildlife

- Youth are able to propose possible solutions to problems related to the protection of critical species.

Wildlife

- Youth recognize that global ecosystems are susceptible to change, and when they do change, there is a ripple effect in all of the ecosystems' populations.

Wildlife

- Youth understand that climate change, deforestation, and desertification are modifications to Earth's physical

environment that are partly cyclical and partly caused by human activity.

C3 FRAMEWORK

- D2.Civ.1.6-8. Distinguish the powers and responsibilities of citizens, political parties, interest groups, and the media in a variety of governmental and nongovernmental contexts.
- D2.Geo.4.6-8. Explain how cultural patterns and economic decisions influence environments and the daily lives of people in both nearby and distant places.
- D2.Geo.9.6-8. Evaluate the influences of long-term human-induced environmental change on spatial patterns of conflict and cooperation.

COMMON CORE STATE STANDARDS CONNECTIONS

ELA/Literacy

- Cite specific textual evidence to support analysis of science and technical texts (RST.6-8.1)
- Distinguish among facts, reasoned judgement based on research findings, and speculations in a text. (RST.6-8.8)
- Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and evidence is relevant and sufficient to support the claims. (RI.6.8)
- Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (WHST.6-8.2)
- Draw evidence from literary or informational texts to support analysis, reflection, and research. (WHST.6-8.9)
- Engage effectively in a range of collaborative discussion (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, issues, and building on others' ideas and expressing their own clearly. (SL.8.1)

Mathematics

- Model with mathematics (MP.4)
- Use ratio and rate reasoning to solve real-world and mathematical problems (6.RP.A.3)
- Summarize numerical data sets in relation to their context. (6.SP.B.5)

FOR FURTHER EXPLORATION

Mara Conservancy
https://www.maratriangle.org/

National Geographic: Battle for the Elephants – Education
https://www.nationalgeographic.org/education/battle-for-elephants/

National Geographic: Big Cats Initiative
https://www.nationalgeographic.org/projects/big-cats-initiative/

National Geographic: Conservation – Encyclopedic Entry
https://www.nationalgeographic.org/encyclopedia/conservation/

National Geographic: Poaching – Education
https://www.nationalgeographic.org/topics/poaching/

Nature Conservancy: Africa
https://www.nature.org/ourinitiatives/regions/africa/index.htm

Panthera: Panthera's Initiatives
https://www.panthera.org/initiatives

Smithsonian Environmental Research Center: Biodiversity & Conservation
https://serc.si.edu/research/research-topics/biodiversity-conservation

South Africa National Parks – Kruger National Park
https://www.sanparks.org/parks/kruger/

United Nations Environment: Climate change
https://www.unenvironment.org/explore-topics/climate-change

United Nations Environment: Ecosystems
https://www.unenvironment.org/explore-topics/ecosystems

Wildlife Conservation Society: Africa
https://www.wcs.org/our-work/places/africa

World Wildlife Fund: Deforestation
https://www.worldwildlife.org/threats/deforestation

World Wildlife Fund: Illegal Wildlife Trade?
https://www.worldwildlife.org/threats/illegal-wildlife-trade

CREDITS

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Mike Ulica, Interim President and CEO
Jean Case, Chairman

Kim Hulse, Vice President, Education Programs
Lina Gomez, Vice President, Global Education Strategy

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Writer
Alexandra M. Silva, Science Educator, Peter Gruber International Academy, Virgin Islands 9-12 International Baccalaureate MYP Science, DP Biology, and DP Environmental Systems & Societies MEd Instructional Leadership: Science Education; MS Ecology & Evolution

Editor
Jeanna Sullivan, National Geographic Society

Project Specialist
Sarah Appleton, National Geographic Society

Educator Reviewers
Kelly Blais, M.Ed.
Melissa Miller, Teacher
Melissa Motes, Teacher
Heidi Ragsdale, STEM Educator
Sandy Wisneski, Teacher

Expert Reviewer
Deirdre A. Doherty, Ph.D., Conservation Ecologist

Graphic Designer
Keven Ramirez, Divertido Design

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