THIS WORLD OF HUMANS

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This World of Humans: Episode #12
Guide for Educators

Hippos and River Ecology

These activities address LS2.A,B,C and LS4.D as well as specific Cross-Cutting Concepts and Science and Engineering Practices (see page 8). Many are also suitable for courses designated as "Writing-Intensive."

About the Article

This article describes a study in which a team of scientists observes over multiple years how *H. amphibius*—commonly known as the hippopotamus—shapes the chemistry and ecology of aquatic communities in sub-Saharan Africa. Findings suggest that human activity has contributed to the redefining of the hippo's role in ecosystem diversity as evidenced by water chemistry and biodiversity differences during the dry season.

About the interview

Dr. Keenan Stears discusses the uniqueness of the study design and what implications findings have for understanding the role of hippos in influencing water chemistry and aquatic biodiversity.

Both the article and the interview can be found here: https://www.visionlearning.com/en/twoh#ep12

Recommended: pair these materials with the Visionlearning Modules: *Factors that Control Regional Climate* and *Factors that Control Earth's Temperature*. For a refresher in the processes of science, see the Visionlearning modules on *Scientific Communication, Understanding Scientific Journals and Articles*, and/or *Using Graphs and Visual Data in Science*. (www.visionlearning.com)

Use in the Classroom

These materials are useful for exploring ways in which scientists design studies to address gaps in research in order to better understand ecosystems and the effects of human activity on climate change. These materials also assist in building understanding of how scientists make sense of data and communicate their findings to various audiences. Students may benefit from listening to the interview before reading the article.

1. **Pre-reading and pre-listening activities** are provided to prompt prior knowledge and help students make connections between the research they are learning about and their own lives. Materials may be used in the classroom to generate discussion, or as homework if the article or interview will be read/listened to in-class. Having students write before speaking helps focus discussions and reading.
2. The **worksheets** are explicitly designed to walk students through the process of reading a scientific paper and build disciplinary vocabulary. Worksheets serve as excellent homework assignments (if the article is read outside of class) and will direct students toward identifying important information about the research. While the answers provided can be used to check student reading, it is really an opportunity to assist students in how to read scientific material. Completed worksheets are excellent for small group discussions or as a debrief with the entire class.
3. **Post-reading and -listening activities** are designed to extend student thinking and engage them more deeply with the text and interview. These questions are great for small groups, for large class discussions, or for short-answer writing assignments.

Pre-reading and –listening activities

1. **Free-association exercise and discussion:** Provide students with the Free-Association Worksheet and instruct them to write words or adjectives they typically associate with each species around/inside of the graphics (3-5 minutes); students should write down whatever words first come to mind. Then, instruct students to write out a list of the ways in which they think or know each species effects their environment in the space provided below each image (5-10 minutes). As a class or in small group discussion, invite students to share their initial impressions of each species and assumptions about environmental impact. There is an option to add a short essay response as a follow up to this activity (recommended 1-3 pages) to reflect critically on what students wrote on their worksheets.

   Suggested short essay prompt: *As you look over your worksheet, compare and contrast the words and behaviors you associated with each species. Were any words more positive or negative? How does your own behavior as a member of* Homo sapiens *affect your ecosystem? Do you think its important to understand how human behavior impacts other ecosystems and species like* H. amphibius? *Explain your thinking.*

2. **Vocabulary preparation:** Provide students with the Vocabulary Worksheet and ask them to offer definitions. Clarifying terminology as a class is recommended. This worksheet is suitable for a 20-minute in-class activity if students have access to dictionaries or the internet. Many of the terms are specific to biology, thus *context* is critical to reinforce when assigning this activity.

Post-reading and –listening activities

1. **Revisiting vocabulary in small groups:** Using the vocabulary sheet students completed at the start, clarify in groups how the authors used terms. Does everyone in the group have matching definitions? If not, which definitions are most appropriate in context? Why? Share any disparate definitions in a full class discussion and explain how your group decided which definitions were ultimately most appropriate.

2. **Method Worksheet:** Use the worksheet as an in-class activity and follow-up with an in-class discussion or lesson about the scientific method and collecting and interpreting data—you can opt to pair this with the Visionlearning module *The Practice of Science*. (https://www.visionlearning.com/en/library/Process-of-Science/49/The-Practice-of-Science/148)

3. **Visualizing Findings Worksheet:** Use the worksheet as a take-home assignment for students. It should be paired with the Visionlearning module *Using Graphs and Visual Data in Science*. (https://www.visionlearning.com/en/library/Process-of-Science/49/Using-Graphs-and-Visual-Data-in-Science/156) If students are color-blind or choose not to color, you can adapt this for accessibility by instructing students to use patterns (drawing vertical or horizontal lines, for example) instead of coloring.

4. **Interpreting Results:** Use the questions below as small-group or whole class discussion questions to promote abstract and critical thinking:

   - What made the experimental context of the Great Ruaha River useful for this study?
   - What is different about what this study did as opposed to other studies done on hippos?
   - What does Dr. Stears mean by "One animal's waste is another's feast?" How do you know?
   - How has human alteration of environmental variables affected the ecosystem in the study?

Extension activities

Vocabulary Worksheet

Below are a list of terms and phrases that you will encounter while reading the article and listening to the interview. Using a dictionary, provide definitions for each term or phrase. If you cannot find a formal definition, write down what you *think* the term or phrase might mean. Keep in mind that the meanings of these terms *in science* may be different from the way we used them in common speech.

(For expected answers to these questions, see https://www.visionlearning.com/en/twoh/request)

Anthropogenic

Ephemeral

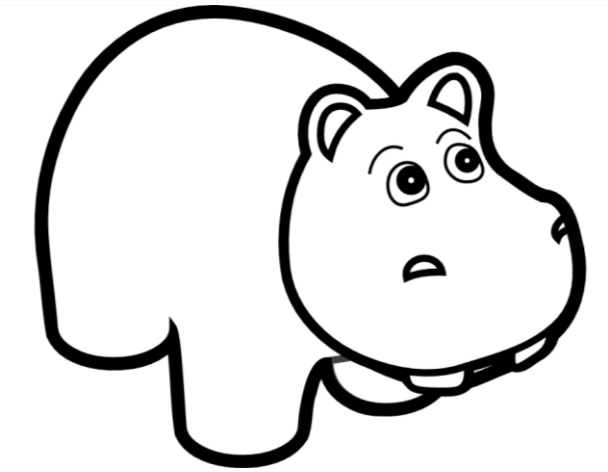
Eutrophication

Hydrology

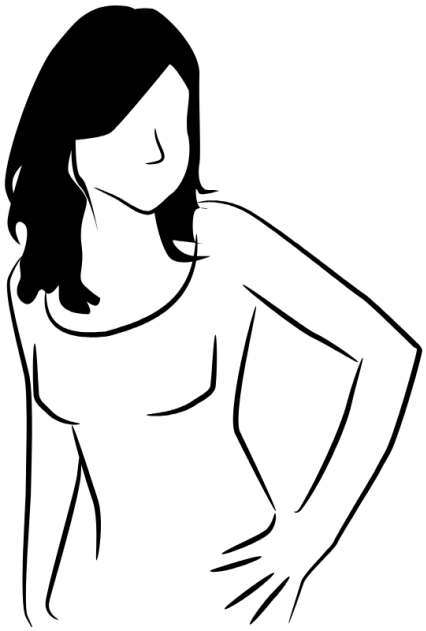
Semiaquatic species

Free-Association Worksheet

What words do you associate with each species below?



Hippopotamus amphibius



Homo sapiens

How does each species affect its environment?

H. amphibius

Homo sapiens

Prepared by K. Oddis

Method Worksheet

Use this worksheet in connection with the Visionlearning module *The Scientific Method*.

(For expected answers to these questions, see https://www.visionlearning.com/en/twoh/request)

1. The high- and low-density pools were used as experimental replicates where **what** was sampled? **What** was measured?

2. Write out the **research questions** that guided the study. Where are the research questions outlined in the article?

3. What was the **hypothesis** or **prediction** of findings?

Visualizing Findings Worksheet

Use this worksheet in connection with the Visionlearning module *Using Graphs and Visual Data in Science*.

4. Discuss the use of visual aids and graphic elements in this study. How did the visual aids enhance the authors' presentation of data and findings?

5. Choose one figure from the study and describe what makes it helpful for audience interpretation of results.

Now, interpret the results of the study visually below. Identify the number of sampling pools used in the study. Then, draw circles to represent each sampling pool. Color or pattern in the number of sampling pools that correspond to each season: yellow or vertical lines for dry season 2013; blue or horizontal lines for wet season 2015; brown or diagonal lines for dry season 2015. Then, label the number of high density (H) and low density (L) pools in each category.

Total # of sampling pools: _____
 # dry season 2013: _____ # wet season 2015: _____ # dry season 2015: _____

Targeted NGSS, Cross-Cutting Concepts, and Science and Engineering Practices

The activities in this guide can be used to address the following standards, concepts, and practices.

Next Generation Science Standards	
LS2.A: Interdependent Relationships in Ecosystems	• Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	• Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations (MS-LS2-4) • 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. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) • 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. (HS-LS2-7
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. (secondary to HS-LS2-7) (HS-LS4-6)
Science and Engineering Practices	
Asking Questions and Defining Problems	• Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions about what would happen if a variable is changed. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
Planning and Carrying Out Investigations	• Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. • Select appropriate tools to collect, record, analyze, and evaluate data. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
Analyzing and Interpreting Data	• Apply concepts of statistics and probability to scientific and engineering questions and problems, using digital tools when feasible. • Analyze and interpret data to determine similarities and differences in findings. • Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships.

Targeted NGSS, Cross-Cutting Concepts, and Science and Engineering Practices

The activities in this guide can be used to address the following standards, concepts, and practices.

Cross-Cutting Concepts	
Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them	• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. • Patterns can be used as evidence to support an explanation. • Patterns can be used to identify cause and effect relationships. • Graphs, charts, and images can be used to identify patterns in data.
Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering	• Events have causes that generate observable patterns. • Cause and effect relationships are routinely identified, tested, and used to explain change. • Cause and effect relationships may be used to predict phenomena in natural or designed systems. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Changes in systems may have various causes that may not have equal effects.
Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change	• Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g. linear growth vs. exponential growth).