HOW TO USE THIS RESOURCE

The images for this resource, which show three examples of animals that live in groups, can serve as phenomena to explore the key concepts described below.

The pedagogical practice of using phenomena to provide a context for understanding science concepts and topics is an implementation practice supported by the Next Generation Science Standards (NGSS). Phenomena are observable occurrences that students can use to generate science questions for further investigation or to design solutions to problems that drive learning. In this way, phenomena connect learning with what is happening in the world while providing students with the opportunity to apply knowledge while they are building it.

The "Implementation Suggestions" and "Teacher Tips" sections provide options for incorporating the images into a curriculum or unit of study and can be modified to use as a standalone activity or to supplement an existing lesson. The student handout includes reproductions of the images and the "Background Information" section.

KEY CONCEPTS

A. Group behavior can increase the chances for an individual and a species to survive and reproduce.

NGSS PERFORMANCE EXPECTATIONS

HS-LS2-8. Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

BACKGROUND INFORMATION

Fish

Unlike human schools, fish schools are self-organizing. Thousands of fish swimming together are better able to avoid predators and catch their prey without ever colliding with each other. Fish use less energy when swimming in a school than alone, probably because they are able to take advantage of the movement of water created by their neighbors.

Elephants

Female elephant herds are made up of related females and their young. The herd is led by the matriarch, which is usually the oldest female of the group. Males leave the group when they become sexually mature (typically at 12–13 years of age) and form their own groups. The matriarch sets the activities of the herd: when she moves, other elephants follow in a line; when she stops to eat, they spread out to eat; and when the herd is threatened, the elephants cluster around the matriarch and follow her lead. When herds move across an open area in daylight, individuals typically bunch together and move quickly until they reach cover.

Bees, Part 1

A honey bee hive contains mostly female worker bees, a few male drones, and a single queen. The role of the queen bee is reproduction. She can lay as many as 1,500 eggs per day in the spring when the size of the hive population rapidly increases.

Bees, Part 2

The queen's every need is provided for by designated worker bees, which provide her with food and even dispose of her waste. Honey bees have thrived on this planet for over 10 million years but are now threatened by colony collapse disorder, the disappearance of the majority of worker bees in a colony. Scientists think the disorder might be caused by a combination of a parasitic mite that sucks the bees' blood, pesticide use, disease, and habitat loss.

IMPLEMENTATION SUGGESTIONS

The following suggestions outline several options for incorporating the images into a unit of study as phenomena:

Engagement, establishing prior knowledge, and providing context:

- Have students examine the fish image and ask them to record the fish behaviors depicted.
  - Ask them to brainstorm the survival or reproductive advantages that these behaviors might confer.
  - The table found in the "Student Handout" may be helpful in having students organize their thoughts.
  - Ask students how this behavior might affect an individual fish versus the group of fish depicted. Student answers may include that an individual fish on the outskirts of the school may be more likely to be subject to predation, but that the group is more likely to survive.
  - Relate schooling behavior to flocking or herding behavior in terms of predator avoidance, or birds flying in a V formation to explain using hydrodynamic disturbances. Alternatively, ask students to suggest other behaviors to compare with the behavior of fish.
  - Have students read through the associated caption to see if the caption contents confirm their ideas.
- Repeat the implementation sequence above with the elephant image.
  - Encourage students to identify similarities or differences between the elephant and fish pictures. Students may identify the role of the matriarch elephant as the group leader, the role of group behavior in avoiding predation, etc.
  - Ask students how the behavior they identified might affect an individual elephant versus the group of elephants depicted. Student answers may resemble those provided for the fish image. One important difference is that the matriarch is more or less likely to survive based on the group's behavior.
  - Have students read the associated caption. Point out to students the timing of when males leave the group. The fact that males only leave the protection of the group once they are sexually mature helps ensure that elephants reach reproductive age, directly contributing to increased survival of the species.
- Repeat the same implementation sequence as above with the bee image.

Exploration, investigation, and assessment:

- Investigate: To further investigate bee behavior, ask students if they think honey bees are solitary or if they live in groups. (Note: some bee species are not eusocial.)
  - Display the first two sentences of the caption ("Bees, Part 1") and have students identify which behaviors would likely be performed by non-queen bees and write down these behaviors in the table in the "Student Handout." Have students suggest the survival advantages of this division of labor.
  - Have students read the remainder of the caption ("Bees, Part 2"). Note that worker bees are not fertile and therefore do not pass on their genes. Have students brainstorm the reproductive advantages of this division of labor.
- Assessment: Using one or more of the images/captions above, ask students to construct an explanation that supports the claim that there is a cause-and-effect relationship between various kinds of group behavior and individual survival and reproductive rates.

TEACHING TIPS

- Present students with the images first, before they read the background information.
- Background information may be edited to support student proficiency, course sequence, etc.
- The images may be projected in lieu of handouts.
- Printed images can be laminated for use in multiple classes.
- Pair or group students to work through one or more of the implementation suggestions.

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