

07-LS1-4
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TRIED AND TRUE

Let's play that again! Engaging students in ecology by using instructional games

by Vanessa A. Klein

Although we might think of play as something that students do when they are not learning, this is far from the reality. When children play, they learn, and they do this without the assistance of lesson plans or purposeful teaching by adults (Gehlbach 1986). Teachers can harness the power of play as an instructional strategy in their classrooms. Instructional play is a way to provide an overarching, purposeful structure to games in order to create a specific outcome (Gehlbach 1986).

Games are a good fit in the Engage portion of the 5E learning cycle (Trowbridge, Bybee, and Powell 2000). An instructional game can serve to focus students' attention, awaken their interest, help them connect to their prior knowledge, stimulate their thinking, and encourage them to question. A well-placed game can also act as a discrepant event to elicit student misconceptions about a concept and begin the process of conceptual change. Similar to a discrepant event, a learning game can function to get the attention of students, provoke thought, cause students to wonder why the game happened as it did, elicit misconceptions, and initiate student questions and inquiry. For example, after playing the mating game, a student may ask, "Why didn't everyone find a mate?" This question could then lead to a discussion on competition between organisms.

This article describes two ecological games, the Salmon Game and the Mating/Animal Communication Game, which can be used in an outdoor education context, as well as in a classroom. The games are great ways to introduce ecological concepts in your middle school science classroom. It is important for students to understand ecological processes. When students are taught ecology through traditional lecture types of instruction, they are apt to think that science is a collection of discrete facts. Ecology is all about connections and interactions at multiple levels, and these two ecological games can be a great introduction to these concepts.



You can use both of these games to elicit student misconceptions. Asking some leading questions about concepts represented in the games can show you where students are with these topics. If you aren't going to use the games themselves to do this, determine students' existing knowledge by asking questions to the class, having students fill out an entrance slip, engaging the class in a discussion, or having students draw up a quick graphic organizer.

The Salmon Game

The Salmon Game addresses concepts of life cycles, ecology, and human impact, as well as several *Next Generation Science Standards* (see sidebar, p. 8). The game represents a part of the life cycle of anadromous salmon species in which the salmon return from the ocean to freshwater streams in order to spawn. During the game, students pretend to be spawning salmon and act out several ecological concepts involved with the biological process of spawning. The game can be used to introduce life cycles, food webs, life

strategies, population ecology, and humans as part of the biosphere.

Setup and gameplay

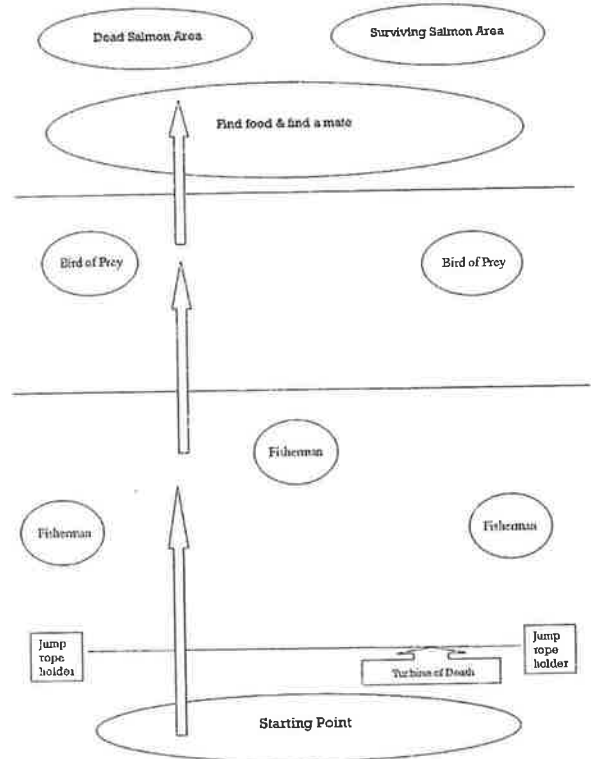
Along with the following directions, use Figure 1, Salmon Game Setup, for clarification. You will need an approximately 3 m × 4.5 m (10 ft. × 15 ft.) area, either inside or outside, to play the Salmon Game. This space is enough for a typical class of 30 students. If you want to play the game with more students at once, such as with an entire grade, it would be better to play the game in a gymnasium or larger outdoor area. You might also want to increase the actual game space to around 4 m × 6 m (13 ft. × 19 ft.). Separate this area into three sections, one after another like the rungs of a ladder (see Figure 1). Each of these sections represents a barrier to the salmon, and students will have to make it through all the barriers to survive.

Safety note: Before playing the game, make sure to remind your students to play safely and not get too rough with each other. Because students will be running together in a group, it is important to set up whatever safety rules you feel are appropriate.

The game begins with the students gathered at the starting point in front of the “turbine of death,” a long jump rope operated by two students (see Figure 1). Students playing salmon need to get through the turbine of death without being touched by the rope. If students are touched by the rope, they must head to the dead-salmon area (see Figure 1). The first time through the game, many students will attempt to make it through the turbine on their own. This is not a good strategy to use, as the lone “salmon” will be caught easily by a bear, bird of prey, or fisher once they pass through the turbine. Discuss the lone-salmon strategy with students after you have completed the game. Through questioning, try to lead students to the realization that salmon move in schools, which is a survival strategy. If you have time, replay the game so students can test the effectiveness of the school strategy. If time is limited and you have time for only one round of the game, you may want to encourage students to move in schools after the first few lone salmon are picked off by predators.

The first section of the 3 m × 4.5 m area should have two or three fisher people in it. If you have enough adults, they can act as the fisher people. If not, select a few students. Students who are the fisher people stand in one place and cannot move around. As salmon swim

FIGURE 1 Salmon game setup



by, the fisher people try to reach out to tag them, which simulates catching a fish. Salmon students who are tagged by fisher people must go to the dead-salmon area.

The second section should have a bird of prey and a grizzly bear. Students who are the bird of prey and bear can move freely in their section but must actually catch salmon by grabbing or tagging them with both hands (remind these students not to be too rough when they tag or grab students who are salmon). Salmon that are caught by predators must go to the dead-salmon area.

The last area is where the surviving salmon go to find food to survive and a mate. If the game is being played in a classroom, gym, or hallway, you can use poker chips, slips of paper, paperclips, or the like as food. If the game is being played outside, you can use rocks, twigs, or such as food. Each salmon needs to collect at least three pieces of food and one mate (an-

other student who has made it that far) before going to the surviving-salmon area. Lay whatever food items you are using on the ground in this last section. You should limit the number of food items so that there is not enough food for the salmon students who make it that far. I usually assume that at least half of a group of 30 students will not make it past all the barriers, so I will put enough “food” out for a little less than half of the number of students who will be salmon. If a salmon does not find enough food or does not find a mate, then that student must go to the dead-salmon area. Salmon who make it through all the obstacles go to the surviving-salmon area.

Follow-up

The Salmon Game can help introduce several ecology concepts. For your students to use the game as a learning tool, you will need to debrief after the game. Asking questions such as “Why was it helpful for you to ‘swim’ in a school?” “Why do you think not everyone found a mate?” or “Why might salmon produce so many young, and how does this differ from the way other organisms, such as primates, reproduce?” Your questions should reflect what you want students to get out of the game. You could focus on several concepts. Many organisms have evolved complex life cycles, such as the multiple species of salmon; in its simplest form, the salmon life cycle is hatch, migrate, spawn, and die. The salmon bring nutrients from the ocean to the rivers and streams. The game can also introduce predator-prey interactions such as food webs, food chains, and population interactions (such as the snowshoe hare and the lynx). Survival strategies can also be discussed after the game or between each game if you play more than once. The game can be used to portray strategies including migration (salmon exhibit reproductive migration), anadromous strategies (salmon live in the ocean but breed in freshwater), and reproductive strategies (salmon are an example of an *r-selected species*, meaning they produce an overabundance of young in the hope that a few will survive into adulthood). Population ecology concepts such as carrying capacity; mating behavior; and competition for resources, mates, and habitat can also be introduced. Beyond ecology concepts, you can discuss human impact on the environment.

If used in the Engage portion of the learning cycle, the game can serve as a springboard into a myriad of ecology concepts; in later phases of instruction, you

can continue to use aspects of the game as examples that students are familiar with through playing the game. For example, if students are learning about terms such as *anadromous* or *carrying capacity*, you could have students recall playing the salmon game in order to demonstrate what some of these terms mean. It is important to ask students some higher-order questions so that you can formally assess what students learned from the game. An example of this type of question might be “If salmon cannot make it upstream to spawn because of damming of a river, how might this affect the bear population?”

The Mating/Animal Communication Game

Depending on what you are using the game to demonstrate, you can either call this game the Mating Game or the Animal Communication Game. The two basic premises of the game are animal communication and the different ways that animals attempt to find mates. Animals communicate in several ways and sometimes communication plays a role in finding, attracting, or selecting a mate. Usually, a species will mate only with others of its species, so organisms need a strategy to find one another. To find each other and choose a mate, animals use several strategies. For example, coral wait for a certain night of the year and then release all of their reproductive cells into the water. Other animals release pheromones to let potential mates know they are fertile and ready to mate. Complex behaviors have also arisen in situations where competition for mates is a factor. Frogs use calls to communicate during the mating season and to let other frogs know where they are. Animals and even plants use a variety of communication strategies and communicate for different purposes, such as for mating, marking or defending a territory, and warning other animals. Using this game, your class can explore these strategies.

Setup

The point of the game is for students to “communicate” in different ways in order to find a mate of their own species. You could play this game with a class of about 30, or you could play the game with an entire grade of students. You would just adjust the number of materials accordingly. Begin by assembling the following materials, which students will use to attempt to find a mate.

Materials

- For a quarter of the class: Open film canisters or disposable paper cups filled with different-smelling substances, such as cinnamon, vinegar, garlic, nutmeg, and perfume (sprayed on some paper); you will need two of each scent, but make sure to have at least one odd-numbered grouping (1 or 3) so that at least one student won't be able to find a mate. Make sure to check for student allergies to any scents that you are using.
- For a quarter of the class: Visual items, such as headaddresses students can wear, colored pieces of paper they can hold, or stickers they can put on their clothing. You will need two of each visual, but make sure to have at least one odd-numbered grouping (1 or 3) so that at least one student won't be able to find a mate.
- For a quarter of the class: Index cards describing behaviors for students to act out. If you don't have index cards, you could just write the behaviors on sticky notes or scraps of paper, or just tell the students which behavior they should do. Examples of behaviors might be waving, bobbing heads and the like. Assign two of each behavior, but make sure to have at least one odd-numbered grouping (1 or 3) so that at least one student won't be able to find a mate.
- For a quarter of the class: Index cards describing sounds for students to make, such as howling, clicking, and chirping. Assign two of each sound, but make sure to have at least one odd-numbered grouping (1 or 3) so that at least one student won't be able to find a mate.
- Since you have few uneven numbered groups, not all students will find a mate. Use this situation to talk about competition for mates and the idea that not all animals get to pass on their genes.

Play

All students are assigned a scent, visual, sound, or behavior. Once they have their assignments, students move around the space performing their task while looking for another student who is performing the same task. Once they have found a partner, the pair stays together. Not all students will find a partner by the end of the game.

Follow-up

The mating game is useful for introducing several ecology and animal-behavior concepts. For students to learn from the game, you will need to ask some follow-up questions and have a short discussion after the game. Your questions/discussion should reflect whatever concepts you want to highlight. For example, you might start out by asking, "Besides finding a mate, what are some other reasons that animals might communicate?" Animals have different communication strategies and communicate for different purposes, such as for mating, marking or defending a territory, and warning other animals that they are poisonous or unsavory. You can also introduce content on why animals might form social groups and how social animals communicate. For example, bees have a complex dance they perform to show others where a food source is located, wolves use body language and posture to enforce a hierarchical social structure, and primates bond with their peers by grooming one another. A more advanced concept to discuss is the role of pheromones in animal communication. The scented canisters in the game are meant to represent *pheromones*, or chemical signals that animals use to attract a mate or to advertise that they are available. The game can also be used to introduce sexual selection and the concept of competition for mates, as well as go into how some animals evolve exaggerated features such as large antlers or long tail feathers. Like the Salmon Game, the Mating Game is a great fit in the Engage portion of the 5E learning cycle. Playing the game with students allows the introduction of many ecology concepts and interests them in learning the content. To formatively assess what your students got out of the game, ask some higher-order thinking questions. After playing the game, you might ask students "How does what you did represent how some animals might communicate?" or "What are some reasons that animals communicate?"

Conclusion

If you have ever taken part in outdoor environmental education or brought your students to an environmental education facility, then you have seen how engaging hands-on and active instruction can be for students. In classrooms, ecology instruction is often factual and sedentary. However, you can bring that environmental education experience into your classroom. Through ecological games and activities that get students out

Connecting to the Next Generation Science Standards (NGSS Lead States 2013)

<p>Standards MS-LS1. From Molecules to Organisms: Structures and Processes http://nextgenscience.org/msls1-molecules-organisms-structures-processes MS-LS2. Ecosystems: Interactions, Energy, and Dynamics http://www.nextgenscience.org/msls2-ecosystems-interactions-energy-dynamics</p>		
<p>Performance Expectations The materials/lessons/activities outlined in this article are just one step toward reaching the performance expectation listed below. MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.</p>		
Dimension	NGSS code/citation	Matching student task or question taken directly from the activity
Science and Engineering Practices	Asking Questions Constructing Explanations and Designing Solutions	Students ask questions about biological and ecological processes after game play. Students use games to construct explanations of ecosystem dynamics and animal communication.
Disciplinary Core Ideas	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Animals engage in characteristic behaviors that increase the odds of reproduction. <p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. <p>LS2.D: Social Interaction and Group Behavior</p> <ul style="list-style-type: none"> Being a part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. 	<p>Students re-create biological concepts and ecological processes through game play.</p> <p>Example questions:</p> <ul style="list-style-type: none"> Why was it helpful for you to “swim” in a school? Why do you think some students did not find a mate? Why might salmon produce so many young, and how does this differ from the way other organisms, such as primates, reproduce? If salmon cannot make it upstream to spawn because of damming of a river, how might this affect the bear population? Besides finding a mate, what are some other reasons animals might communicate? How does what you did represent how some animals might communicate?
Crosscutting Concept	Systems and System Models	Students use examples from the games to investigate ecological systems.

of their chairs, students will be engaged and ready to learn more about ecological concepts. Students, especially kinesthetic learners, enjoy getting to move around and use their bodies while they learn. The games described here will help motivate your students to learn and love ecology.

Both the Salmon Game and the Mating Game can introduce students to several biological concepts. Teachers can manipulate the rules or structure of these games to introduce, exclude, or emphasize various concepts and core ideas. You can remind students about a certain feature of the game in order to highlight a concept that you are teaching later on or have students identify certain concepts they have learned previously while playing the game. However you choose to use these games in the classroom, your students will be engaged in learning. ■

References

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