It's All Connected: Trophic Tag

In this game, students play the roles of phytoplankton, copepods, bay anchovies, striped bass, bacteria, and fishermen. Each round of the game simulates different scenarios of organism composition and ratios within an ecosystem to illustrate the concepts of ecological balance and interdependence. The game simulates a food chain through a highly simplified scenario; in the actual environment, many species eat more than one type of food. The food chain in this game can be a strand in a more complex food web. The game works best with 15-30 students.

Materials

- Organism ID Cards (see below), printed out and preferably laminated
- 50-150 ping-pong or nerf balls
- 1 gallon plastic bags (one for each student)

Introduction

Ask students where all their energy comes from. Ask what they had for dinner last night. Ask how the energy in their food links back to energy from the sun (diagram on dry erase board if available).

Have 6 volunteers come to the front and give each volunteer a food chain card. Ask the volunteers to line up in the order of a food chain. Review food chain/energy flow through ecosystem concepts: plants (phytoplankton) use light energy to photosynthesize, producing their own "food;" zooplankton, some small fish, and filter feeders eat the phytoplankton to obtain energy (in this case we use copepods); other small fish and filter feeders eat the zooplankton (here bay anchovies); large fish eat the small fish (rockfish), people catch the large fish; bacteria decompose dead things and other organic matter (like waste), recycling nutrients back into the system.

Ask students which organisms are primary producers? Which are primary consumers? What are secondary consumers? What are tertiary consumers/apex predators?

Set-up

1. Print out and laminate the Organism ID cards (available below).
2. Identify boundaries of your ocean ecosystem with cones, about a half basketball court size.
3. Scatter plankton (ping pong/nerf balls) randomly around the playing area, reserving a bunch for use in Round 3.

Rules

1. Everyone has to stay within the boundary.
2. Everyone has to stop "feeding" promptly when instructor indicates.
3. No running: copepods can only hop because this is how copepods move in the water; fish can power walk.

Round 1: Primary consumers (15-30 copepods)

4. Distribute a copepod ID tag to each student.
5. Hand students a stomach (gallon size plastic bag). Students can place ID cards in their plastic bags. Have them start "swimming"/hopping around the ecosystem. When you say go, students will try to fill their stomachs with as many "phytoplankton" as they can.
6. Start the round, continuing until all phytoplankton are consumed. Give signal to stop feeding. Ask students how many copepods filled their stomach with 6 or more balls? These copepods survived. What happened to all the food?
7. Introduce concept of carrying capacity: that resources in a system can only support certain number of organisms indefinitely. What will happen in the bay now that all the food is gone? How could we balance the Bay?
8. Have students return plankton to the playing area.

Round 2: Secondary consumers (switch out 4-6 copepods with bay anchovies, depending on class size)

1. Place 2 hula hoops in the ecosystem as hiding places for copepods. Only one person at a time can hide in a hula hoop for only 5 sec at a time, and students must take 5 steps away from the hula hoop before reentering.
2. Add secondary consumers to the ecosystem. Tell students that bay anchovies eat zooplankton, like copepods. The anchovies are now "it" and need to tag copepods. If a copepod is tagged, he/she is eaten and has to empty the contents of his/her stomach into the anchovy's bag, then sit out on the side. Meanwhile, copepods are still hungry—they still need to eat while trying to avoid the predators.
3. Begin feeding, continuing until most of the plankton have been eaten. How many copepods have plankton in their stomachs? Those copepods survived. How about the anchovies?
4. What would happen to the food if we kept playing? Is there anything missing?
5. Have students return plankton to the playing area.

Round 3: Decomposers (switch out 1-4 copepods with bacteria—there are actually more bacteria than this in the real world, but this number works for the game)

1. Now when copepods are tagged, they hand over half of their "phytoplankton" to the anchovy, then go to the side and pair up with a bacterium to start the decomposition process: bacteria decompose dead things and organic matter (like waste, food particles from sloppy feeding, etc.), releasing nutrients. Since nutrients fuel phytoplankton growth, the pair can throw the copepod's left over ping-pong balls back into the ecosystem. These phytoplankton provide new food for the copepods.

2. Start this round of feeding. If things are going well, you can add some copepods back into the game to illustrate reproduction. Stop until most phytoplankton are consumed or after the ecosystem persists for a few minutes.
3. How many copepods survived? Anchovies? How did the bacteria impact the system? Is the system balanced? Is anything else missing?
4. Have students return plankton to the ecosystem.

Round 4: Apex predator (switch out 1-3 copepods with rockfish/striped bass)

1. Replace a copepod with a rockfish. You can have some copepods switch out with anchovies/bacteria as well so that everyone gets a chance to be "it."
2. Rockfish eat anchovies. Anchovies still eat copepods, copepods still eat phytoplankton, and bacteria are still decomposers. Again, if a student is tagged, he/she hands over half of his/her phytoplankton to the predator, then sits on the side to share the rest of the phytoplankton with bacteria, throwing the phytoplankton back into the game. Hula hoop rules still apply (one critter at a time, no hovering near the hula hoop). How many of each species survived? Is the ecosystem in balance? If not, how could you adjust the number of each organism to achieve balance?

Round 5: Humans as apex predators (switch out 1-2 copepods with a fisherman/woman)

1. Discuss how people are part of an ecosystem and how they might impact it.
2. Select a copepod to be a fisherman. Fishermen need to first find bait—by tagging and linking arms with an anchovy—before they can fish. The linked anchovy and fisherman try to catch a rockfish. The fisherman takes any caught rockfish and his/her food to the edge of the lake. At the end of the round, ask what happens to the energy from the rockfish caught by the fisherman.
3. Determine who survived and whether the system is in balance (there should be more copepods than anchovies, more anchovies than rockfish, etc. What would happen if there were too many rockfish? What would happen if fishermen caught too many rockfish?
4. If there's time, try to balance the system by adjusting numbers of each species.

Wrap-up

Review key concepts. What do students think might happen in the bay if rockfish were overfished? Review the concept of interconnectedness. Why are bacteria so important? Discuss the idea of food webs: real ecosystems are complex and are composed of many food chains with multiple pathways to and from each organism.

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This activity was adapted from Minnesota Department of Natural Resources MinnAqua Program, "Food Chain Tag," *Leader's Guide* 2007, pp. 1:2-1-1:2-28 and tested by over 450 students by COSEE Coastal Trends through the University of Maryland Center for Environmental Science Horn Point Lab Science, STEM Education Program.