



## Islands in the Stream 2002: Exploring Underwater Oases

# Reproductive Lottery

### FOCUS

Reproductive strategies of reef fishes

### GRADE LEVEL

9-12 (Biology)

### FOCUS QUESTION

Why do spawning reef fishes come together in such large numbers to spawn, and why do they release such large numbers of eggs?

### LEARNING OBJECTIVES

Students will be able to explain that fishes that reproduce externally have to release great numbers of eggs and milt (sperm) in order to ensure fertilization.

### ADDITIONAL INFORMATION FOR TEACHERS OF DEAF STUDENTS

In addition to the words listed as Key Words, the following words should be part of the vocabulary list.

Reproductive  
Adaptation  
Spawning  
Fertilization  
Gametes  
Vulnerable  
Aggregation  
Spawn

There are no formal signs in American Sign Language for any of the key words and many are difficult to lipread. Writing these words on the board to refer to during the lesson will be extremely helpful. They can also be given to the students as

a handout. This activity is very visual and should be very easily understood by the students.

Suggested Learning Procedure Modifications:  
Step #2: Give the class five sheets of typing paper. Have them cut each sheet with scissors into 20 postage size pieces of paper and place all 100 pieces into a bowl or container.  
Step #3: Divide class into two equal groups, of which half will represent female fishes and the other half will represent male fishes.

### MATERIALS

- Typing paper
- 3 sets of red, blue, yellow, orange and green markers
- Scissors
- 2 large bowls or containers

### TEACHING TIME

One 45-minute class period

### SEATING ARRANGEMENT

Groups of 10

### MAXIMUM NUMBER OF STUDENTS

20 students

### KEY WORDS

External fertilization  
Fecundity  
Spawning aggregation

## BACKGROUND INFORMATION

Though some animals ensure the survival of their species by staying with their offspring during the beginning of their lives and providing them with protection and care, others ensure the survival of their species by playing the odds. A 12-year old red snapper will release over nine million eggs in one spawning because only a very small percentage of these eggs will result in a fertilized egg and resulting larva that will survive to reach adulthood. This is a reproductive strategy, because at least a few of those millions will survive just by beating the odds, and the snapper does not have to expend energy on parental care and instead, can put energy towards her own survival and be ready to spawn again the next year.

Reef fishes of the South Atlantic Bight, such as the gag grouper and red snapper, have high fecundity (large numbers of eggs and sperm per individual); a reproductive adaptation that ensures that at least some of the offspring will survive to reach adulthood. Groupers and snappers are solitary, territorial fishes that claim a spot on a reef habitat and remain there almost the entire year. Though living alone in a territory provides these fishes with enough food, it does not provide the opportunity for congregating with large numbers of members of the same species for reproduction. To address this need, snappers and groupers and other territorial reef fishes will leave their territories at approximately the same time each year to come together in large spawning aggregations. Populations of these fishes will meet at the same site each year to release eggs and milt into the water for external fertilization. These aggregations once numbered thousands of fishes, because bringing many fishes together, all releasing thousands or even millions of eggs and sperm into the water, ensures the chances of successful fertilizations. Scientists are unsure what brings the eggs and sperm together in the water, but one factor is just the concentration of these gametes in the same area of water, thus ensuring that at least some of them will "find" each other and an egg will become successfully fertilized.

After an egg is fertilized, it still has a limited chance of survival. The eggs are very vulnerable to predators and sudden changes in the environment, such as cold snaps. The eggs of these fishes do not have large amounts of yolk in them on which the developing zygote can feed, so the fish that hatches from the egg emerges as a tiny larva. They, too, are very vulnerable to predators and changes in the environment, as well as drifting into areas where food is limited. As the young fish continues to grow and develop, the chances of survival increase, but only a few will survive to adulthood. But the reproductive strategy works, because by playing the odds, enough eggs survive to become members of the spawning community themselves and the species continues.

## LEARNING PROCEDURE

1. Discuss with students how reef fishes, such as snappers and groupers, come together in large aggregations to spawn. Tell them that one mature female red snapper may release as many as nine million eggs at once during a spawning. Ask them why they think this would be an advantage to the species. Write their ideas on the board.
2. Divide the class into two groups of ten. Give each group five sheets of typing paper. Have them cut each sheet with scissors into 20 postage size pieces of paper and place all 100 pieces of paper into a bowl or container.
3. Divide each group into five students that represent female fishes and five students that represent male fishes. Pair one female fish student with one male fish student and give each student pair one of the colored markers, so one pair is the blue fish, one pair is the red fish, one pair is the yellow fish, one pair is the orange fish, and one pair is the green fish. Explain to the students that each pair has to reproduce through external fertilization, but the female only releases one egg at a spawning, and the male only releases one sperm at spawning. Give students another piece of typing paper, and have each female fish cut off another postage stamp-sized piece of paper and put a dot on it with their colored marker.

Give each male student a data sheet.

4. Place each of these pieces of paper in the bowl with the other pieces and mix them up. Have each male fish draw one piece of paper out of the container without looking. If the paper has the pair's colored dot on the paper, they have a successful fertilization. Have them place the paper back in the bowl, and try another drawing to draw out the correct colored dot. Have them repeat these steps for three more trials and record the number of successful fertilizations on their data sheet.
5. Tell students that all of the fishes in the group are now the same species and any colored dot represents an egg. Leave the five pieces of paper with colored dots in the bowl. Have each male fish draw from the bowl for a colored dot, and write the number of times the group of males draws a colored dot for a successful fertilization on the data sheet next to trial one of this section. Replace papers and repeat these steps four more trials.
6. Have "female fishes" cut out four more postage-sized pieces of paper, put colored dots on them and place them in containers. Female fishes are now releasing five eggs each.
7. Tell males they are now releasing five sperm cells, so each now gets five attempts at a successful fertilization. Have all five males draw five pieces of paper each and then record the number of successful fertilizations for trial one of this section. Replace papers and repeat these steps for four more trials.
8. Have "female fishes" cut out five more postage-sized pieces of paper, put colored dots on them and place them in containers. Female fishes are now releasing ten eggs each.
9. Tell males they are now releasing ten sperm cells, so each now gets ten attempts at a successful fertilization. Have all five males draw ten pieces of paper each and then record the number of successful fertilizations for trial one of this section. Replace papers and repeat these steps for four more trials.
10. Have "female fishes" cut out ten more postage-

sized pieces of paper, put colored dots on them and place them in containers. Female fishes are now releasing 20 eggs each.

11. Tell males they are now releasing 20 sperm cells, so each now gets 20 attempts at a successful fertilization. Have all five males draw 20 pieces of paper each and then record the number of successful fertilizations for trial one of this section. Replace papers and repeat these steps for four more trials.
12. Have students compare how the number of successful fertilizations changed as they became more fecund, or as they released more eggs and sperm. Have students discuss again why a fish may need to release millions of eggs in order to ensure successful fertilizations.

#### THE BRIDGE CONNECTION

[www.vims.edu/bridge](http://www.vims.edu/bridge)

Choose "Biology," then "Fishes" for information on life history and reproduction of fishes.

#### THE "ME" CONNECTION

A reef fish comes together with others of its species and releases its gametes into the water and then its part in the regeneration of its species, at least for that spawning season, is over. Compare this to a human parent. What do humans have to do in order to ensure that their offspring survive to adulthood? Discuss this as a class.

#### CONNECTIONS TO OTHER SUBJECTS

Mathematics

#### EVALUATION

Have students write an explanation of why fishes that reproduce externally have to have such a high fecundity and why it is an advantage for these fishes to come together in such large aggregations to spawn.

#### EXTENSION

Mathematics – Have students graph the results of their findings and see if a pattern emerges. Have students predict how much successful fertilization

would occur if each female released 100 eggs and each male had 100 attempts to fertilize the eggs.

### RESOURCES

<http://fwie.fw.vt.edu/WWW/macsis/fish.htm>

Detailed information on the life histories and reproduction of many species of fishes.

<http://www.fishbase.org/search.cfm>

Detailed information on the life histories and reproduction of many species of fishes.

Moyle, Peter B. *Fish: An Enthusiast's Guide*,  
University of California Press, 1993.

Information on the life histories and reproduction of fishes.

### NATIONAL SCIENCE EDUCATION STANDARDS

#### Content Standard C: Life Science

- Interdependence of organisms
- Behavior of organisms

### FOR MORE INFORMATION

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### Student Handout

#### Reproduction Lottery Data Sheet

One Female Fish, One Egg; One Male Fish, One Fertilization Attempt:

Successful Fertilizations:

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 5: \_\_\_\_\_

Total: \_\_\_\_\_

Five Female Fish, Ten Eggs Each; Five Male Fish, Ten Fertilization Attempts Each:

Successful Fertilizations:

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 5: \_\_\_\_\_

Total: \_\_\_\_\_

Five Female Fish, One Egg Each; Five Male Fish, One Fertilization Attempt Each:

Successful Fertilizations:

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 5: \_\_\_\_\_

Total: \_\_\_\_\_

Five Female Fish, 20 Eggs Each; Five Male Fish, 20 Fertilization Attempts Each:

Successful Fertilizations:

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 5: \_\_\_\_\_

Total: \_\_\_\_\_

Five Female Fish, Five Eggs Each; Five Male Fish, Five Fertilization Attempts Each:

Successful Fertilizations:

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 5: \_\_\_\_\_

Total: \_\_\_\_\_