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Islands in the Stream 2002: Exploring Underwater Oases

Spawn!

Focus
Environmental needs of spawning reef fishes

Grade Level
9-12 (Biology)

Focus Question
What environmental conditions are necessary to ensure the success of spawning reef fishes?

Learning Objectives
Students will understand that the ability of certain reef fishes to have a successful spawning is dependent on numerous environmental conditions.

Students will be able to list some of the factors needed by reef fishes in the South Atlantic Bight to have a successful spawn.

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.
Evolve
Reef
Habitat
Territorial
Spawning
Aggregation
Conducive
Survival
Fertilized
Larvae
Hatching
Estuary
Upwelling
Spawned
Solitary
Abundance

The key words are integral to the unit but will be very difficult to introduce prior to the activity. They are really the material of the lesson. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread. It would be helpful to write the key words on the board prior to the lesson. They can then easily be referred to during the lesson. You may want to give the key words as a handout to your students. If some of the topics in the Background Information section have not already been introduced in your class, you may need to add an additional 20 minutes or so to teach vocabulary and some of the Background Information to the students prior to the activity. Write the rules to the game on the board so that the students can easily follow and access them.

Materials
- ❒ Card stock paper
- ❒ Six decks of "Spawn" cards

Teaching Time
One 45-minute class period

Seating Arrangement
Groups of four students

Maximum Number of Students

24 students

Key Words

Chlorophyll densities
Current
Hard bottom habitat
Phytoplankton
Spawning aggregation

Background Information

Like all species, the reef fishes of the South Atlantic Bight, such as the gag grouper and red snapper, are dependent on the environment where they have evolved to live. 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 individuals 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 into 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 hundreds or 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 have noticed that these spawning aggregations only occur in places where certain environmental conditions are conducive to survival of newly-released eggs and sperm, the resulting fertilized eggs, and hatching larvae. Snappers and groupers tend to spawn on rocky reef habitats that are in a current that will carry the eggs and larval fishes to a nearby area of high food production. In the South Atlantic Bight, these fishes form spawning aggregations around hard bottom habitats usually on the edge of the continental shelf. Though it is not certain why the fishes depend on reef habitats while spawning, one hypothesis is that as currents flow in the vicinity of these reefs, eddies and gyres are sometimes formed that will carry the eggs to areas where the tiny larval and juvenile fishes have a better chance of finding food and shelter.

Most of the reef fishes in the South Atlantic Bight spawn in the Gulf Stream. Some spawn in the gyres and eddies that spin off of the Gulf Stream towards shore. All of these currents lead to areas of high food production, either to inshore estuaries and salt marshes or to the Charleston Gyre. Estuaries and salt marshes have high food production because they are often at the mouths of freshwater rivers that are carrying a high nutrient load from inland sources. Nutrients in these rivers enter the estuaries, thus providing a nutrient-rich environment in which phytoplankton and marsh grasses grow. These plants, producing their own food, can in turn support a large community of animals from tiny herbivores to large predators, including the larval and juvenile offspring of spawning snappers and groupers. By spawning in currents that bring them inshore, these young fishes can find plenty of food and have a better chance of survival.

Young fishes also find plenty of food in the Charleston Gyre, but for different reasons. The Charleston Gyre is a current that spins inshore off of the Gulf Stream. The Charleston Gyre carries the warm water of the Gulf Stream into the colder waters above the continental shelf. When warm water comes in contact with cold water, upwelling occurs. The colder, denser water sinks below the warm water. When it does, it stirs up the nutrients on the ocean floor that are left behind by decomposed marine organisms. These nutrients are carried to the surface as they are displaced upward by the colder, denser water. Near the surface waters, they are available to phytoplankton, and can support a large population of these microscopic plants. Like the plants in estuaries, the phytoplankton that results from upwelling can support a large community of animals. In the Charleston

Gyre, upwelling is constantly occurring, and as a result, it is one of the highest areas of food production in the South Atlantic Bight. The larval reef fishes that are spawned in the Gulf Stream in the South Atlantic Bight are spun into the Charleston Gyre where the abundance of food offers a better chance of survival.

To spawn successfully, reef fish need hard bottom habitats in strong currents that can carry eggs and larvae to areas of high food production. To ensure successful spawning, all of these characteristics have to be available to these fishes. This is important because protecting ecologically and economically important fishes such as snappers and groupers cannot be guaranteed just through setting catch and size limits. As they are dependent on many factors of their environment, entire ecosystems need to be protected if their survival as a species is to be continued.

Learning Procedure

1. Print "Spawn" cards onto card stock and cut out each individual card. Print enough sets that the class can be divided into groups of four and each group can receive a deck of cards.
2. Discuss with the students how organisms adapt to their environment and how they become dependent on certain features of their environment in order to ensure their survival. Explain that the reef fishes of the South Atlantic Bight are an example of this. Explain that fishes, such as snappers and groupers, are solitary and live on reef habitats. When they spawn though, they come together in groups of hundreds or even thousands over reef habitats in currents that can carry eggs to areas that have an abundance of food. Explain that without these conditions, the resulting fertilized eggs and hatching larvae may not be in an environment suitable for survival.
3. Tell the students that they will be playing the card game "Spawn." Divide students into groups of four. Give each student group a deck of the "Spawn" cards and explain the rules. The object of the game is to have a hand that includes a card listing a reef fish, a card listing a rocky reef habitat, a card that lists a current, and a card that lists a nearby habitat with high food production. When all of these cards are in hand, the student has a successful "Spawn" and wins the game. The rules are very similar to those of "Gin." Cards are shuffled and each student is dealt four cards. The rest of the deck is placed face down in the center of the students. The top card is flipped over and laid face-up next to the deck. The student to the left of the dealer goes first by taking the flipped over card or the card at the top of the deck. A student will finish his/her turn by discarding one card from his/her hand and placing it face up on the flipped over card. Students will keep the cards that make the best hand (those that together provide the conditions necessary for a reef fish to have a successful spawning) and should discard all other cards (such as non-reef fish, non-reef habitats, oceanic conditions without currents and nearby habitats with low food production), as these will not produce a winning hand. When the student has all four cards needed, the student will lay them face down, say "Spawn!" and be declared the winner. If all the cards in the face-down deck have been drawn and no one has successfully "spawned" (i.e., won), shuffle the cards in the face-up deck, place this deck face-down, flip the top card over to make another face-up deck, and continue playing.
4. Have students play a few hands to allow the connection between spawning reef fishes and the environmental conditions they need to successfully spawn.

The BRIDGE Connection

www.vims.edu/bridge

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

The "Me" Connection

Have students collect menus from local seafood restaurants. How many of the fishes discussed in the activity show up on the menu? Discuss with students how these fishes might not be on the menu if some

of the environmental factors necessary for the successful spawning of snappers and groupers were somehow disturbed.

Connections to Other Subjects

Social Studies/History

Evaluation

Based on everything they have learned about the environmental needs of spawning reef fishes, have each student write a description of a fisheries management plan that would protect both the fishes and their environmental needs.

Extensions

Social Studies – Mapping. Have students search the Internet to find maps that show currents and chlorophyll densities (food production) and have them map potential places for reef fishes to spawn so that currents will carry their young to a food source.

English/Language Arts - Have students read the sections of Song for the Blue Ocean by Carl Safina on spawning groupers. Have them write a response to these sections, describing what they think about what man has done to grouper populations.

Resources

http://fwie.fw.vt.edu/WWW/macsis/fish.htm
Detailed information on the life histories of fishes, including many of the reef fish found in the South Atlantic Bight.

http://206.74.146.33/scaquarium/scaweb/curriculum/iexplore/sixth_eighth/units/reefs/reefs_back.htm - Detailed information on reefs and reef fishes of the South Atlantic Bight.

http://www.fishbase.org/search.cfm - Detailed information on the life histories of fishes, including many of the reef fishes found in the South Atlantic Bight.

Islands in the Stream, Editor, George Sedberry. A collection of scientific papers on reef and reef fishes in the South Atlantic Bight.

National Science Education Standards

Content Standard C: Life Science

- Interdependence of organisms
- Behavior of organisms

For More Information

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Student Handout

Spawn Cards

Reef Fish

Gray Triggerfish

Reproductive Method: Collects seasonally in large groups for spawning. Releases eggs and milt in water for external fertilization.

Reef Fish

Red Snapper

Reproductive Method: Collects seasonally in large groups for spawning. Releases eggs and milt in water for external fertilization.

Reef Fish

Snowy Grouper

Reproductive Method: Collects seasonally in large groups for spawning. Releases eggs and milt in water for external fertilization.

Fish

Clearnose Skate

Reproductive Method: Female and male come together for internal fertilization. Larval skates released in egg cases.

Fish

Oyster Toadfish

Reproductive Method: Female and male come together. Female attaches eggs to hard surface and male fertilizes externally and then guards eggs until larvae hatch.

Reef Fish

Blueline Tilefish

Reproductive Method: Collects seasonally in large groups for spawning. Releases eggs and milt in water for external fertilization.

Fish

Sand Tiger Shark

Reproductive Method: Female and male come together for internal fertilization. Embryo stays inside female and is born fully developed.

Fish

Seahorse

Reproductive Method: Female and male come together. Female lays eggs in a pouch on the male's stomach. Male carries and protects eggs until after they hatch.

Habitat

Hard Bottom Reef

Student Handout

Habitat

Rocky Outcrop Reef

Habitat

Rocky Outcrop Reef

Habitat

Hard Bottom Reef

Habitat

Muddy Bottom

Habitat

Sandy Bottom

Habitat

Saltmarsh Tidal Creek

Oceanic Condition

Gulf Stream Current

Oceanic Condition

Gulf Stream Current

Habitat

Open Ocean

Student Handout

Oceanic Condition

No Current

Oceanic Condition

Gyre Current Off of the Gulf Stream

Oceanic Condition

Eddie Current Off of the Gulf Stream

Oceanic Condition

No Current

Oceanic Condition

No Current

Oceanic Condition

No Current

Productivity of Nearby Habitats

Salt Marsh

Nutrients from freshwater rivers support abundant phytoplankton production and marsh grass production.

Productivity of Nearby Habitats

Charleston Gyre

Upwelling brings nutrients to the surface to support abundant phytoplankton production.

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Charleston Gyre

Upwelling brings nutrients to the surface to support abundant phytoplankton production.

Student Handout

Productivity of Nearby Habitats

Charleston Bump

The Charleston Bump is a large reef habitat in the Gulf Stream. The fast moving current of the Gulf Stream does not carry nutrients for phytoplankton production.

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Salt Marsh

Nutrients from freshwater rivers support abundant phytoplankton production and marsh grass production.

Habitat

Hard Bottom Reef

Oceanic Condition

Gulf Stream Current

Productivity of Nearby Habitats

Charleston Gyre

Upwelling brings nutrients to the surface to support abundant phytoplankton production.

Fish: Reef

Red Porgy

Reproductive Method: Collects seasonally in large groups for spawning. Releases eggs and milt in water for external fertilization.

Productivity of Nearby Habitats

Open Ocean

The open ocean does not have enough nutrients for abundant phytoplankton production.

Productivity of Nearby Habitats

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The open ocean does not have enough nutrients for abundant phytoplankton production.