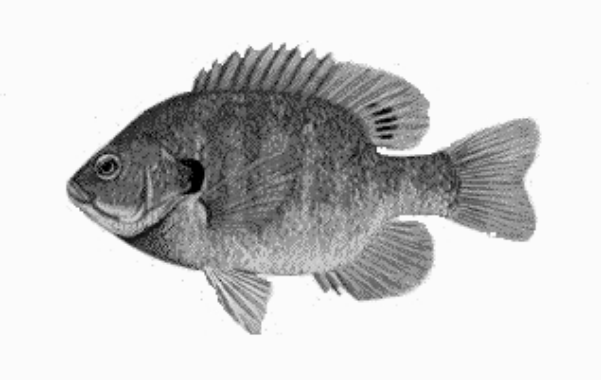
FISH AND WILDLIFE
HABITAT + O_2 = BLUEGILLS

OBJECTIVES



Students will be able to:

- identify habitat needs in the life cycle of a bluegill.
- identify ways humans can harm and improve bluegill habitat.

METHODS

Students role play fish in a simulation of a bluegill's life cycle.

BACKGROUND

All animals need habitat for survival. The basic elements of habitat are: food, water, shelter and space. If a critical component of habitat is in short supply or missing, this habitat component is a "limiting factor" to an animal's survival. For an aquatic organism, such as a bluegill, the complex inter-relationships of what constitutes habitat are often hard to visualize since all aspects of habitat are met under the water's surface.

Life for a bluegill begins as one of 6,000 to 18,000 eggs in a small, shallow crater on a sand or gravel bar. The male makes this "nest" by fanning away bottom material with violent swishes of its body. He will fiercely guard the eggs until the young fish hatch and can swim on their own. To the male, the nest represents the territory (space) it needs for survival of his offspring.

Hatching takes only two to five days under normal weather conditions. However, unseasonably cold water temperatures may stop spawning activity entirely.

Once hatched, the tiny "fry" are only one-eighth inches (2-3 mm) long. Only the earliest and fastest swimmers escape being eaten by other fish, including other bluegills. Lakes and rivers with abundant rooted vegetation provide hiding places for these tiny fish. When homeowners remove vegetation to create swimming areas the small bluegills become easy prey.

Rapid growth in the first year keeps these small fish constantly looking for food. First zooplankton then, tiny crustaceans make up the fry's diet. By the end of their first year the bluegill is almost two inches long.
As the bluegill grows, its main diet changes to small crayfish, aquatic insects and small fish. Bluegills cruise from cover to cover searching for food, preferred water temperatures and

Grade Level: 2 - 12

Subjects: Math, Phy Ed, Science

Duration: 45 to 60 Minutes

Group Size: >10

Setting: indoor or outdoor large area

Key Vocabulary: habitat, limiting factor, fry, zooplankton, spawning, year class

Materials:
- *8 different colors of tokens*
- *containers*
- *boundary markers*

For Extension:
Handouts and pencils

Bluegills living in the Mississippi River are migratory with regards to winter and summer habitat. Some may travel up to 3 miles to find suitable "over-wintering" habitat. High quality over-wintering habitat is an area with no current, dissolved oxygen $\geq$ 5 ppm, water depths > 4 feet, and "warm" water (> 0.5^{o} C).

adequate oxygen, exposing them to additional predation from herons and otters. By the end of their second year, most bluegills are about 3.25 inches long.

In the spring, bluegills are found along permanent cover such as rocks, logs and piers. By summer these fish have moved into recently emerged aquatic vegetation beds. Sometimes low water conditions may isolate bluegills from the main body of water. In the heat of summer, oxygen levels may drop drastically in these areas and fish will suffocate and die, a condition known as summerkill.

The fish that make it through summer may face problems in winter. In winter, bluegills seek habitats with good oxygen, abundant food and little current. Excessive snow and thick ice reduce the amount of sunlight penetrating shallow water areas. Photosynthesis (which produces oxygen) stops and the plants die. As oxygen levels drop, decomposition of bottom material continues further reducing dissolved oxygen. If levels drop enough most of the fish will suffocate, a condition known as winterkill.

Those bluegills that reach three years of age will spawn, probably for the first time. At four years of age most bluegills will be 5.5 inches long - too large to be eaten by most other predator fish, but large enough for predation by humans.

In waters where spawning habitat is limited, large concentrations of spawning bluegills may occur in a few areas. Because bluegills attending nests are easy to catch, excessive harvest by anglers can occur. This not only removes the adults from the population, but it also leaves the now unprotected nest open to predation. Egg mortality can be 100 percent.

The adult bluegill constantly faces death throughout the rest of its life. Of the original 6,000 - 18,000 eggs, less than one-half of 1 percent will die of old age. In some years, no eggs will survive past the first year from an individual nest. Fortunately for the bluegill enough spawners survive from year-to-year to maintain a population. Other fish species are not so lucky. That is however, a different fish story...

The bluegill itself is an important link in the food chain of other fish species and the loss of a bluegill "year class" could result in lower numbers of northern pike, largemouth bass, or perch to name a few.

MATERIALS

- Large playing field, or gym
- Rope, cones or carpet squares to mark off vegetative cover (“hiding cover”) for bluegills
- 8 different “tokens” i.e. colored or labeled pieces of paper, or soft baits available in bulk from sporting/fishing stores (Different colored bio-degradable items could also be used. For example beans or pasta.)
- Envelope, bag or container to hold tokens one for each student.

PROCEDURES

This activity will be repeated twice. The first time, students will simulate bluegill fry and obtain habitat items necessary for survival to become an adult. The second time they will represent adult bluegills seeking out habitat requirements needed to survive and reproduce.

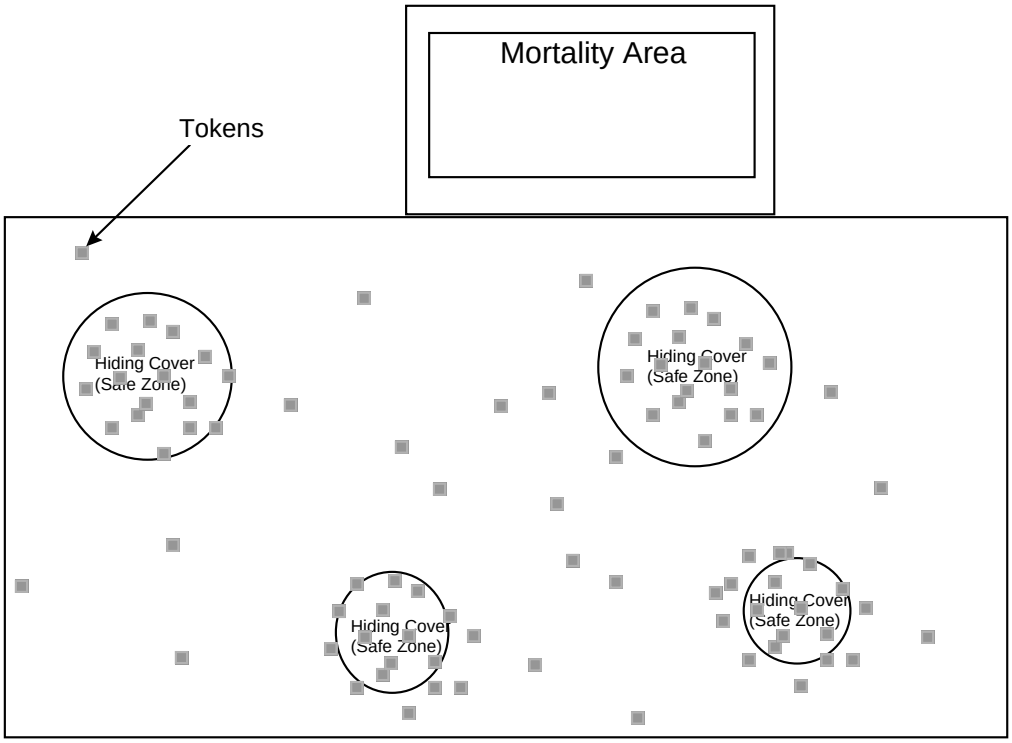
1. Prepare supplies for simulation. Eight different colored or labeled tokens will be needed in the quantities in Table 1.

Table 1. Quantities of 8 different tokens needed for the activity and the habitat need each token represents for fry or adult bluegills.

Suggested Token Colors and Number Needed		What Each Token Represents and the Habitat Need it Meets		
Color	Number Needed Per Student	Bluegill Fry	Age 1 to Adult Bluegills	Color You Used
YELLOW	3	Freshwater Shrimp (F)	Oxygen (W)	
BLUE	2	Water Temperature (W)	Water Pollution (W)	
BROWN	4	Rotifers (F)	Insect Larvae (F)	
ORANGE	3	Plants (S)	Amphipods (F)	
RED	3	Algae (F)	Baited Hook	
PINK	4	Cladocerons (F)	Insect Adults and Crustaceans (F)	
GREEN	3	Oxygen (W)	Plants (F)*	
WHITE	2	Water Pollution (W)	Spawning Habitat (SP)	

F = Food
W = Component of water which is important for determining survival
S = Shelter
SP = Space
* = Plants offer shelter for the prey adult bluegills feed on. The plants also provide shelter for the adult bluegills. For the purpose of this activity, plants represent an important component of adequate food supply and are included as a food token.

Figure 1. Example of playing area layout for simulations.



In nature, not all habitat is the same size. Therefore, vary the size of the hiding cover safe zones. Recommended sizes for a class of 25 are one each of the following diameters: 14, 12, 10, and 6 feet. *(Add one additional hiding cover of 8 foot diameter for every 5 children if your class size is greater than 25.)*

2. Preparation of the playing field (Figure 1). Preparation is the same for the fry and adult simulation: Layout playing field boundaries to represent the shoreline of a waterbody. Mark areas of cover (safe zones) for fry or adult bluegills.

In nature not all habitat is the same size so the size of the cover should vary. Recommended cover sizes for a class of 25 are one each of the following diameters: 14, 12, 10, and 6 feet. (Add one additional 8-foot diameter cover for every 5 children if your class size is greater than 25.)

Scatter the tokens throughout the playing field. The majority of the tokens should be inside the cover. Make sure to place some tokens outside of the cover since some food would be available in these areas of the lake.

3. Review with students the components of habitat: Food, water, shelter and space. Ask them to list examples of what they think may be food for a bluegill; what bluegills may use as shelter; and why water, and what in water, would be important to a bluegill.

4. *START OF THE FRY SIMULATION*:

a. Assign 3 children to be predators and the rest to be fry. All of the bluegill fry hatch from a single "nest" in one of the cover zones. Fry can move anywhere within the boundaries of the "lake" as they forage for food and seek out habitat needs. While cover is a safe area, if fry are too close to the edge, predators can tag (eat) them. (In nature, many predators cruise the edge of vegetation looking for prey that has ventured too close to the edge.)

The predators (largemouth bass, northern pike, perch and bullhead) should be scattered around the rest of the playing area. They cannot enter the cover, but they can tag fry if they can reach them. They can also tag fry as fry move from one zone of vegetation or cover to another. When a predator tags fry, the fry must give their tokens to the predator and move to the mortality zone. The simulation continues until all tokens have been picked up, or all fry tagged.

b. Once all tokens have been picked up, have the students add up the number of each kind of token they have collected. Survival of fry depends on water temperatures being warm enough for eggs to develop and hatch; getting enough food; and good water quality (free of pollution and having adequate oxygen); and finding shelter from predators. As fry, bluegills are more susceptible to extremes in water temperature, pollution, and pH. Therefore, the quantities of the different tokens they have will determine if they survived. If they do not meet the criteria below, they must move to the mortality zone. Note: Predators do not have to add up their totals.

Have the students add up their tokens grouped as follows. Then, in the order below, determine which ones had enough of each token to survive. It is important to explain why each of the following is a limiting factor and how it affects a bluegill.

Water Temperature: > 3 tokens to survive. Fish eggs need certain temperature conditions to develop and hatch. Bluegill fry are more sensitive to temperature changes than adults.

Food: > 8 tokens to survive. Students must have at least 9 food tokens to survive (all of the items identified as food in Table 1 added together). Studies have found that bluegills need to consume approximately 35% of their weight in a week to survive. Therefore, if each food token equals 4% of their body weight, then they need 9 tokens.

Dissolved Oxygen: > 4 tokens to survive. The state standard for dissolved oxygen is 5 parts per million (ppm). Each dissolved oxygen token represents 1 part per million. If

they have less than 5, then sometime during their life as a fry they were in an area where dissolved oxygen was not adequate for their survival.

Plants: > 2 tokens to survive. Plants and other cover are essential for fry to survive their first year of life.

Water Pollution: < 3 tokens to survive. Bluegill eggs and fry are more susceptible to water pollution than adults. Acid rain; animal waste runoff; and fertilizer runoff from yards, fields and golf courses are some of the sources of pollution affecting fish.

c. Tell students that each of them represented so many fry out of a nest of 10,000. (For example, if 20 students simulated fry, then each of them represented 500 fry.) Then determine how many adults are entering the adult simulation: number of children who survived by the number of fry each represents = number of adults. If no fry survived to become adults, tell them this is not uncommon. (If no fry survived, use 2,000 adults as the number to use for the adult simulation.)

5. *START OF THE ADULT SIMULATION:*

a. Redistribute the tokens throughout the playing field. Assign 3 children to be predators and the rest to be adult bluegills. All of the adult bluegills will begin in a single school of fish in the largest vegetative cover zone. Once again, the adults can move anywhere within the boundaries of the "lake" as they forage for food and seek out habitat needs. Predators cannot enter the vegetative cover (safe area), however, if adults get too close to the edge of the cover, the predators can tag (eat) them.

b. The predators (largemouth bass, northern pike, great blue heron, and flathead catfish) should be scattered around the rest of the playing area. They can tag the adults as the bluegills move from one zone of vegetation to another. Adult bluegills must give their tokens to the predator and move to the mortality zone when they are tagged. The simulation continues until all tokens have been picked up, or all bluegills are tagged.

c. Once all tokens have been picked up, have the students add up the number of each kind of token they have collected. Survival of adults depend on; getting enough food; living in areas where water quality is good (free of pollution and having adequate oxygen); and finding shelter from predators. Adults also must find suitable spawning habitat to reproduce. The quantities of the different tokens they have will determine if they survived. If they do not meet the criteria below, they must move to the mortality zone. Note: Predators do not have to add up their totals.

Have the students add up their tokens grouped as follows. Then, in the order below, determine which ones had enough of each token to survive. It is important to explain why each of the following is a limiting factor and how it affects a bluegill.

Food: > 8 tokens to survive. Students must have at least 9 food tokens to survive (all of the items identified as food in Table 1 added together). Studies have found that bluegills need to consume approximately 35% of their weight in a week to survive. Therefore, if each food token equals 4% of their body weight, then they need 9 tokens.

Tell students that plants offer shelter for the prey adult bluegills feed on. The plants also provide shelter for the adult bluegills. For the purpose of this activity, plants represented an important component of adequate food supply for adult bluegills and is therefore included as a food token.

Spawning Habitat: > 1 token to survive: Adult bluegills must find suitable spawning habitat to successfully reproduce. Otherwise the population of bluegills in the waterbody may decline. Several factors can affect the availability of spawning habitat: shoreline development, floods or droughts, sedimentation, etc.

Water Pollution: < 5 tokens to survive. Adult bluegills are more tolerant of water pollution than fry. However, water quality does affect the survival of adults. Acid rain; animal waste runoff; and fertilizer runoff from yards, fields and golf courses are some of the sources of pollution affecting fish.

Dissolved Oxygen: > 4 tokens to survive. The state standard for dissolved oxygen is 5 parts per million (ppm). Each dissolved oxygen token represents 1 part per million. If they have less than 5, then sometime during their life as an adult, they were in an area that dissolved oxygen was not adequate for their survival.

"Baited Hooks": <2 tokens to survive. Humans are one of the predators of adult bluegills. Fishing for bluegills involves tricking the adult bluegill into thinking that the bait on the hook is something good to eat. Students with more than one hook token were released by the first angler who caught them, only to be caught and kept by another.

6. Using the number of adults entering into the population at the end of the fry simulation, now calculate how many adult bluegills each student represented. Multiply the number of children surviving X number of adults they represent. This is how many bluegills made it to old age.

7. Discuss how humans can harm or improve bluegill habitat.

ASSESSMENT

1. Have students compare and contrast different habitat needs for fry and adults. How are their habitat needs similar? How do they differ?

   To show the different habitat needs, have students:

   - Complete a concept map (Figure 2); or
   - Create a bluegill habitat mobile with a wire coat hanger and pictures they draw of bluegill fry and adults and the different habitat components (food, water shelter and space).

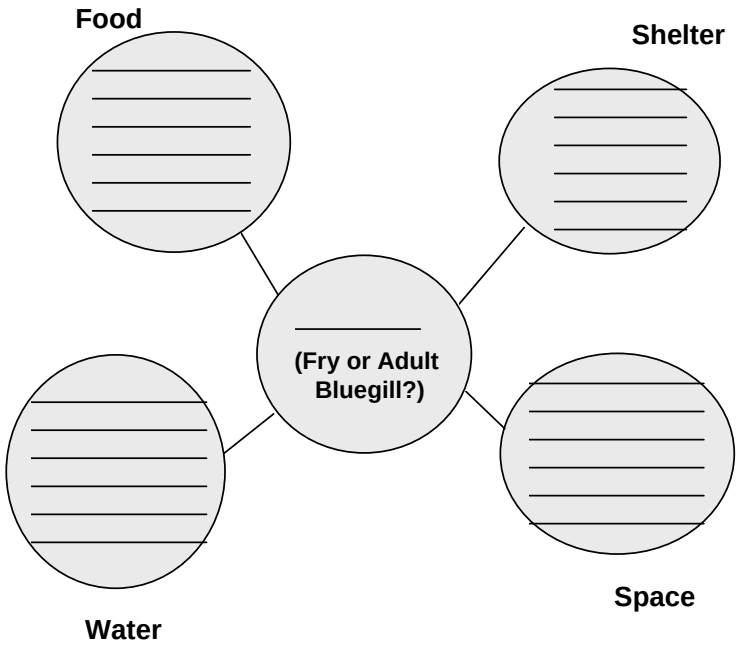
2. Have the student modify the simulation game to reflect human's negative impacts on bluegill habitat (i.e. loss of vegetation cover, over fishing, etc.). Then have the students modify the simulation game to reflect humans improving habitat (enlarge vegetation cover, decrease pollution, etc.).

EXTENSIONS

1. Repeat the activity as modified by the students to reflect human impacts (positive and negative).

2. Hand out "Life and Times of the Bluegill Family" worksheet and have students complete the calculations as a wrap-up to the activity.

Figure 2. Sample Concept Map.



ANSWER KEYS TO: THE LIFE AND TIMES OF THE BLUEGILL FAMILY

There's a FRACTION of how many there used to be!!:

68
9000
8000
4000
3000
3000
2500
2000
250
50
40
40/10000

They added and subtracted their numbers:

9000
8000
4012
3000
3000
2500
2000
650
50
5

The Life and Times of the Bluegill Family
There's a ***FRACTION*** of how many there used to be!!

Directions: Please read carefully and fill in each blank.

This is a story of two fish, Bee and Lou Gill. They lived in a backwater lake of the Mississippi River. They married at the age of four, as both were mature and madly in love. Bee enjoyed Lou's intelligence and wit, whereas Lou thought Bee's scales fit just right. Only a few short months after the March wedding, Lou built a nest in which Bee would lay her eggs. Lou knew it was time to build a nest because the water temperature was 20 degrees Celsius or ____ degrees Fahrenheit (to change Celsius to Fahrenheit, multiply 20 X 9/5 and add 32). Lou made a fine nest, and Bee laid 10,000 eggs in early June. Lou was as happy as a fish in water as he fertilized the eggs shortly after that. However, not all the eggs hatched into fry. Approximately 1/10 of the eggs did not hatch. This left _____ fry.

Bee did not stay around the nest for too long. Afterall, it was Lou's job to guard the fry. Lou was a good dad, fighting off predators such as other fish. However, 1/18 of the fry got preyed upon while 1/18 could not find enough food and also died. This left fry. After about one week of protecting the fry, Lou knew it was time to find Bee and leave the fry behind. He had done all he could to protect them. However, the fry were now on their own to face the underwater world of the Mississippi River.

The young fish adapted to their surroundings, as they stayed close to the weeds in shallow water. While in the weeds, they hid from predators and found food to eat. However, not all the remaining fish would live to see their third birthday. Two-quarters of the fish were eaten by other fish, raccoons, great blue herons, kingfishers and other predators. This left _____ fish. Pollution also took a toll on the fish, as another 1,000 fish died before they were age three. This left _____ fish that were heading toward their fourth birthday.

As the fish were getting older, they were also getting bigger. From the original 10,000 eggs, there were now _____ fish that were 6 inches long. Joe Fishermen and

Amy Angler now became predators on the fish. Joe caught 4/27 and Amy 5/27 of the fish during the next year, however, 1/2 of those caught were not kept, but released. There were now _____ fish remaining. Other predators were also around. Other large fish, such as northern pike and largemouth bass, preyed upon 500 of the remaining fish. This left _____ fish after 4 years.

Joe and Amy continued to fish for bluegill. Over the next 3 years, together they kept 1/2 of the population each year. Therefore, after 7 years, there were _____ fish remaining from the 10,000 eggs.

The bluegill were now over 8 inches long. Joe and Amy each kept 50 fish during each of the next 2 years. This left ____ fish. During year 10, Joe kept 1/10 of the remaining fish while Amy kept 5/50.

How many fish remained after year 10 to only die of old age?

What fraction of fish remained after 10 years?

Worksheet developed by Brian Brecka, Mississippi River Fisheries Biologist, Wisconsin Dept. of Natural Resources, Alma, WI.

The Life and Times of the Bluegill Family

They added then ***SUBTRACTED*** their numbers!!

Directions: Please read carefully and fill in each blank.

This is a story of two fish, Bee and Lou Gill. They lived in a backwater lake of the Mississippi River. They married at the age of four, as both were mature and madly in love. Bee enjoyed Lou's intelligence and wit, whereas Lou thought Bee's scales fit just right. Only a few short months after the March wedding, Lou built a nest in which Bee would lay her eggs. Lou knew it was time to build a nest because the water temperature was 68 degrees. Lou made a fine nest, and Bee laid 10,000 eggs in early June. Lou was as happy as a fish in water as he fertilized the eggs shortly after that. However, not all the eggs hatched into fry. One thousand of the eggs did not hatch. This left _____ fry.

Bee did not stay around the nest for too long. Afterall, it was Lou's job to guard the fry. Lou was a good dad, fighting off predators such as other fish. However, 460 of the fry got eaten while 540 could not find enough food and also died. This left fry. After about one week of protecting the fry, Lou knew it was time to find Bee and leave the fry behind. He had done all he could to protect them. The fry were now on their own to face the underwater world of the Mississippi River.

The young fish adapted to their surroundings, as they stayed close to the weeds in shallow water. While in the weeds, they hid from predators and found food to eat. However, not all the remaining fish would live to see their third birthday. Three thousand nine hundred eighty-eight of the fish were eaten by other fish, raccoons, great blue herons, kingfishers and other predators. This left _____ fish. Pollution also took a toll on the fish, as another 1,012 fish died before they were age three. This left fish that were heading toward their fourth birthday.

As the fish were getting older, they were also getting bigger. From the original 10,000 eggs, there were now _____ fish that were 6 inches long. Joe Fishermen and Amy Angler now became predators on the fish. Joe caught 416 and Amy 584 of the fish

during the next year, however, ½ of those caught were not kept, but released. There were now _____ fish remaining. Other predators were also around. Other large fish, such as northern pike and largemouth bass, preyed upon 500 of the remaining fish. This left ____ fish after 4 years.

Joe and Amy continued to fish for bluegill. Over the next 3 years, together they kept 450 each year. Therefore, after 7 years, there were _____ fish remaining from the 10,000 eggs.

The bluegill were now over 8 inches long. Joe and Amy each kept 150 fish during each of the next 2 years. This left ____ fish. During year 10, Joe kept 25 of the remaining fish while Amy kept 20.

How many fish remained after year 10 to only die of old age?

Worksheet developed by Brian Brecka, Mississippi River Fisheries Biologist, Wisconsin Dept of Natural Resources, Alma, WI.