Black Sea Bass Encounter

Below is an adaptation of the Shark Encounter (Lawrence Hall of Science: MARE 2002) lesson plan to be about Black Sea Bass and to incorporate information learned from Dr. Jensen's presentation and subsequent discussion.

Lesson Overview

Students simulate field research by working in small teams to collect, analyze and discuss data on local populations of Black Sea Bass.

Lesson Rationale

Black Sea Bass are an important fish species in both commercial and recreational fisheries in New Jersey. The population decreased from the early 1970s to the late 1990s, but currently is recovering to higher levels. Black Sea Bass provide a good example of fluctuations in a fish population and successful fisheries management.

Key Concept

Fish populations fluctuate over time and the actions of humans can influence the fluctuations in positive and negative ways.

Time Required

Two 40-minute class periods.

Overview

Black Sea Bass are an important fish species in both commercial and recreational fisheries in New Jersey; they range from Maine to Florida. The Atlantic and Mid-Atlantic Fishery Management Councils manage the fisheries. However, the size of the Black Sea Bass population has fluctuated over time and decreased by half between the early 1970s and late 1990s.

In this activity, students simulate field research by working in small teams to collect, analyze, and discuss data on local populations of Black Sea Bass.

In Session 1, students are introduced to their challenge: given limited time and resources, how can they accurately estimate a Black Sea Bass population? Students test their methods and afterwards classmates discuss why they place their confidence in one method over another. Students learn a standardized method for sampling and estimating the population of an organism in the field. Students work in small research teams to randomly select studies, collect data, and

convert raw data into a useable format. From the raw data students calculate the mean length of Black Sea Bass sampled, the sex ratio of the population, estimates of the population density, and the percentage of males in different length bins.

In Session 2, student teams share their data in a conference setting. Their goal is to determine an overall population estimate, account for any discrepancies, observe and compare their results with results from previous years, and determine if any meaningful recommendations can be generated the history of the local Black Sea Bass population.

Materials Needed

For Session 1

For the class:

- Poster of challenge goals
- 2 50 foot ropes for the Mid-Atlantic region
- 100 quadrats (1 ft x 1 ft)

For each student group:

- 1 bag of numbered poker chips, small tiles, or pieces of paper
- Calculators
- 1 Clipboard
- 1 Data Sheet

For Session 2

For the class:

- Graph of Black Sea Bass Data Over Time
- Clipboards
- 1 sheet of chart paper
- Colored markers

For each student:

- 1 sheet of 8.5 in x 11 in paper
- 1 pen/pencil

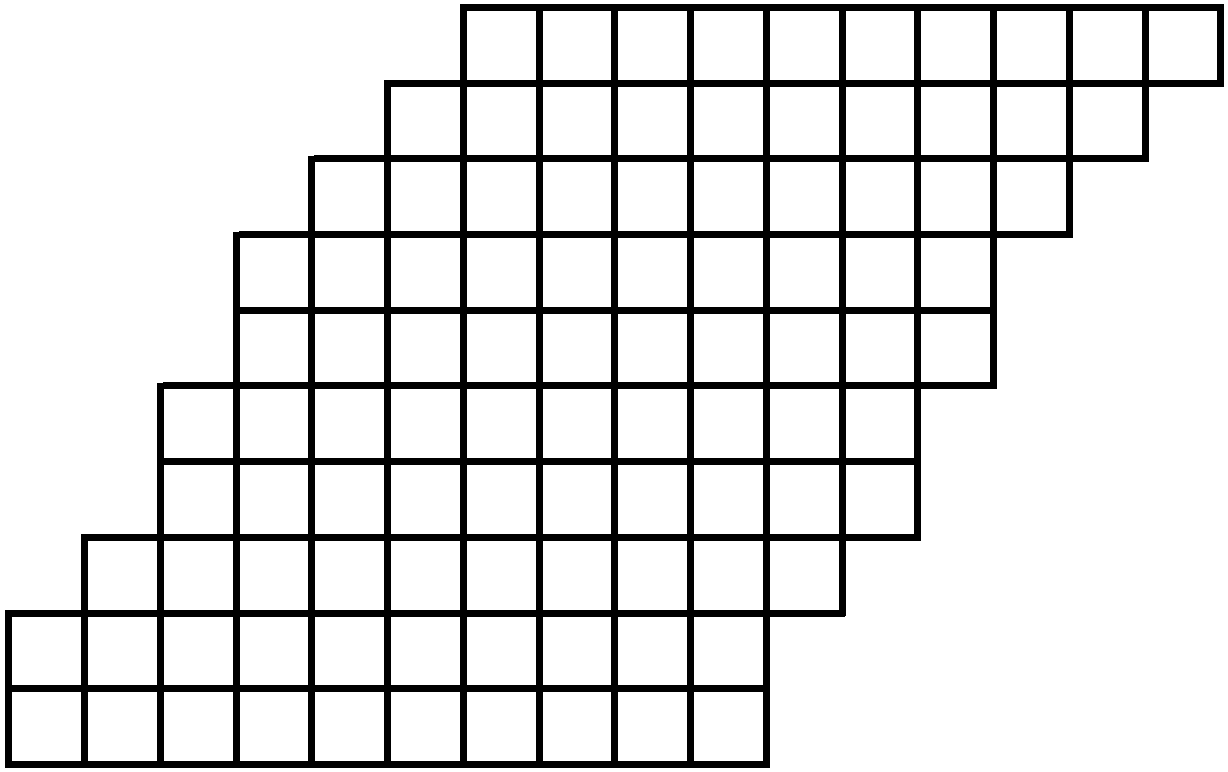
Preparation

For Session 1

1. Write the three goals for the challenge on the large poster:
    i. Estimate the current Black Sea Bass population in the Mid-Atlantic region
    ii. Determine what sorts of changes (if any) are occurring
    iii. Decide what can be done to prevent damage to the population.
2. To construct the Mid-Atlantic region of the Atlantic Ocean, first determine how much space you have to work with. The Mid-Atlantic region can be as small as a few feet across or as large as an entire room. The larger the Mid-Atlantic region, the more dramatic the activity will be. The Mid-Atlantic region is constructed out of square pieces known as quadrats. Quadrats are used to break-up a large study area into smaller, more

workable units. Since quadrats need to be measurable, the area of our quadrats will be one square foot.

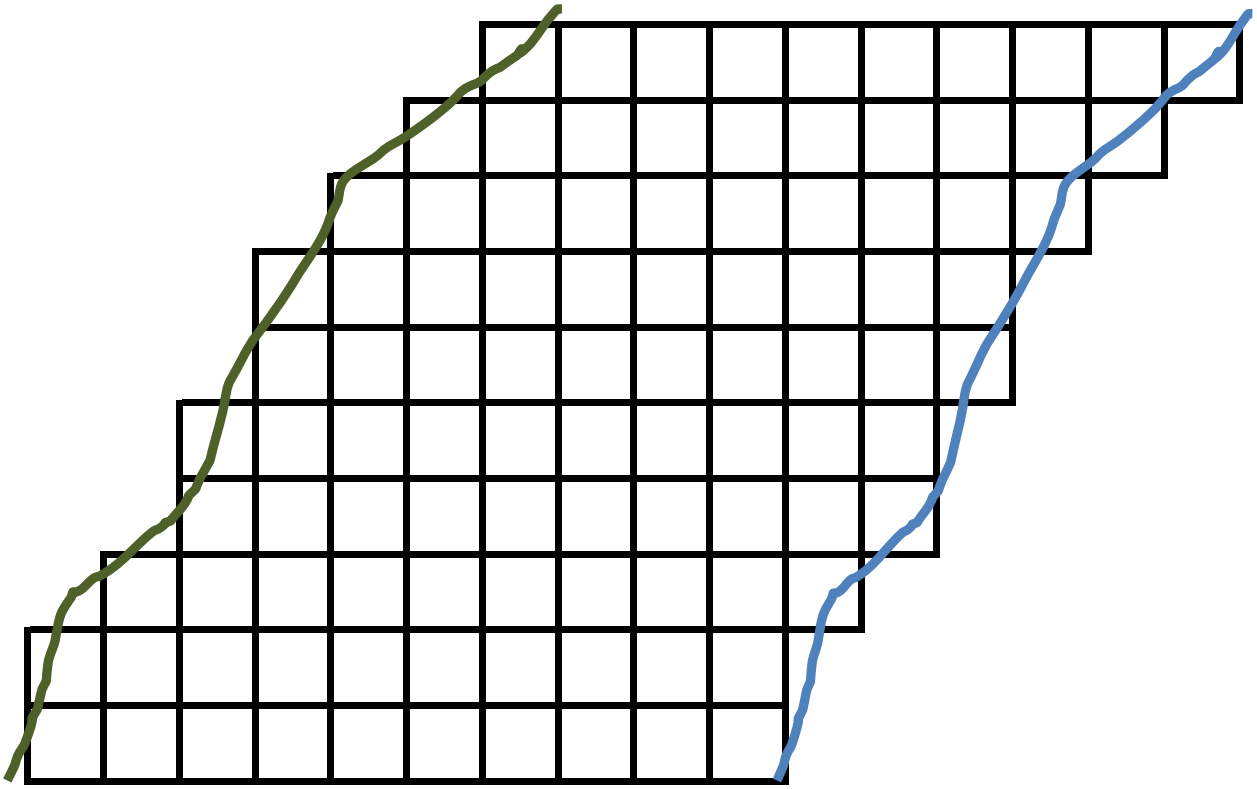
3. Some quadrats will have blank bottoms and some will have pictures of Black Sea Bass on the underside with data to record. Some of the quadrats with data will also have a flag. Print out the Black Sea Bass data quadrats and the flags (at the end of the document) and attach to the bottom of all the quadrats.



4. Lay your quadrats on the floor forming the Mid-Atlantic region surface (see diagram above). Stiff poster board, card stock, or double-faced newsprint cut into squares works well as quadrats. Lay as many quadrats as needed to fill your space. To make sampling effective for each group, we suggest you have no fewer than 50 useable quadrats in your Mid-Atlantic region (a useable quadrat is one that is 100% within the rope boundary). Intersperse the data quadrats as randomly as possible with the blank quadrats as your build the Mid-Atlantic region. It's not important that you remember where the data quadrats are placed.
5. Adding Realism: Fieldwork is often frustratingly unpredictable. The saying, "whatever can of wrong will go wrong" often applies: equipment breaks, if forgotten or lost; weather rarely cooperates; unexpected data can crop-up; wildlife can be annoying or dangerous; food can go bad; tempers can flare and patience can then. It's all part of the fun of fieldwork! To simulate unpredictability, we've provided you with some flags to slip under several quadrats. If students find a flag, they must follow whatever instructions are given on the flag – usually, it involves not recording whatever data may be within that

quadrat. If data cannot be collected then the students should move on to their next quadrat.

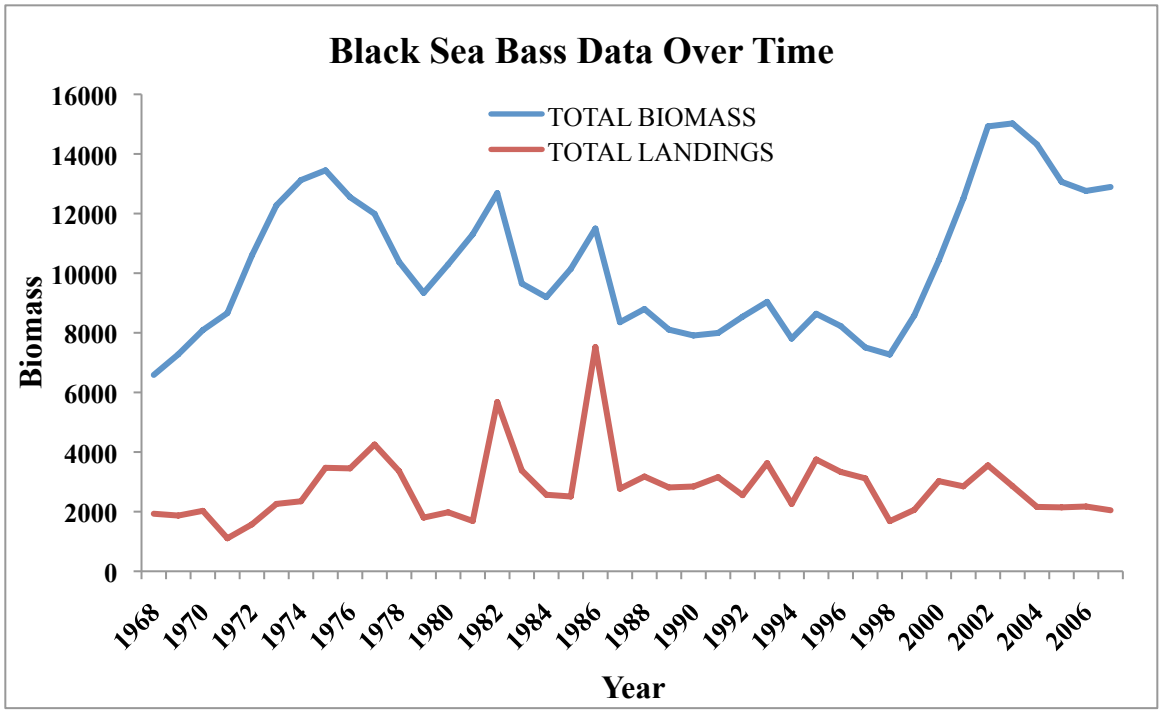
6. After laying out the quadrats, you must now establish the Mid-Atlantic region boundary. Using the ropes, lay each rope along the far left and far right sides of the quadrats (this is to simulate the coastline on the left and the eastern edge of the Gulf Stream on the right). While the ropes will cut across some of the quadrats on the outer edge, try to fit as many whole quadrats inside the rope as possible (see diagram below). When the Mid-Atlantic region's boundaries have been established, **count the total number of usable quadrats in the Mid-Atlantic region**. After recording this number, the activity is ready to begin.



7. Random Numbers: Make a bag of random numbers for each student group by marking poker chips, small tiles, or pieces of paper with numbers from 1-100. Place the numbered pieces into a bag (gallon Ziplocs work well).
8. Make a copy of the Data Sheet for each student group.

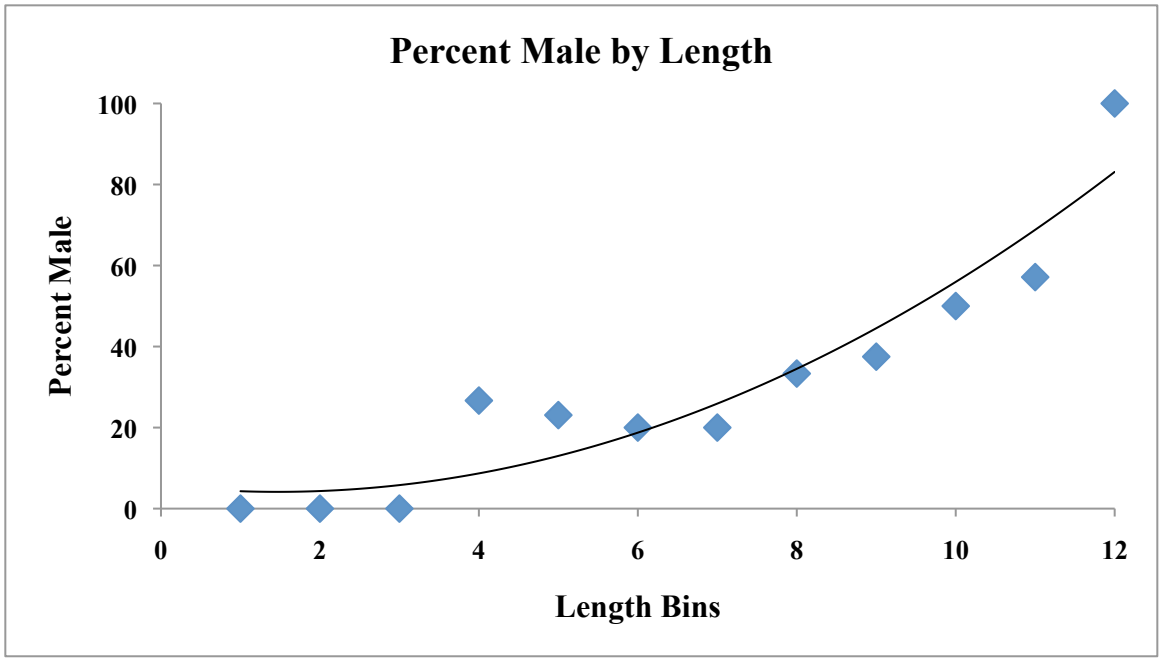
For Session 2

1. Make a large poster showing a line graph of the total biomass of Black Sea Bass by copying the following onto chart paper. Total Biomass is the estimated Black Sea Bass population in the ocean.
2. Make a large poster showing a line graph of the total biomass and the total landings by copying the following onto chart paper with colored markers. Total Landings is the number of Black Sea Bass that were caught in the commercial and recreational fisheries.



Below is the data table of values for the Black Sea Bass Data Over Time Graph.

YEAR	TOTAL BIOMASS	TOTAL LANDINGS
1968	6587	1930
1969	7278	1869
1970	8091	2028
1971	8661	1106
1972	10595	1573
1973	12278	2260
1974	13123	2348
1975	13450	3471
1976	12550	3452
1977	11991	4252
1978	10378	3359
1979	9339	1801
1980	10295	1979
1981	11304	1687
1982	12686	5677
1983	9655	3382
1984	9196	2567
1985	10146	2509
1986	11498	7522
1987	8355	2770
1988	8798	3178
1989	8105	2812
1990	7910	2844
1991	7994	3157
1992	8540	2552
1993	9039	3627
1994	7805	2258
1995	8639	3750
1996	8226	3333
1997	7509	3118
1998	7270	1682
1999	8584	2061
2000	10431	3024
2001	12506	2849
2002	14924	3553
2003	15024	2859
2004	14319	2159
2005	13065	2144
2006	12759	2173
2007	12892	2047



Procedure – Session 1

Introduction to Sampling Techniques

1. Describe the following scenario to your students.

   The Mid-Atlantic region is located between Massachusetts and North Carolina. Its relatively warm temperatures due to the Gulf Stream make it an ideal field site for marine biology students to sample. Biologists have recognized for some time that the Mid-Atlantic region is where a large portion of the Black Sea Bass population lives. From their fieldwork over the last 40 years, biologists have noticed changes occurring in the local population of Black Sea Bass. Biologists want to:

   i. Estimate the current Black Sea Bass population in the Mid-Atlantic region
   ii. Determine what sorts of changes (if any) are occurring
   iii. Decide what can be done to prevent damage to the population.

2. Display the Goals on a poster where all of the students can refer to them.

The Challenge

1. Ask the students, how a scientist might accomplish these goals in the Mid-Atlantic region? Elicit ideas from the class as to how they would go about estimating the size of a fish population. Summarize and record every answer on the board or on chart paper. Remind students that they have only enough time and money for eight fishing trips.
2. Ask for volunteers who think they can come-up with a procedure to get an accurate estimate of the number of Black Sea Bass in the Mid-Atlantic region.
3. Allow a student to explain their procedure and then actually carry it out in the Mid-Atlantic region in the classroom. What did they get for their population estimate? Do

students agree with this procedure? Spend about five minutes having students estimate the population using different procedures.

4. Ask the students, which technique they liked best? In which technique do students have the most confidence in their estimates? The least? Why?
5. Pose to the students that just about now they may be coming to the realization that field sampling and population estimates aren't as easy a task as they might first think. At this point, introduce the following method that marine scientists often use to estimate the size of fish populations.

Prelude to Simulated Fishing Collecting Activity

1. This activity introduces students to a simulated field study of Black Sea Bass. Approach this activity as if you were about to actually participate in the fieldwork.
2. Call the students "scientists" and tell them that they will all have an opportunity to "collect or fish" in the Mid-Atlantic region in the classroom.
3. Divide the students into groups of approximately 6 students per "research team" (group). Have one student in each team act as the recorder and manage the data sheet.
4. Distribute a copy of the Data Sheet, a clipboard, calculators, and a pencil to each team.

Step 1 – Getting to Know the Mid-Atlantic Region

1. Tell the students that when the research teams arrive at the site, their first job will be to determine the boundaries of the Mid-Atlantic region. Have the recorder use the grid provided on the data sheet to draw in the rope margins as it appears on the floor. Each cell on the grid corresponds to a quadrat in the Mid-Atlantic region.
2. Have each team determine to total number of usable quadrats within the Mid-Atlantic region and the number of usable quadrats on their sketch.

Step 2 – The Random Sample

1. Tell the students that selecting which quadrats to sample is always a little bit tricky. To be a scientifically valid survey, the quadrats explored must be randomly selected to a certain mathematical precision. Some field biologists use computers to randomly generate a series of numbers. Others take pages of number sequences into the field and blindly point to different areas of a page to select a series of numbers. Our method involves a bag and a collection of pieces numbered from 1-100.
2. Distribute a bag of numbered pieces to each group. Have students take turns reaching into the bag and selecting a tile or chip with a number. Return the tile or chip to the bag after recording the number on the data sheet. Repeat this process until students obtain 8 quadrats from which to sample. **Each team will select all eight quadrats before beginning any fishing collection trips**.

Step 3 –The Fishing Collecting Trips

1. Prepare students for the fishing collecting trips by demonstrating how to sample from the Mid-Atlantic region as follows:
    a. Only one scientist per team can enter the Mid-Atlantic region at a time.
    b. Scientists should remove their shoes so as not to damage the quadrats for other teams.
    c. Before the scientist enters the Mid-Atlantic region, have the team locate the first quadrat to be sampled. The scientist will proceed to that quadrat, lift the square, and look for any data.
    d. If data is present, the scientist will read the data to the recorder.
        i. If a scientist lifts a quadrat and finds a flag, the scientist must follow any special directions. If it instructs the scientist to abort the fishing collection trip, then any data present must be ignored and that fishing collection trip is forfeited. Teams should record this incident in the Other Observations section on the data sheet.
    e. After a quadrat has been sampled and data is recorded, the scientist should replace the quadrat and either proceeds to the next quadrat or leaves the Mid-Atlantic region and gives another scientist from the team a chance. Continue until all randomly selected quadrats have been sampled and recorded.

Step 4 – Making Sense of the Data

1. Students will have recorded the following data from each quadrat sampled: Quadrat #, Black Sea Bass Length, Male or Female, and Other Observations/Comments.
2. Describe to the students how to analyze or make sense of their data as follows:
    a. Mean Length- Using the length data, teams will determine the average size of Black Sea Bass sampled within the Mid-Atlantic region. To determine the average size, instruct the students to first sum the total lengths of Black Sea Bass. Then divide the sum of lengths by the total number of quadrats that had Black Sea Bass present. This will result in the average size of Black Sea Bass sampled.
    b. Male/Female Ratio- Have the students sum the total number of females sampled and the total number of males sampled. Then have the students divide the number of females by the number of males to determine the sex ratio.
    c. Population Estimate- Can a realistic estimate of the Black Sea Bass population be determined from a single team's data? The answer depends on what sort of data the students observed. If students find a Black Sea Bass within each quadrat, they may feel confident that the population is evenly distributed throughout the Mid-Atlantic region. They can then multiply the number of Black Sea Bass within each quadrat by the number of usable quadrats to get a population estimate. If the students do not find the population to be evenly distributed but clumped in one region of the Mid-Atlantic region, then their data alone may not be a valid means of estimating population size. In this case, they can pool their data with another team to try to estimate the population.

   d. Percent Male by Length- Have the students pool their data on the length and sex of the fishes they sampled to complete the Percent Male with Length graph. First, they should complete the length column of the table below with all of the observed lengths. Then they should tally how many males and females were observed in each length bin. Then they should calculate the sum of all fish observed in each length bin. To determine the percentage of males at each length, they will need to divide the number of males by the total number of fish observed and then multiple by 100. Once the students have completed the above table have them plot their results in the Percent Male with Length graph on their worksheets.
3. Tell the students that in the next session they will participate in a Black Sea Bass Conference, that everyone can share their data. As researchers, they will also try to determine just what is happening with the Black Sea Bass population in the Mid-Atlantic region and find out if their goals for the study were met.

Procedure – Session 2

Black Sea Bass Conference

1. When all of the research teams have completed their fishing collection trips and calculations, it's time to gather as a class and have a conference. Tell the students that just as scientists meet to discuss their research with other scientists, this is the student scientists chance to share their data.
2. On the board, record each research teams values for mean length, sex ratio, and population density. Question each group about any odd observations or occurrences during their fishing collection trips.
3. After accepting student's population estimates, tell them what the actual population is in the pool and see which teams are closed.
4. Using the large plot of population biomass recorded over the past 40 years of research, ask the students to study the graph to determine if the population is increasing, maintaining, and decreasing. (NOTE- the graph that you are showing students is of biomass in metric tons, but the numbers that they estimated are density. This can be a good opportunity to explain the difference between density and biomass to your students and lead them in a discussion about why fisheries scientists would be interested in looking at biomass.)
5. Students will clearly see that the Black Sea Bass population has been fluctuating over the past four decades. Have students project this trend into the future. What seems to be the fate of this species? Help the students look into different parts of the graph of total biomass; has the trend been the same throughout the 40 years? What is the difference between 1968 and 2007? What is the trend between these two points? Have there been times when the trend was opposite than the overall trend?

Discussing Fishing Efforts

1. Tell the students that one final bit of data must be identified to locate a factor in the population's fluctuations. Show the students the second large plot of the total biomass and the total landings. Explain to the students that the total landings are the total number of Black Sea Bass that were caught by recreational and commercial fishermen combined.
2. Ask the students to look at the data and observe patterns in the data. Help the students look into different parts of the graph of total landings; has the trend been the same throughout the 40 years? What is the difference between 1968 and 2007? What is the trend between these two points? Have there been times when the trend was opposite than the overall trend?
3. Have the students compare the pattern between the total biomass and the total landings over the 40-year data series. Do the two data sources follow similar or different patterns? Are there times when the two data sources follow similar patterns but other times follow different patterns? Why?
4. Ask the students to think about what has happened to the fishing fleet over the past 40 years.

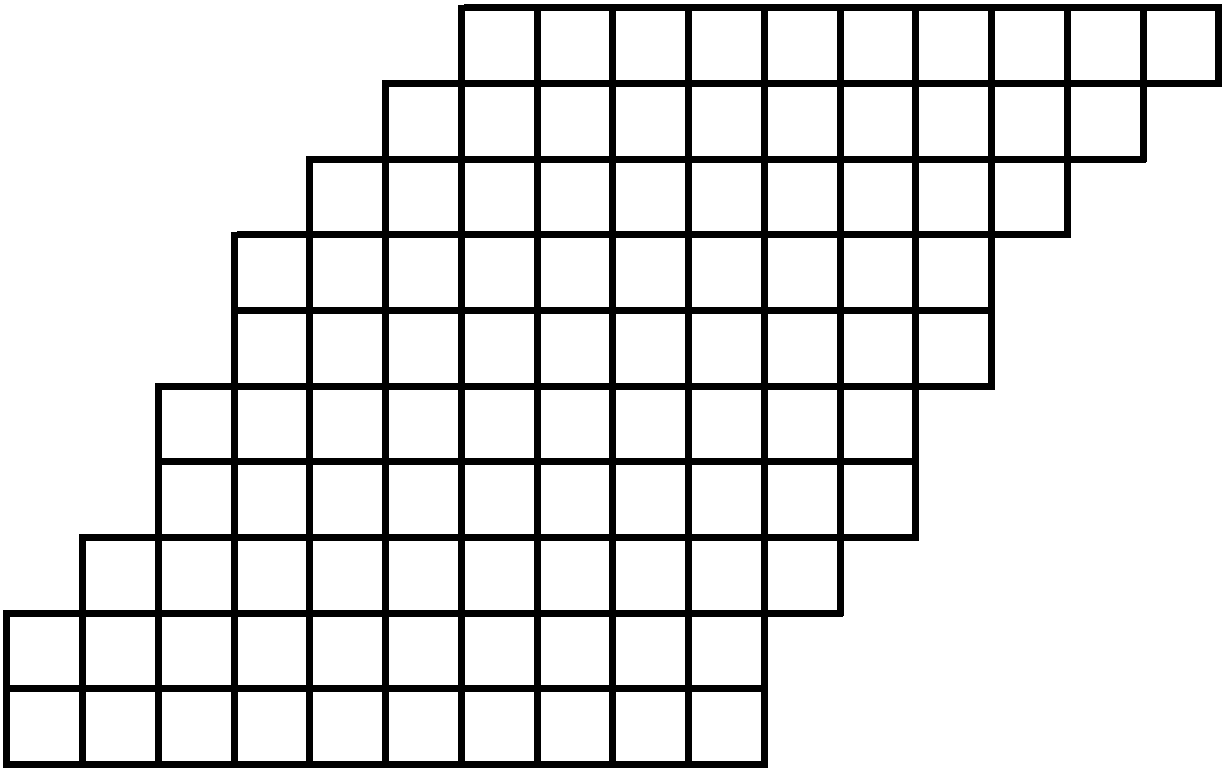
Wrap-Up

1. Distribute a sheet of paper and pen/pencil to each student. Have them do a "Quick Write" about the following topic:

   > What are the short term, medium term, and long-term consequences to the total biomass of Black Sea Bass by increasing the amount of fishing pressure? What about decreasing the amount of fishing pressure? What arguments and evidence can you give to support your predictions?

2. Lead a whole group discussion and have students share their predictions with the class.
3. Write the key concept (Fish populations fluctuate over time and the actions of humans can influence the fluctuations in positive and negative ways) on the board.
4. Ask the students if they have other observations or comments about the activity.

Black Sea Bass Encounter Data Sheet



1. Total Usable Quadrats: _____

QUADRAT #1	QUADRAT #2
Fish Length: _____	Fish Length: _____
Male or Female: _____	Male or Female: _____
Other Observations/Comments:	Other Observations/Comments:
_____	_____
_____	_____
_____	_____
QUADRAT #3	**QUADRAT #4**
Fish Length: _____	Fish Length: _____
Male or Female: _____	Male or Female: _____
Other Observations/Comments:	Other Observations/Comments:
_____	_____
_____	_____
_____	_____

QUADRAT #5	QUADRAT #6
Fish Length: _____	Fish Length: _____
Male or Female: _____	Male or Female: _____
Other Observations/Comments:	Other Observations/Comments:
_____	_____
_____	_____
_____	_____
QUADRAT #7	**QUADRAT #8**
Fish Length: _____	Fish Length: _____
Male or Female: _____	Male or Female: _____
Other Observations/Comments:	Other Observations/Comments:
_____	_____
_____	_____
_____	_____

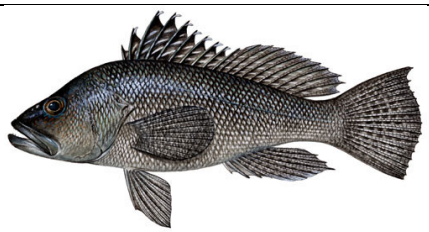
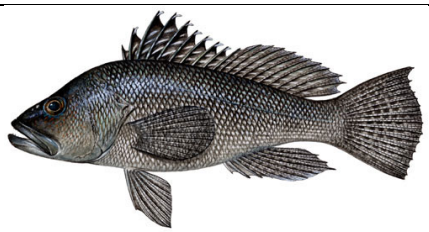
2. Total Number of Black Sea Bass Sampled: _____
3. Average Number of Black Sea Bass per Quadrat: _____
4. Mean Length of Black Sea Bass Sampled: _____
5. Female to Male Sex Ratio: _____
6. Black Sea Bass Population Estimate: _____
7. Calculate the % Males with Length and then graph the Length Bins vs. Percent Male

Length Bins (cm)	**Number Males**	**Number Females**	**Total Observed**	**Percent Male**
0-5				
5-10				
10-15				
15-20				
20-25				

25-30				
30-35				
35-40				
40-45				
45-50				
50-55				
55-60				

Black Sea Bass Encounter Quadrats

Print out the following grid and cut out each square and attach to an individual grid cell. Remember that the four flags should be placed randomly with four quadrats in addition to the fish information.

 15 cm ~ Female	 15 cm ~ Female
 15 cm ~ Female	 16 cm ~ Female
 16 cm ~ Female	 17 cm ~ Female
 17 cm ~ Female	 18 cm ~ Female

 18 cm ~ Female	 18 cm ~ Female
 19 cm ~ Female	 20 cm ~ Female
 20 cm ~ Female	 20 cm ~ Female
 21 cm ~ Female	 22 cm ~ Female
 22 cm ~ Female	 22 cm ~ Female

 23 cm ~ Female	 23 cm ~ Female
 24 cm ~ Female	 25 cm ~ Female
 25 cm ~ Female	 26 cm ~ Female
 27 cm ~ Female	 27 cm ~ Female
 28 cm ~ Female	 29 cm ~ Female

 29 cm ~ Female	 30 cm ~ Female
 31 cm ~ Female	 31 cm ~ Female
 32 cm ~ Female	 32 cm ~ Female
 33 cm ~ Female	 34 cm ~ Female
 34 cm ~ Female	 35 cm ~ Female

 36 cm ~ Female	 36 cm ~ Female
 37 cm ~ Female	 38 cm ~ Female
 38 cm ~ Female	 40 cm ~ Female
 41 cm ~ Female	 42 cm ~ Female
 43 cm ~ Female	 44 cm ~ Female

 45 cm ~ Female	 46 cm ~ Female
 48 cm ~ Female	 50 cm ~ Female
 53 cm ~ Female	 54 cm ~ Female
 16 cm ~ Male	 17 cm ~ Male
 19 cm ~ Male	 19 cm ~ Male

 21 cm ~ Male	 21 cm ~ Male
 24 cm ~ Male	 26 cm ~ Male
 28 cm ~ Male	 30 cm ~ Male
 33 cm ~ Male	 35 cm ~ Male
 37 cm ~ Male	 39 cm ~ Male

 40 cm ~ Male	 42 cm ~ Male
 43 cm ~ Male	 46 cm ~ Male
 47 cm ~ Male	 49 cm ~ Male
 51 cm ~ Male	 51 cm ~ Male
 52 cm ~ Male	 54 cm ~ Male

 55 cm ~ Male	 56 cm ~ Male
 57 cm ~ Male	 58 cm ~ Male
 58 cm ~ Male	 59 cm ~ Male
 60 cm ~ Male	No fish present
No fish present	No fish present

No fish present	No fish present
No fish present	No fish present
No fish present	No fish present
No fish present	No fish present
No fish present	No fish present

No fish present	No fish present
FLAG Ran out of gas in fishing boat (Abort collection trip and ignore data)	**FLAG** Aggressive Sea Lion eats the stomach of the Black Sea Bass (Abort the collection trip and ignore the data)
FLAG Forgot fishing rods (abort collection trip and ignore data)	**FLAG** Nor'easter blows in (Abort collection trip and ignore data)