



**VA SEA**

# SEARCHING FOR SEA SCALLOPS: THE ROLE OF SCIENCE IN FISHERIES MANAGEMENT

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**Grade Level**

7<sup>th</sup> Grade

**Subject area**

Life Science

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**Title:** Searching for Sea Scallops: The Role of Science in Fisheries Management

**Focus:** Students will collect data on populations of sea scallops and then use those data to provide recommendations for sustainably managing the fishery in the next fishing year

**Grade Level:** 7<sup>th</sup> Grade Life Science (with optional extensions for HS Biology)

### VA Science Standards

LS.1 The student will demonstrate an understanding of scientific and engineering practices by

- b) planning and carrying out investigations
  - independently and collaboratively plan and conduct observational and experimental investigations; identify variables, constants, and controls where appropriate and include the safe use of chemicals and equipment
  - take metric measurements using appropriate tools and technologies including the use of microscopes
- c) interpreting, analyzing, and evaluating data
  - identify, interpret, and evaluate patterns in data
  - construct, analyze, and interpret graphical displays of data
  - compare and contrast data collected by different groups and discuss similarities and differences in their findings
  - consider limitations of data analysis and/or seek to improve precision and accuracy of data

LS.8 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time. Key ideas include

- a) organisms respond to daily, seasonal, and long-term changes; and
- b) changes in the environment may increase or decrease population size.

LS.9 The student will investigate and understand that relationships exist between ecosystem dynamics and human activity. Key ideas include

- a) changes in habitat can disturb populations; and
- c) variations in biotic and abiotic factors can change ecosystems.

BIO.7 The student will investigate and understand that populations change through time. Key ideas include

- b) genetic variation, reproductive strategies, and environmental pressures affect the survival of populations.

BIO.8 The student will investigate and understand that there are dynamic equilibria within populations, communities, and ecosystems. Key ideas include

- d) natural events and human activities influence local and global ecosystems and may affect the flora and fauna of Virginia.



## Learning Objectives

- Students will collect data on sea scallop shell height, age, sex, and gonad area
- Students will create bar graphs of sea scallop shell heights and ages and will graph the relationship between shell height and gonad size
- Students will analyze and draw conclusions from their data to come up with recommendations for sustainably managing the sea scallop fishery

## Total Length of Time Required

Total Time: 90-120 minutes for lesson, depending on time allotted for class discussion at the beginning and end of the activity

## Key Words & Vocabulary

Adductor muscle: a muscle whose contraction moves a part of the body toward another part of the body

Allocation: an amount or proportion of a resource assigned to a particular participant in an industry

Bivalve: having a shell consisting of two halves hinged together

Dredge: a tool for bringing objects or organisms up from the seabed by scooping or dragging

External fertilization: a mode of reproduction in which the fusion of male and female gametes occurs outside of the body (typically in water)

Fecundity: a measure of the number of offspring or gametes an organism can produce

Fishery: the occupation or industry of catching or rearing fish

Fishing year: a period of time used for fisheries management that does not necessarily correspond to a calendar year

Gametes: an organism's reproductive cells; eggs in females and sperm in males

Gonad: an organ that produces gametes

Hinge: a movable joint connecting the two halves of a bivalve shell

Larva (plural larvae): a distinct form in early development that occurs after fertilization and before metamorphosis into an adult

Population: a group of individuals of the same species living in the same area or region

Spawning: the process of releasing eggs and sperm into the water column for external fertilization

## Background Information

The Atlantic sea scallop (*Placopecten magellanicus*) is a marine bivalve that supports a major fishery on the U.S. East Coast from North Carolina to Maine. Being a bivalve means that they have two shells joined together by a hinge. These two shells are held together by a large adductor muscle, also called the “meat” since this is the portion of the scallop that people typically eat. Scallop shells are typically reddish-pink or brown on top and white or cream on bottom. They sit on the bottom of the seafloor and feed on phytoplankton, which are tiny organisms that drift in the water column. Sea scallops can live up to 20 years and grow up to 9 inches long. They have separate sexes, with females exhibiting pink gonads and males exhibiting white gonads due to the presence of eggs or sperm. Spawning occurs in the spring and fall, with larvae staying in the water column for 4 to 6 weeks before settling to the bottom and undergoing metamorphosis into juvenile scallops. These small scallops can clap their shells together to swim and avoid predators.

Scallops are harvested using dredges, metal bags of rings that are towed along the seafloor. The size of the rings is designed to scoop up large scallops and let the small scallops fall through and remain on the bottom. There are two main portions of the sea scallop fishery, Limited Access (LA) and Limited Access General Category (LAGC), both managed by the New England Fishery Management Council. LAGC vessels receive individual fishing quotas that they can fish throughout the year. LA vessels are managed through days-at-sea (DAS) and a system of rotational access areas. LA vessels may fish their DAS on any open bottom, which is seafloor that is not currently closed or part of an access area. The access areas are established to take advantage of how quickly scallops grow in their early years. By closing an area to fishing, the scallops inside have time to grow before they are susceptible to the fishery, and they generally reach larger sizes than those in open bottom areas. Larger meats are worth more per pound, so this strategy can be highly profitable for the fishery. In addition, though sea scallops can reproduce at age 2, they produce very small quantities of eggs or sperm until about age 4. After this, scallop fecundity, an individual’s output of eggs and sperm, increases with age. By closing areas to allow scallops to reach at least 5 years old, scallops have the chance to grow and reproduce multiple times before they can be targeted by the fishery. However, this strategy is only effective in areas with high densities of young scallops that are similar in age. In areas with a mixed distribution of ages, the older scallops are likely to start dying off due to the higher natural mortality levels associated with more advanced ages, negating some of the gains from the growth of juveniles.

To close areas effectively, the whole sea scallop resource is surveyed by fisheries scientists every year. Scientists collect data using cameras or a smaller version of the dredge used in the commercial fishery. These surveys collect data on scallop shell height, meat weight, meat quality, disease prevalence, gonad weight, sex, and reproductive stage. When a large group of small, young scallops is found in the same area, the New England Fishery Management Council often decides to close that area for about 3 years to allow the scallops to grow and reproduce. In this lesson, students will simulate this process by collecting data about scallops in one area of the resource and then sharing their findings with the rest of the class. New groups will be formed where students can compare how scallop populations differ between areas and provide recommendations to the management council about which areas should be closed, which should be opened as an access area, and which can remain as open bottom for fishing using DAS.

## Materials & Supplies

- Computer and projector for PowerPoint presentation
- Student handouts
  - Survey Data Collection (Part 1)
    - Optional: Biology Extension Questions
  - Management Recommendations (Part 2)
    - Optional: Biology Extension Questions
- Prepared scallop samples for 5 to 10 groups
  - Pre-cut and stapled scallops (attached at the end of the lesson plan)
  - Small bag or paperclip for organizing scallops by group/dredge tow
- Colored pencils or markers for graphing
- Metric ruler
- Calculators
- Dry erase board/chalkboard/easel for sharing group data

## Teacher Preparation

This lesson works well with groups of 2 to 4 students, depending on class size and practice with group activities. There are 5 sets of scallops (each representing a separate dredge tow), but instructors can create two copies of each set for a total of up to 10 groups of students. Instructors will need to print the scallops at the end of this lesson plan. Ideally, these should be printed in color to allow students to age and determine the sex of the scallops successfully. Each scallop will need to be cut out but can be laminated for repeated use. There are two parts to each scallop, labeled with the same number on the left corner of the hinge. Instructors should staple the top shell to the bottom shell at the hinge, so that the top shell can be flipped up to reveal the inside of the scallop (example below). The scallops for each dredge tow/group can be placed in a small bag, paper clipped, or placed loose at the group's workstation.



Students will also need individual copies of the two handouts, colored pencils or markers for graphing, metric rulers, and a calculator for the group. Both handouts have an optional page of biology extension questions for more advanced courses or homework assignments. During this activity, students will create a whole classroom plot of the relationship between shell height and female gonad area. There is a blank plot in the PowerPoint slides for projection, but a whiteboard, chalkboard, or easel could also be used for this component of the lesson. Depending on how comfortable the class is with graphing, the instructor may wish to review the process for creating bar graphs and scatter plots before or during this lesson. There are additional slides for this purpose included at the end of the PowerPoint presentation.

### Procedure

1. Instructors should use the included PowerPoint presentation to introduce the lesson and the activity. Key talking points are included in the notes section of each slide.
  - There are additional slides at the end of the presentation with examples for creating bar graphs and scatter plots. Instructors can use these slides wherever they would be most helpful for the class, including before starting the lesson or after students have collected their initial data.
2. Students should be divided into 5 to 10 groups of 2 to 4 students, depending on class size and practice with group activities.
3. Distribute the prepared scallop samples (each group should receive the scallops from one dredge tow). Students will also need individual copies of the Survey Data Collection worksheet, colored pencils or markers for graphing, calculators, and metric rulers.
4. Working together with their group, students will complete the first worksheet, Survey Data Collection. Instruct groups to send 1 or 2 members to the front of the class to plot their data on the group graph of shell height vs. female gonad area.

- If multiple groups were assigned the same dredge tow, either nominate one of the groups to complete this portion of the activity or inform students that they can add their points right next to others on the graph that fall in the same location.
- 5. After all groups have completed the first worksheet, call the class back together to discuss the process and general observations from the data they collected.
- 6. Use a jigsaw approach to create new groups that have at least one member from each original group (students will be comparing the data they collected from their dredge tow to other dredge tows). Distribute individual copies of the second worksheet, Management Recommendations.
  - If there are not enough students from a particular dredge tow for each new jigsaw group, instruct groups to send one member to learn about the results from that dredge tow from another group.
- 7. Students will work together in these new groups, using the data they collected from their dredge tows in part 1, to determine which areas should be closed, designated as open bottom, or allocated an access area trip in the next fishing year.
- 8. When all groups have decided on their management recommendations and answered the follow-up questions, call the class back together to discuss the findings of each group and touch on any remaining key ideas from the lesson.
  - One option here is to lead a discussion on where groups agree or disagree using evidence from their findings. There is also a blank recommendation table in the PowerPoint for summarizing the management recommendations from the entire class.

### **Assessment**

Student assessment should be based on worksheet completion, graphing exercises, participation in group activities, and contribution to the class discussion.

### **References and Additional Resources**

NOAA Fisheries Atlantic Sea Scallop Species Page

<https://www.fisheries.noaa.gov/species/atlantic-sea-scallop#overview>

NOAA Fisheries “Atlantic Sea Scallop: A Fishery Success Story” Story Map

<https://storymaps.arcgis.com/stories/5c7e77ff4db0464bb2ea598e766b9764>

VIMS Sea Scallop Research Program

<https://www.vims.edu/research/units/centerspartners/map/comfish/scallop/index.php>



## Searching for Sea Scallops: Survey Data Collection (Part 1)

Name: \_\_\_\_\_

Date: \_\_\_\_\_

My Tow Number: \_\_\_\_\_

**Introduction:** As fisheries scientists, your job is to conduct a survey of the sea scallop resource so that managers can determine which areas can be harvested in the following fishing year. Your group has been assigned a single location to survey, and your task is to collect biological information about the scallops in your dredge tow.

### Instructions:

1. Open your dredge tow and remove the scallops inside.
2. For each scallop, use the metric side of the ruler to measure the shell height (distance from the hinge to the edge of the shell) in millimeters (mm).
3. Count the rings on the outside of the shell to determine the scallop's age.
4. Open up the scallop and record the sex of the animal by examining the color of the gonad. Female scallops have pink gonads and male scallops have white gonads.
5. For only the female scallops, use your ruler to measure the length (long distance) and width (short distance) of the gonad. Measure the longest and widest portions of the gonad without letting your ruler go across the adductor muscle.
6. Use your gonad measurements to calculate the estimated area of the gonad using the formula in the gonad area column. You may substitute 3.14 for  $\pi$  in the formula.
7. Repeat until your group has collected data on every scallop in your tow, then complete the graphing activities and answer the follow-up questions. Individuals must write their own answers, but the questions can be discussed as a group.

Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) $A = L/2 \times W/2 \times \pi$

**Group Graphing Activity:** Use your shell height measurements to create a bar graph below. The shell heights are grouped in bins of 5 mm, so a measurement of 107 mm should go in the 106-110 column. Then, use your scallop age data to create a second bar graph.

Number of Scallops													
	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	101-105	106-110	111-115	116-120
	Shell Height (mm)												

Number of Scallops									
	1	2	3	4	5	6	7	8	9
	Age								

**Whole Classroom Graphing Activity:** Send one or two members of your group to add your measurements to the graph of shell height vs. female gonad area at the front of the classroom. The two columns you will need for this activity are highlighted in gray. This graph is a scatter plot, so each paired data point (x, y coordinate) should be a single dot.

**Question 1:** What do you observe about the scallops in your dredge tow? Are they all similar in size or do they vary in size?

**Question 2:** Compare your bar graphs of shell height and age. Do they look similar or different? Why do you think this is?

**Question 3:** Looking at the whole classroom graph, how does gonad area change as shell height increases?

**Biology Extension Questions:**

**Question 4:** Scallops are broadcast spawners, meaning they release eggs and sperm into the water column where they form gametes and develop into larvae. These larvae eventually develop into juvenile scallops. Based on the relationship between gonad area and shell height, how might the number of eggs and larvae a female can produce change as she grows?

**Question 5:** Take a closer look at the distance between each of the growth rings. Do they get closer or farther apart as the scallop gets older?

**Question 6:** What can you infer about how scallops grow from the spacing between rings? Use evidence to support your claim.

## Searching for Sea Scallops: Management Recommendations (Part 2)

Name: \_\_\_\_\_

Date: \_\_\_\_\_

My Tow Number: \_\_\_\_\_

**Introduction:** Each year, survey results from different areas are compared to determine how to best manage the sea scallop fishery in the following fishing year. As a group, you will compare your results and create management recommendations for allocating fishing effort across the areas represented by the dredge tows. There is no set way to do this, and often the decisions require a lot of conversation.

### Instructions:

1. Each member of the group should give a brief overview of the results from their dredge tow, including the shell height and age distributions.
2. After every member has a chance to share, work together to determine how to allocate fishing effort to each of the areas. Your options are:
  - a. Create a new closed area to allow scallops to grow and reproduce (useful for areas with small scallops that need protection)
  - b. Assign an access area trip to allow all vessels to harvest scallops (useful for areas with large scallops that can support heavy fishing pressure)
  - c. Designate the area as open bottom so vessels can choose whether to harvest there (useful for areas with mixed scallops that can support a little fishing pressure)
3. Include a brief statement of the rationale for each decision. What data did you use to make your decision?
4. Once your group has made a management recommendation for every area, complete the follow-up questions. Everyone must write their own answer, but you may discuss the questions as a group.

Tow Number	Management Decision	Rationale
1		
2		
3		
4		
5		

**Question 1:** How does your scallop tow compare to the tows from other groups? Do you have smaller or larger scallops? Younger or older?

**Question 2:** Did you base your decisions on shell heights, ages, gonad sizes, or some combination of the three? Why did you focus on these metrics?

**Question 3:** Did your group disagree on how to manage any of the areas? If so, how did you determine which management action to proceed with?

**Biology Extension Questions:**

**Question 4:** Every year, adult scallops spawn and produce new juvenile scallops. Why do you think there were no 1-year-olds observed in the survey?

**Question 5:** Scallops can live to be 20 years old. Why do you think there were no scallops older than 7 years old observed in the survey?

**Question 6:** If you had the time and funding to collect another type of data during your survey, what would you choose? Why?



## Searching for Sea Scallops: Survey Data Collection (Part 1) Instructor Key

Name: \_\_\_\_\_

Date: \_\_\_\_\_

My Tow Number: \_\_\_\_\_ 1-5 \_\_\_\_\_

**Introduction:** As fisheries scientists, your job is to conduct a survey of the sea scallop resource so that managers can determine which areas can be harvested in the following fishing year. Your group has been assigned a single location to survey, and your task is to collect biological information about the scallops in your dredge tow.

### Instructions:

1. Open your dredge tow and remove the scallops inside.
2. For each scallop, use the metric side of the ruler to measure the shell height (distance from the hinge to the edge of the shell) in millimeters (mm).
3. Count the rings on the outside of the shell to determine the scallop's age.
4. Open up the scallop and record the sex of the animal by examining the color of the gonad. Female scallops have pink gonads and male scallops have white gonads.
5. For only the female scallops, use your ruler to measure the length (long distance) and width (short distance) of the gonad. Measure the longest and widest portions of the gonad without letting your ruler go across the adductor muscle.
6. Use your gonad measurements to calculate the estimated area of the gonad using the formula in the gonad area column. You may substitute 3.14 for  $\pi$  in the formula.
7. Repeat until your group has collected data on every scallop in your tow, then complete the graphing activities and answer the follow-up questions. Individuals must write their own answers, but the questions can be discussed as a group.

Measurements for shell height are likely to differ by 1-2 mm. Measurements for gonad length and width will likely vary further, up to about 5 mm, depending on the orientation of the ruler. All included measurements are approximate.

### Dredge Tow 1

Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) $A = L/2 \times W/2 \times \pi$
72 mm	2	Male			
77 mm	3	Female	34 mm	13 mm	347 mm <sup>2</sup>
58 mm	2	Female	25 mm	10 mm	196 mm <sup>2</sup>
61 mm	2	Male			



77 mm	3	Male			
65 mm	2	Female	29 mm	11 mm	251 mm <sup>2</sup>
60 mm	2	Male			

### Dredge Tow 2

Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) A = L/2 x W/2 x π
81 mm	4	Male			
58 mm	2	Female	25 mm	10 mm	196 mm <sup>2</sup>
113 mm	7	Female	82 mm	32 mm	2,061 mm <sup>2</sup>
86 mm	3	Female	50 mm	21 mm	825 mm <sup>2</sup>
77 mm	3	Male			
110 mm	6	Male			

### Dredge Tow 3

Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) A = L/2 x W/2 x π
119 mm	7	Female	84 mm	33 mm	2,177 mm <sup>2</sup>
99 mm	5	Male			
110 mm	6	Female	79 mm	31 mm	1,923 mm <sup>2</sup>
106 mm	6	Male			
112 mm	5	Female	82 mm	32 mm	2,061 mm <sup>2</sup>

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#### Dredge Tow 4

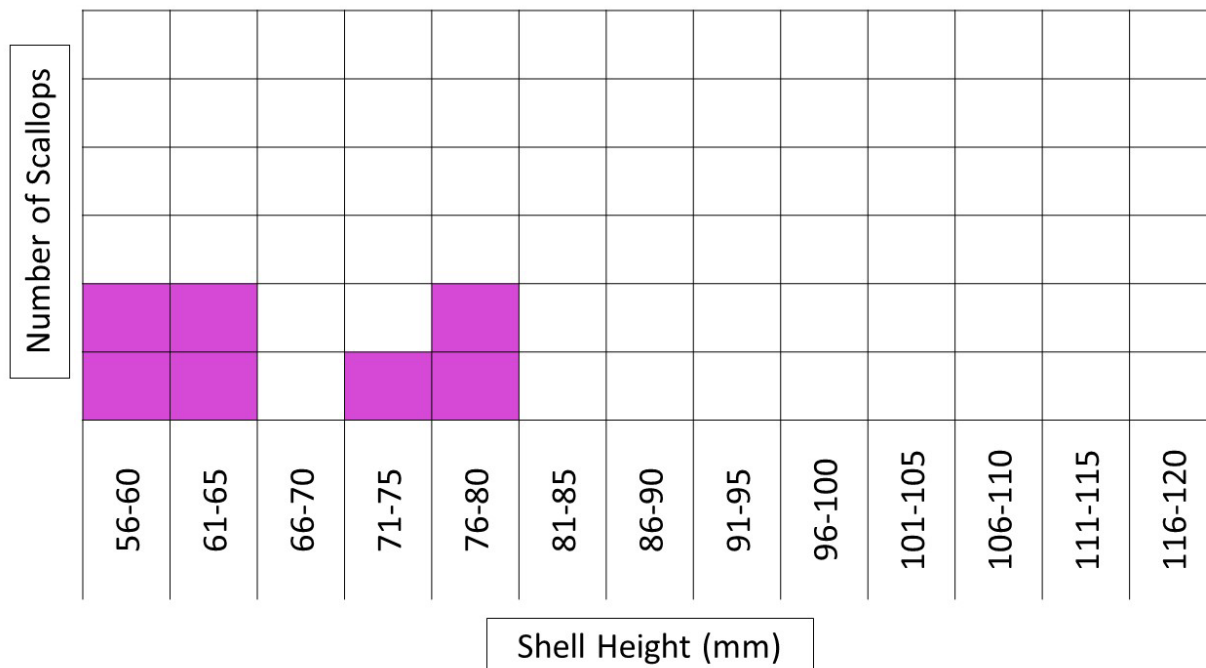
Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) $A = L/2 \times W/2 \times \pi$
60 mm	2	Female	27 mm	10 mm	212 mm <sup>2</sup>
90 mm	4	Male			
71 mm	3	Female	31 mm	12 mm	292 mm <sup>2</sup>
81 mm	3	Male			
84 mm	4	Female	50 mm	21 mm	825 mm <sup>2</sup>
62 mm	2	Male			

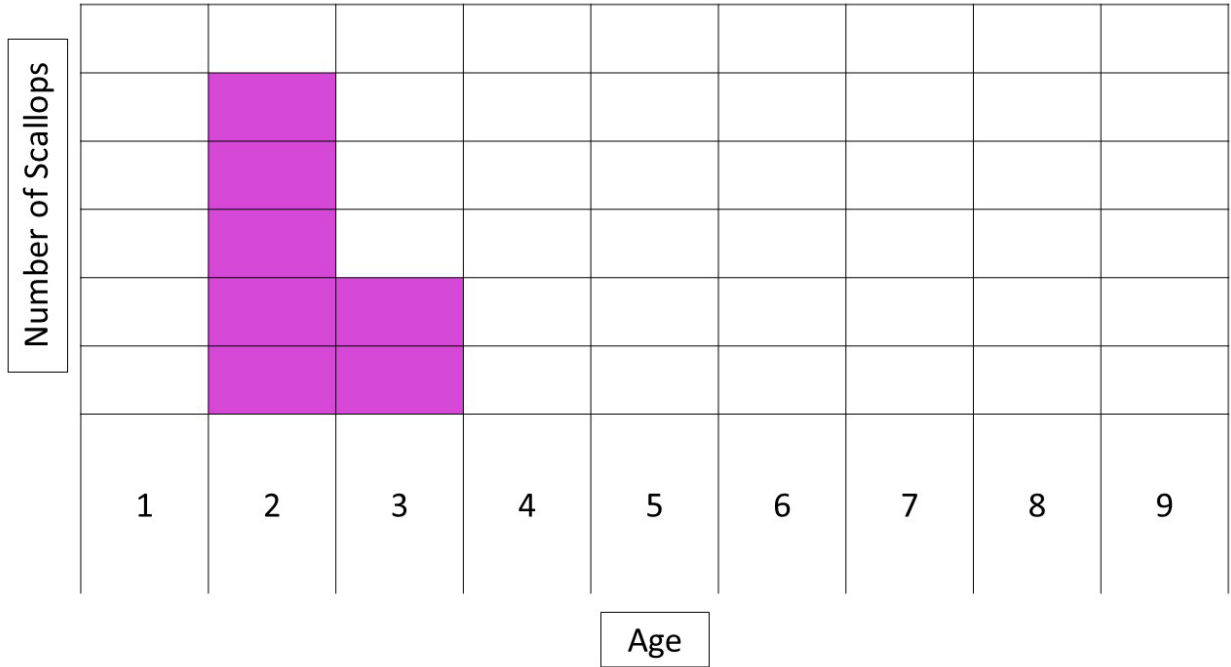
#### Dredge Tow 5

Shell Height	Age	Sex	Gonad Length (L)	Gonad Width (W)	Gonad Area (A) $A = L/2 \times W/2 \times \pi$
69 mm	6	Female	30 mm	11 mm	259 mm <sup>2</sup>
79 mm	7	Male			
72 mm	6	Female	31 mm	12 mm	292 mm <sup>2</sup>
82 mm	7	Female	49 mm	20 mm	770 mm <sup>2</sup>
75 mm	6	Male			

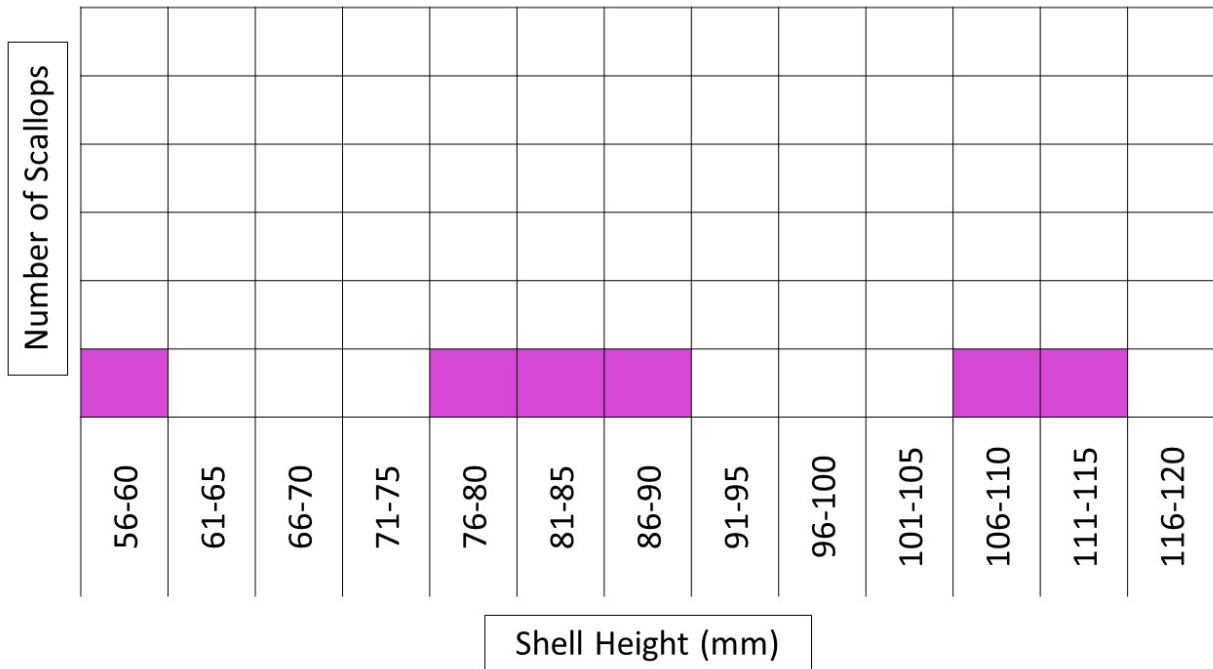
**Group Graphing Activity:** Use your shell height measurements to create a bar graph below. The shell heights are grouped in bins of 5 mm, so a measurement of 107 mm should go in the 106-110 column. Then, use your scallop age data to create a second bar graph.

**Dredge Tow 1**



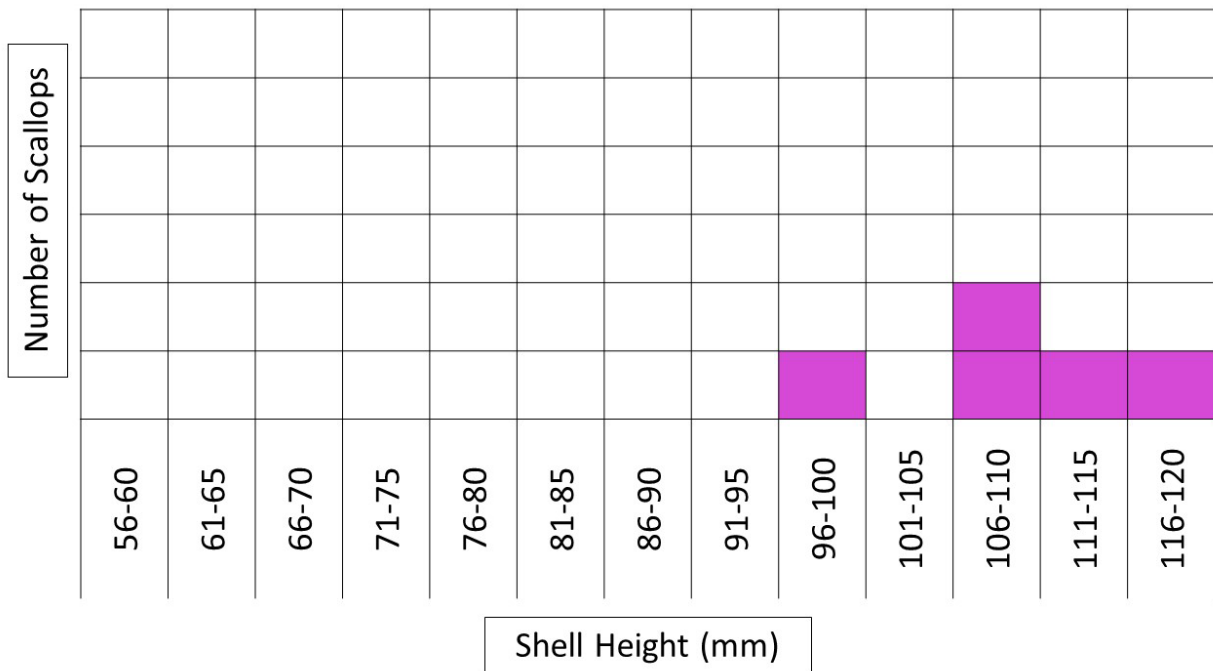


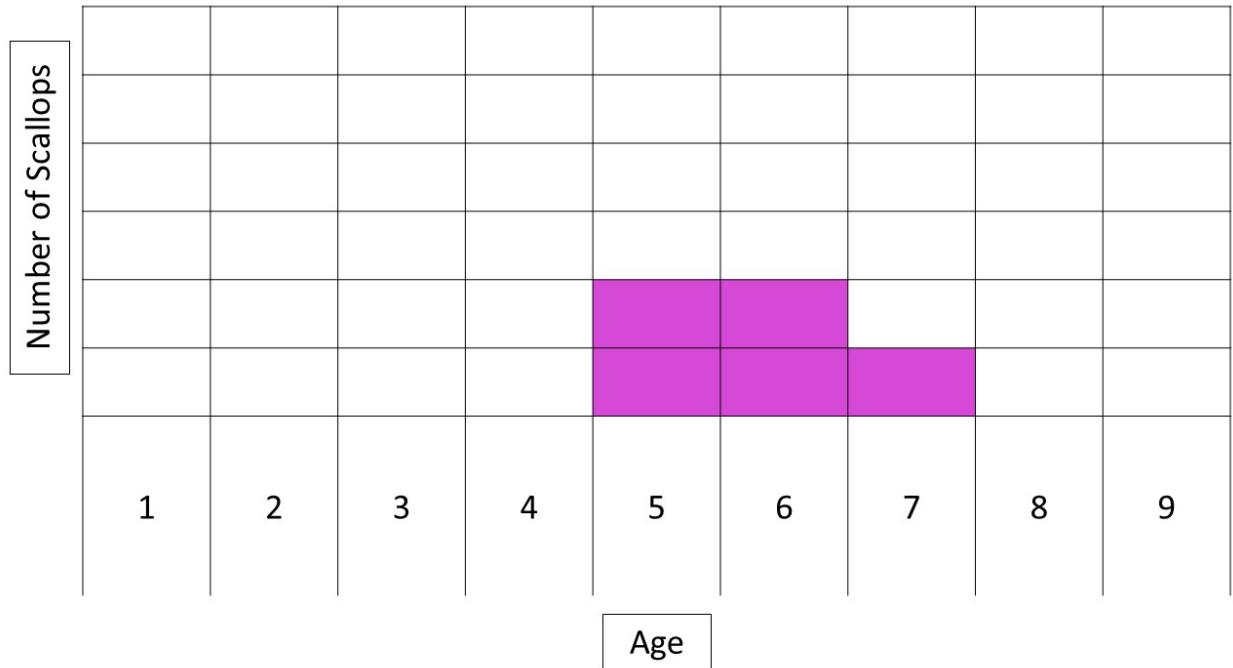
**Dredge Tow 2**



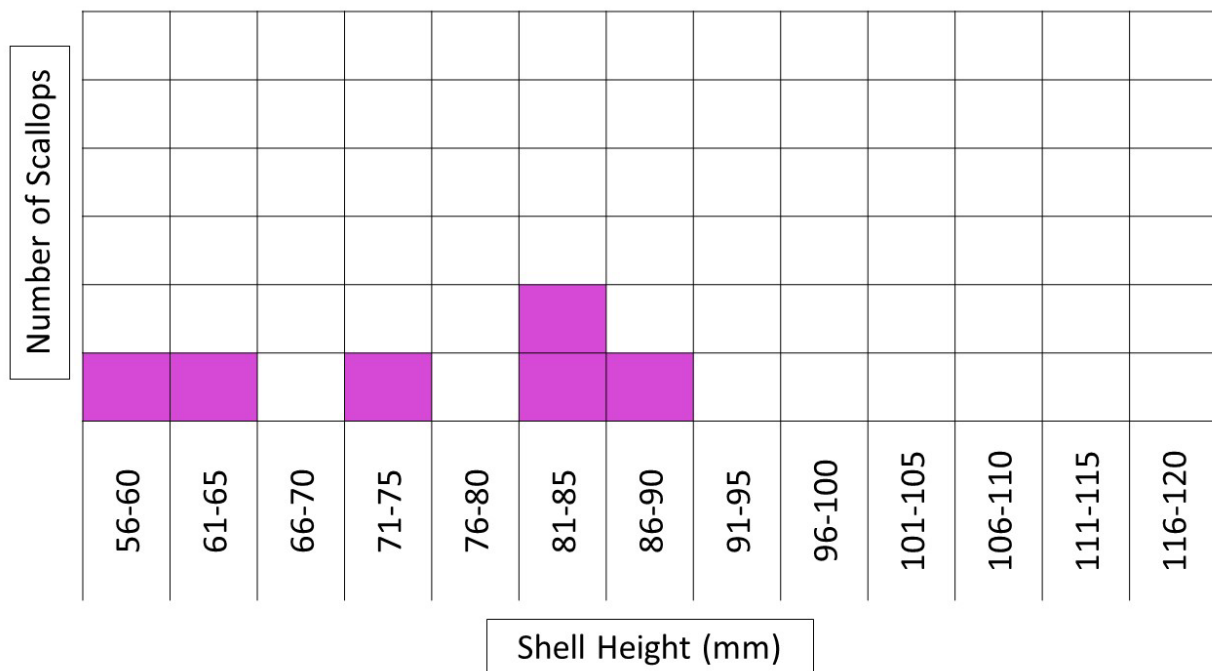


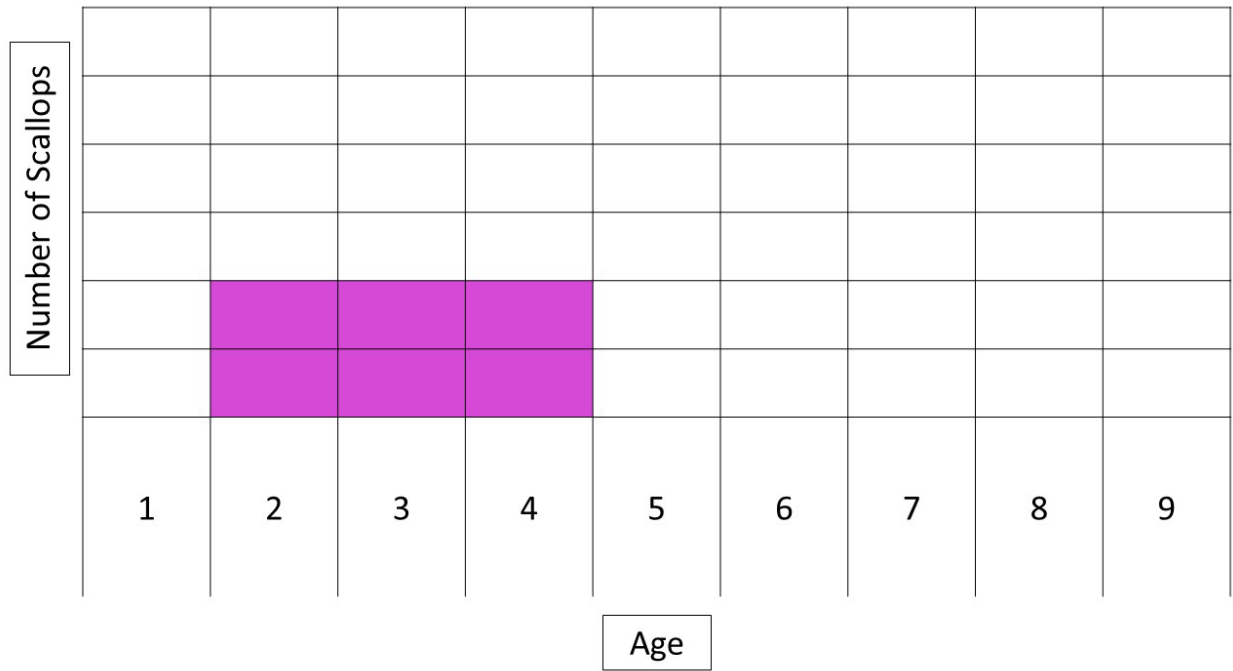
**Dredge Tow 3**



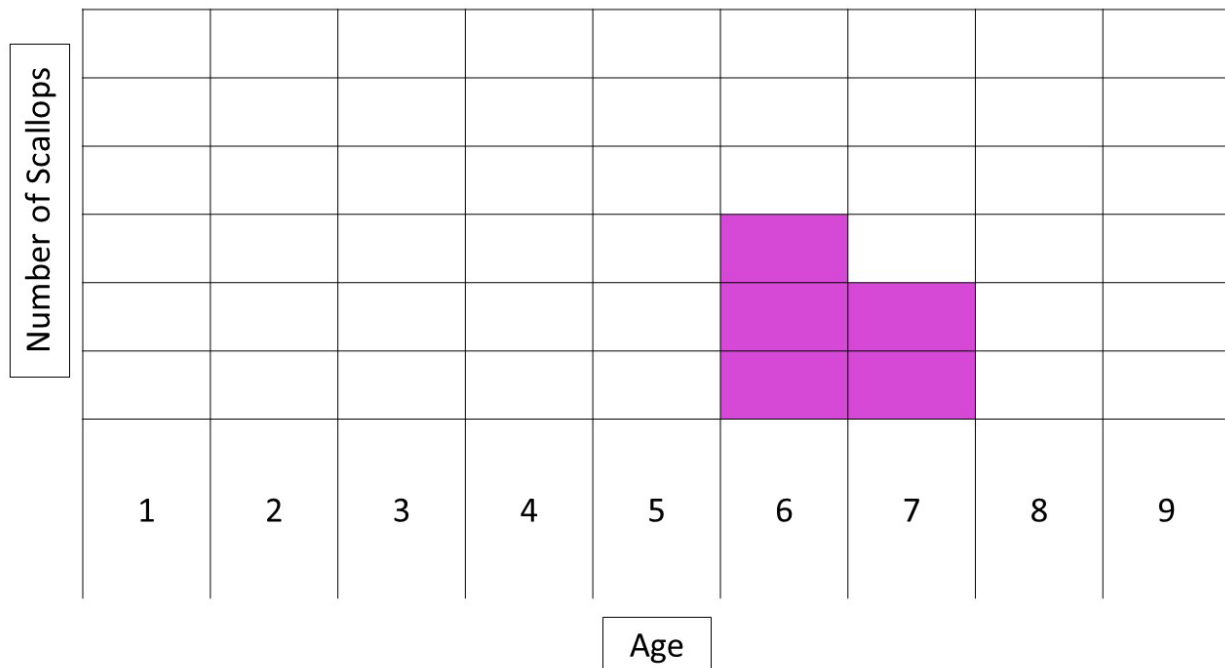
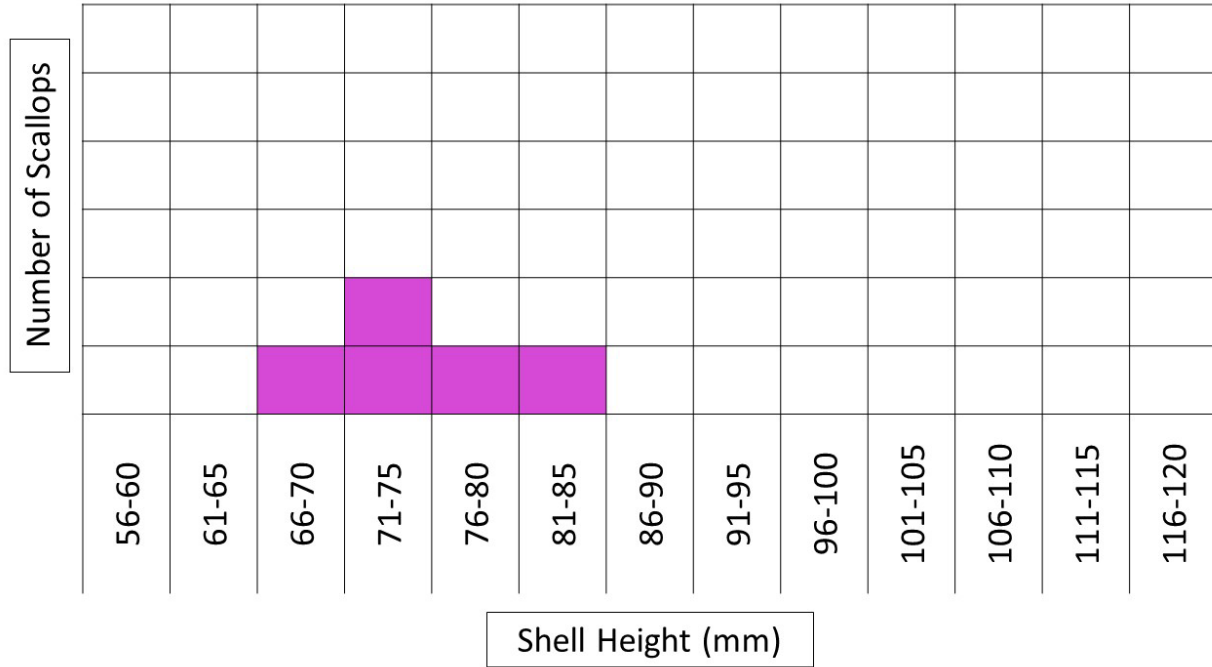


**Dredge Tow 4**





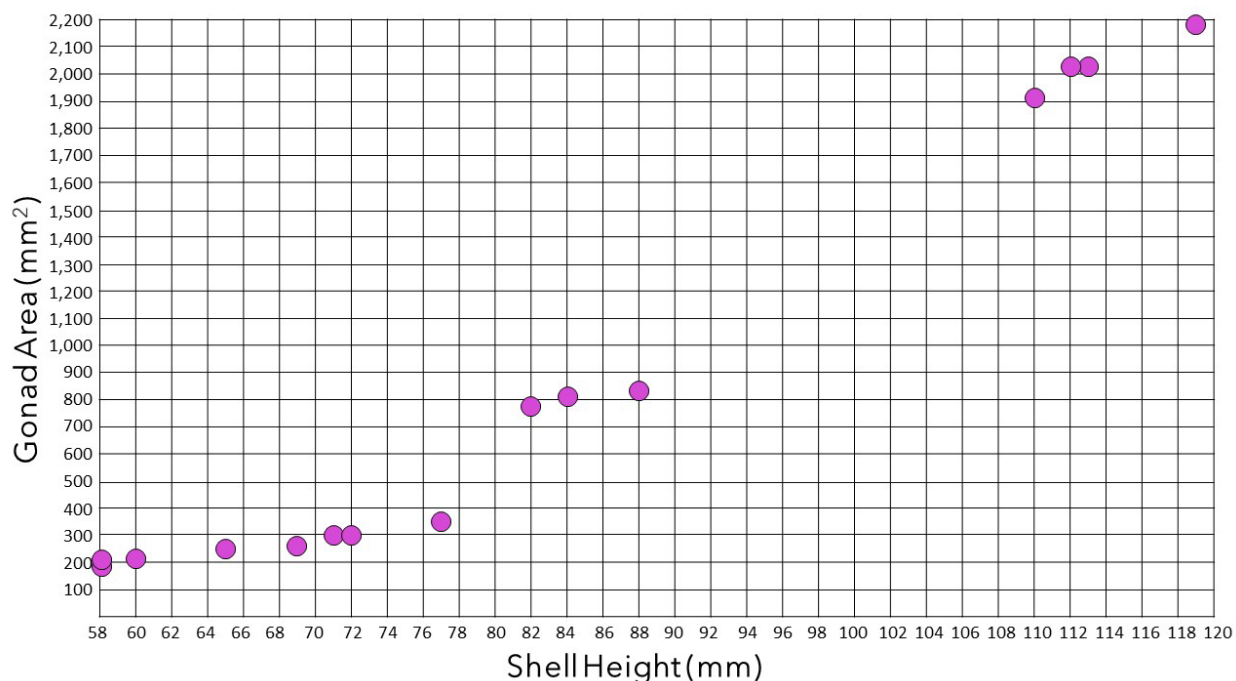
**Dredge Tow 5**





**Whole Classroom Graphing Activity:** Send one or two members of your group to add your measurements to the graph of shell height vs. female gonad area at the front of the classroom. The two columns you will need for this activity are highlighted in gray. This graph is a scatter plot, so each paired data point (x, y coordinate) should be a single dot.

The classroom graph should show that gonad size increases as shell height increases. The included data points are likely to vary somewhat from those calculated by the students due to differences in gonad length and width measurements, but the pattern and relationship should be consistent.



**Question 1:** What do you observe about the scallops in your dredge tow? Are they all similar in size or do they vary in size?

**Dredge Tow 1:** The scallops are all similar in size and are at the low end of the size range.

**Dredge Tow 2:** The scallops vary in size across the whole size range.

**Dredge Tow 3:** The scallops are all similar in size and are at the high end of the size range.

**Dredge Tow 4:** The scallops vary in size but are all on the low to middle portions of the size range.

**Dredge Tow 5:** The scallops are all similar in size and are at the low end of the size range.



**Question 2:** Compare your bar graphs of shell height and age. Do they look similar or different? Why do you think this is?

**Dredge Tow 1:** The scallops are both small and young. The bar graphs look fairly similar.

**Dredge Tow 2:** The scallops are a mix of shell heights and ages. The ages are more clumped than the shell heights.

**Dredge Tow 3:** These scallops are large and range from 5-7 years old. The bar graphs look fairly similar.

**Dredge Tow 4:** The scallops are a mix of small to medium shell heights and ages 2 to 4 years old. The ages are more clumped than the shell heights.

**Dredge Tow 5:** These scallops are small but old. There is no overlap between the two bar graphs.

**Question 3:** Looking at the whole classroom graph, how does gonad area change as shell height increases?

Gonad area increases as shell height increases. Larger scallops have larger gonad areas.



### **Biology Extension Questions:**

**Question 4:** Scallops are broadcast spawners, meaning they release eggs and sperm into the water column where they form gametes and develop into larvae. These larvae eventually develop into juvenile scallops. Based on the relationship between gonad area and shell height, how might the number of eggs and larvae a female can produce change as she grows?

Female scallops can produce more eggs as they grow larger. This leads to more eggs that can potentially be fertilized in the water column, so scallops have the ability to produce more offspring per spawning event as they grow larger.

**Question 5:** Take a closer look at the distance between each of the growth rings. Do they get closer or farther apart as the scallop gets older (closer to the outer portion of the shell)?

The growth rings get closer together as the scallop gets older. (It may be more difficult to see this for dredge tow 1 since the oldest scallop in this group is only 3 years old.)

**Question 6:** What can you infer about how scallops grow from the spacing between rings? Use evidence to support your claim.

Growth slows as scallops get older, with young scallops growing the fastest and older scallops growing much more slowly. Since growth lines are laid down each year, the rings being closer together at the outer edge of the shells indicates that scallops experience slower growth in later years.



## Searching for Sea Scallops: Management Decisions (Part 2) Instructor Key

Name: \_\_\_\_\_

Date: \_\_\_\_\_

My Tow Number: \_\_\_\_\_ 1-5 \_\_\_\_\_

**Introduction:** Each year, survey results from different areas are compared to determine how to best manage the sea scallop fishery in the following fishing year. As a group, you will compare your results and create management recommendations for allocating fishing effort across the areas represented by the dredge tows. There is no set way to do this, and often the decisions require a lot of conversation.

### Instructions:

1. Each member of the group should give a brief overview of the results from their dredge tow, including the shell height and age distributions.
2. After every member has a chance to share, work together to determine how to allocate fishing effort to each of the areas. Your options are:
  - a. Create a new closed area to allow scallops to grow and reproduce (useful for areas with small scallops that need protection)
  - b. Assign an access area trip to allow all vessels to harvest scallops (useful for areas with large scallops that can support heavy fishing pressure)
  - c. Designate the area as open bottom so vessels can choose whether to harvest there (useful for areas with mixed scallops that can support a little fishing pressure)
3. Include a brief statement of the rationale for each decision. What data did you use to make your decision?
4. Once your group has made a recommendation for every area, complete the follow-up questions. Everyone must write their own answer, but you may discuss the questions as a group.

Tow Number	Management Decision	Rationale
1	Create a new closed area	Small scallops need protection to grow and reproduce
2	Designate open bottom	There are some large scallops to harvest and not many small scallops to protect
3	Assign an access area trip	This area has large scallops and can support heavy fishing pressure
4	Create a new closed area	Small scallops need protection to grow and reproduce
5	Assign an access area trip or designate as open bottom	These scallops are old and unlikely to grow



**Question 1:** How does your scallop tow compare to the tows from other groups? Do you have smaller or larger scallops? Younger or older?

**Dredge Tow 1:** Our scallops are generally smaller and younger than other groups.

**Dredge Tow 2:** Our scallops cover a wider range in size and age than other groups.

**Dredge Tow 3:** Our scallops are generally larger and older than other groups.

**Dredge Tow 4:** Our scallops are younger than many groups but have a wider range in size and age than Dredge Tow 1.

**Dredge Tow 5:** Our scallops are smaller than many groups but also older than many groups.

**Question 2:** Did you base your decisions on shell heights, ages, gonad areas, or some combination of the three? Why did you focus on these metrics?

Answers will vary between groups. In real management decisions, all three metrics are considered, though more weight is often placed on shell heights than ages. Gonad size and reproductive output are usually assumed to increase with shell height and age and are typically not included in management discussions directly.

**Question 3:** Did your group disagree on how to manage any of the areas? If so, how did you determine which management action to proceed with?

Answers will vary between groups.



**Biology Extension Questions:**

**Question 4:** Every year, adult scallops spawn and produce new juvenile scallops. Why do you think there were no 1-year-olds observed in the survey?

1-year-old scallops are generally too small to be captured by the metal rings in the survey dredge.

**Question 5:** Scallops can live to be 20 years old. What is one explanation for why there were no scallops older than 7 years old observed in the survey?

Most marketable scallops are harvested before they reach 8 years old because this fishery is very profitable and there are many fishing vessels. Increases in length and gonad size start to slow when scallops reach 5 or 6 years old, so it tends to be more profitable to harvest them than continuing to protect them in access areas.

**Question 6:** If you had the time and funding to collect another type of data during your survey, what would you choose? Why?

Answers will vary. Some of the other metrics that scientists collect data on are meat size, meat quality, disease prevalence, and reproductive stage.

