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Migrating to Motherhood: The Story of Female Blue Crabs in Their Ecosystem

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MIGRATING TO MOTHERHOOD:

THE STORY OF FEMALE BLUE CRABS IN THEIR ECOSYSTEM

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Grade Level
7th Grade

Subject area
Life Science

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Title: Migrating to Motherhood: The story of female blue crabs in their ecosystem.

Focus: Migratory patterns of blue crabs, life stages of blue crabs, ecosystem use by life stage, human impacts to blue crab populations, blue crab fisheries and harvesting.

Grade Level: 7th grade Life Science

VA Science Standards

LS.1 (C) The student will demonstrate an understanding of scientific and engineering practices by interpreting, analyzing, and evaluating data

- construct, analyze, and interpret graphical displays of data

LS.6 The student will investigate and understand that populations in a biological community interact and are interdependent. Key ideas include

a) relationships exist between predators and prey and these relationships are modeled in food webs
b) The niche of each organism supports survival.

LS.7 The student will investigate and understand that adaptations support an organism's survival in an ecosystem. Key ideas include

a) biotic and abiotic factors define land, marine, and freshwater ecosystems
b) physical and behavioral characteristics enable organisms to survive within a specific ecosystem.

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
b) variations in biotic and abiotic factors can change ecosystems.

Learning Objectives

- Students will examine why different life stages utilize different habitats. (LS.7)
- Students will explore how abiotic factors (e.g. salinity, temperature) and biotic factors (e.g. predators) impact blue crab location and survival. (LS.6)
- Students will calculate summary statistics of blue crab size by life stage. (LS.1)
- Students are provided extension options to plot summary statistics and frequency by life stage. (LS.1)
- Students will make real-world connections to blue crab life stage, fishing and conservation. (LS.9)

Total length of time required for the lesson

Total lesson time: 60 minutes
Prep and setup time: 15 minutes

Key words, vocabulary

Abiotic factor: nonliving things in an ecosystem that affect populations

Biotic factor: living things in an ecosystem that affect populations

Brackish: water that is a mix of salt and fresh water

Carapace: a hard, protective, decorative, or disguising shell covering the back or part of an animal

Estuary: an area where a freshwater river or stream meets the ocean

Invertebrate: an animal that lacks an internal skeleton for support and instead has an external skeleton that provide support and protection

Juvenile: an individual organism that has not yet reached its adult form

Larvae: a stage in an animal's development occurring after birth and are typically structurally different than the adult form

Megalopae: larval stage following the zoea in the development of most crabs

Migration: a pattern of behavior in which animals travel from one habitat to another in search of food, better conditions, or reproductive needs

Nursery Habitat: generally, habitats that enhance the growth and survival of juveniles

Salinity: the degree of saltiness of the water, measured in parts per thousand (ppt)

Spawns: to produce or deposit eggs

Terminal Molt: the final molt, usually at maturity, after which the animal no longer molts

Tributary: a body of water that feeds into a larger stream, river or other body of water. The larger, or parent, river is called the mainstem

Zoea: a free-swimming planktonic larval form of many decapod (crabs)

Background Information

Migration

Animals migrate short and long distances, in search of food, better environmental conditions or reproductive needs. One of the most recognizable migrators are Canada geese, which migrate from Northern U.S.A. and Canada in the Fall to Southeastern U.S.A. and Mexico for more favorable temperatures. Similarly, monarch butterflies follow a similar path at the end of the summer, also in search of favorable winter temperatures. Lastly, right whales migrate from their feeding grounds in the Antarctic Ocean to temperate coasts in the southern hemisphere, such as Chile, Argentina, and Australia to breed. Similar to whales, butterflies and birds, the blue crab, *Callinectes sapidus,* is also a migrator.

It is critical for scientists to study and understand blue crab migration and movement to help protect the species. Blue crabs are an important economic resource and play an important ecological role in estuarine ecosystems. When scientists understand where and when different life stages occupy different areas of an ecosystem, they can better inform marine resource managers how to protect those species from human disturbance such as fishing.

Blue Crab Life Cycle

Blue crabs have a complex life cycle and move and migrate throughout estuary systems. Adult blue crabs live in mid salinity waters within estuaries. In the Chesapeake Bay, this can include the tributaries, the upper and middle mainstem of the bay, and coastal lagoons. Blue crabs mate in mid salinities (15-25 ppt), during the females terminal molt to maturity. This is the only time a female is able to mate, and she will no longer grow in size. After mating, females will migrate to spawning grounds with high salinity waters (20-30 ppt). This migration is necessary, as blue crab eggs and larvae require high salinities to correctly develop. Once in the high salinity spawning grounds, females will deposit fertilized eggs onto their abdomen. Egg-bearing females are colloquially called "sponge crabs" because their eggs resemble large spherelike "sponges" stuck to their abdomen. The sponge will start as a vibrant orange color, then over the course of one to two weeks, the larvae within the eggs will begin to develop and consume the orange yolk, transforming the eggs from orange to brown to black. Black eggs indicate that the larvae will hatch soon. The larval crabs, called zoea, will be transported by currents offshore, out of the estuary, and will develop in high salinity coastal waters for about 30 days (30-35 ppt). When larval zoea are fully developed, they will migrate back into estuaries and metamorphose into larval megalopae. Larval megalopae will metamorphose into small juvenile crabs. Juvenile crabs will disperse into nursery habitat such as salt marsh, sea grass beds, or woody debris in low to mid salinity areas (0-15 ppt). Low salinity areas and nursery habitats are conducive to juvenile blue crab survival because low salinity allows for faster and larger growth and the structured nursery habitats provide refuge from predators.

Ecosystem Drivers of Migrations

Overall, blue crab migration is driven by a need to find favorable abiotic and biotic conditions in the ecosystem. The main abiotic drivers of blue crab movement are salinity and temperature. Low or high salinity is needed for survival for certain life stages and individuals, for example egg-bearing females will migrate to high salinities because their eggs require it. In the Chesapeake Bay, temperature changes will cue animals about migration times. For example, when the water warms up in the spring, adults will mate and begin their reproductive cycle and subsequent migration.

The main biotic drivers of blue crab movement are predators and prey. As juveniles, blue crabs migrate into nursery habitats for refuge from predators and to find food. Juveniles have a high mortality rate and predators include adult blue crabs, eels, estuarine sharks, and fish such as Atlantic croaker, black seabass, striped bass, summer flounder and yellow perch. Prey of juvenile crabs include amphipods, gastropods, isopods, polychaetes, shrimp, small clams and oysters, detritus, and plant matter. Juvenile crabs span sizes up to about 100 mm in size, measured by carapace width (lateral spine to lateral spine), although juveniles below 70mm in size and are much more vulnerable than crabs above 70 mm in size. The probability of survival increases dramatically as blue crabs grow, as not only are larger blue crabs more equipped to protect themselves (stronger shells, stronger and larger claws) but they also outgrow the size of some fishes' mouth. As blue crabs grow, they are able to move out of the structured habitat and into mid-high salinity waters. Predators for adult blue crabs include cobia, loggerhead sea turtles, and red drum. The main predator of adult blue crabs are humans. There is a large fishery for blue crabs in the U.S. Overfishing of adults has led to population crashes of blue crabs. The current management policies to protect the species include: a closure of the Virginia dredge fishery, creating a spawning sanctuary for female crabs, and putting regulations on taking ovigerous females. These policies improved the status of the population and as of 2019, the Chesapeake Bay blue crab stock is considered healthy.

Student handouts

- Individual crab cards (answer map provided for teacher)

- Group Female blue crab question sheet 01 (answer key provided for teacher)
- Individual Female blue crab question sheet 02 (answer key provided for teacher)

Materials & Supplies

- Computer and projector for Power Point and displaying map
    - Alternatively, the map could be printed onto a poster and reused year to year
- Blue crab card printouts (these can be laminated and reused or reprinted year to year)
- Scissors to cut out blue crabs
- Tape (masking or office) to stick crab cards to map
- Dry erase board or easel
- Color pencils
- Pencils
- Paper
- Calculator

Teacher Preparation

The teacher will cut out and laminate (if they so choose) the crab cards. The teacher should prepare enough cards for each student. Thirty crab cards are included in the lesson plan, with 12 juveniles, 9 adult females, 3 females with orange eggs, 3 females with brown eggs, and 3 females with black eggs. If the classroom has more than 30 students, the teacher should pair students together. If the classroom has less than 30 students, the teacher can omit some crab cards or give some students multiple cards, see the appendices for suggestions on how to omit cards. The remaining instructions will describe using 30 cards per 30 students.

The teacher will provide copies of materials:

- Female blue crab question sheet 1 (1 per group)
- Female blue crab question sheet 2 (1 per student)
- Crab cards

The teacher will set up group stations at tables in the classroom. There should be enough group stations, so groups are about 3 students. Each group station should be equipped with a calculator, colored pencils, pencils, and tape, as well as the group activity sheet and enough individual answer sheets for each group member. Colored pencils are only necessary for the graphing extension.

The teacher should have a white board or easel ready with the categories: juvenile, adult, orange egg bearing, brown egg bearing, or black egg bearing, set up as a blank table (completed example seen in procedure).

The lesson plan also includes an optional graphing extension. A teacher can insert the graphs into the PowerPoint to go over as a class or assign the empty graph questions to students.

Procedure

1. Begin the lesson with the power point: *Migrating to Motherhood: The story of female blue crabs in Chesapeake Bay.* The lesson includes questions to try to engage students prior to the activity

and assessment. Slides 22 through 26 can be used as guides through the lesson plan and are optional based on the classes comfortability with topics discussed.

2. Distribute crab cards randomly to individual students.
3. Students will be asked to write down the size of the crab on their card on an easel or white board under the appropriate categories (juvenile, adult, orange egg bearing, brown egg bearing, or black egg bearing). If a student is unable to decipher if a crab is an adult or juvenile, the teacher should remind them of the power point: juveniles are typically less than 80 mm CW and have less pronounced coloration.

For example:

Life stage:	Juvenile (mm)	Adult (mm)	Orange Eggs (mm)	Brown Eggs (mm)	Black Eggs (mm)
	13	113	128	124	110
	17	120	129	147	107
	25	145	130	165	131
	27	92			
	32	100			
	41	160			
	48	80			
	50	85			
	54	98			
	66				
	75				
	72				
Total Count:	12 crabs	9 crabs	3 crabs	3 crabs	3 crabs

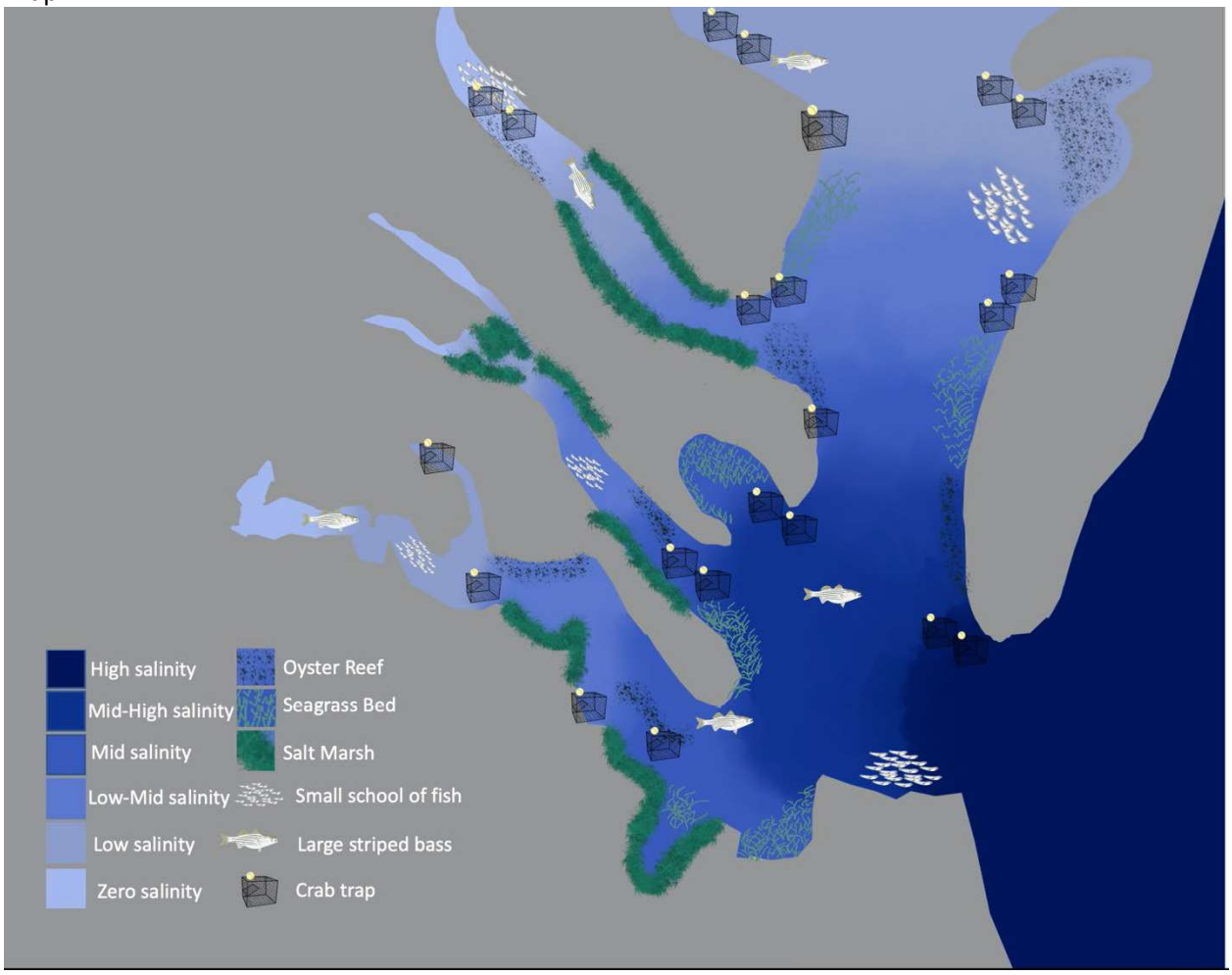
4. Then, have students get into groups based on their crab's life stage. There will be five groups: a large group of juvenile crabs, a medium group of adult crabs, and 3 small groups of egg bearing crabs. The number of crabs in each category should then be counted as a class and put below the list of sizes, for example there are 12 juvenile crab cards, 9 adult crab cards, and 3 crab cards per egg bearing stage. The teacher should pause and note the size of different groups to the entire class. Because the adult and juvenile stages have 9 and 12 cards, respectively, the teacher should further break these groups into smaller groups of three students. The egg bearing life stages should already have three students. If crab cards were removed if the class had less than 30 students or if students were partnered up because the class had more than 30 students, the teacher should try to keep 3-4 kids in a group, with the group comprising of one life stage.
5. Groups should complete the female blue crab question sheet 1 together.
6. Students will then be asked to put a piece of tape on the back of their crab card and then go to the projection of the map, and one by one, place their crab where they believe it belongs based on what they learned from the Power Point lesson. Students should then return to their original seat to complete their individual worksheet, Female Blue Crab Question Sheet 2.
7. As students place crabs on the map, the teacher should keep track of correct and incorrect placements. Once all the crabs are placed the teacher can invite other students to move crabs

around that their classmates put up, if they don't agree with the placement. Waiting until all of the crabs are placed and then removing incorrect crabs should prevent the class from knowing who exactly placed the card incorrectly.

8. Students should now complete the female blue crab question sheet.

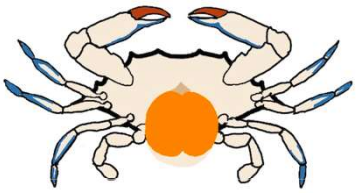
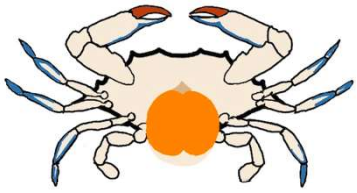
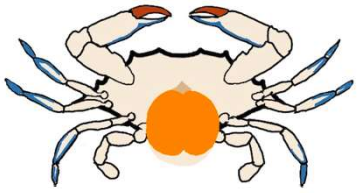
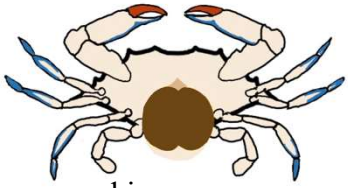
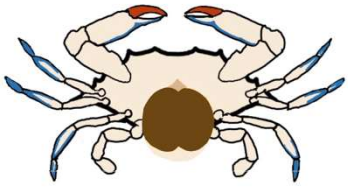
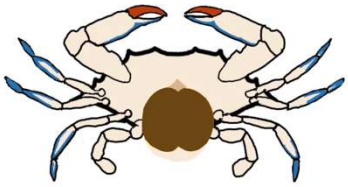
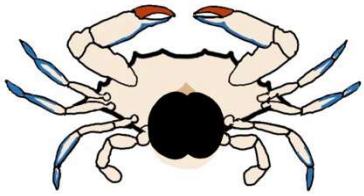
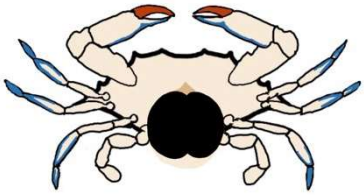
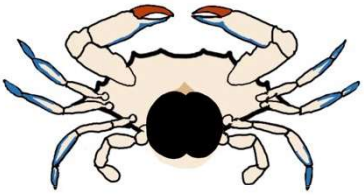
Appendices

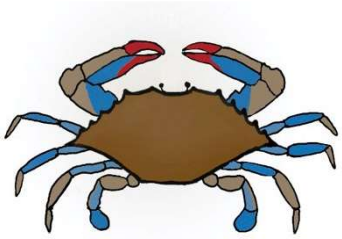
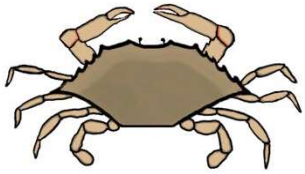
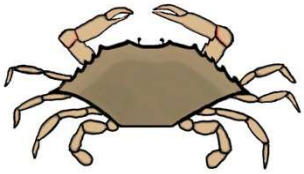
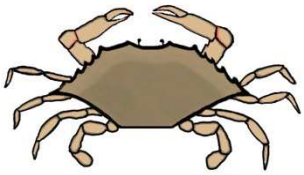
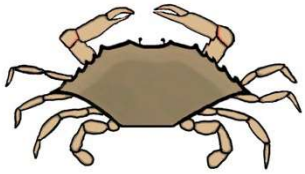
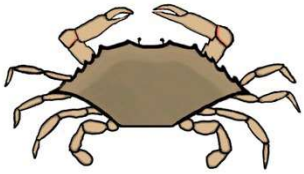
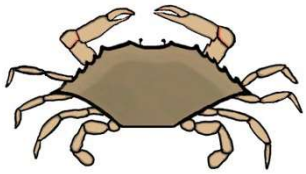
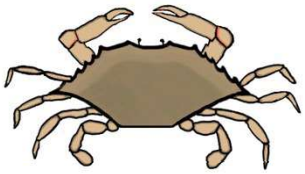
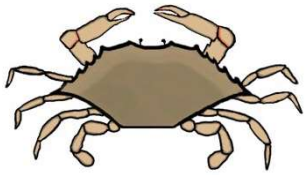
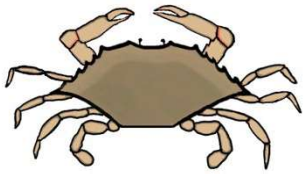
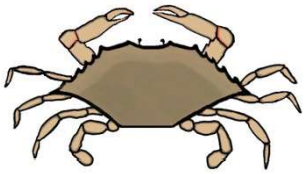
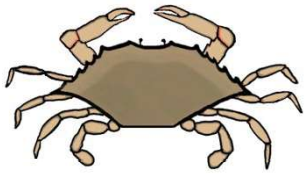
Map:



*included in PowerPoint, it is recommended the teacher use the power point slide with a projector for the activity.

Crab cards:

128 mm carapace width  I am still migrating to the spawning grounds!	129 mm carapace width  I just got to the spawning grounds!	130 mm carapace width  I am hungry from my migration and am looking for a fishy snack!
124 mm carapace width  I am snacking on some oysters!	147 mm carapace width  I need a safe place to clean my eggs!	165 mm carapace width  Oh no! I think I am lost!
110 mm carapace width  I am looking for a fishy snack!	107 mm carapace width  My eggs are hatching!	131 carapace width  I am snacking on some oysters!
113 carapace width  I just mated!	120 mm carapace width  Oh no! I walked into a trap!	145 mm carapace width  I am migrating to the spawning grounds!
92 mm carapace width  I am looking for a mate	100 mm carapace width  I am eating some oysters!	160 mm carapace width  My eggs just hatched!

80 mm carapace width  I am hiding out!	85 mm carapace width  I am having a fishy snack!	98 mm carapace width  Oh no! I walked into a trap!
13 mm carapace width  I am hiding in sea grass!	17 mm carapace width  Oh No! I am about to get eaten by a striped bass!	25 mm carapace width  I am hiding in salt marsh!
27 mm carapace width  I am hiding in salt marsh!	32 mm carapace width  I am hiding in salt marsh!	41 mm carapace width  I am taking shelter in shallow water!
48 mm carapace width  Oh no! I am about to get eaten by a striped bass!	50 mm carapace width  I am taking shelter in shallow water!	54 mm carapace width  I am hungry for oysters!
66 mm carapace width  I am hiding from predators!	75 mm carapace width  Oh no! I am about to get eaten by another crab!	72 mm carapace width  I am hungry for a crab snack!

Appendix 1:

Suggestions for how to omit cards for classes with less than 30 students. If the teacher omits cards, they should keep more juvenile cards than mature cards and more mature cards than egg cards, and to omit cards with duplicate prompts. It is recommended that the teacher alternates between removing juvenile and adult crabs until there is 6 remaining adults and 9 juvenile cards, after which one of each colored egg crab should be removed. If less than three egg bearing females were to be removed, the teacher should begin by removing black eggs, then brown eggs. Note that if crab cards are omitted the provided answer keys may shift based on the sizes that are removed and if cards are duplicated group size and dynamics may change.

Number of Students	Number of juvenile cards to omit	Number of adult cards to omit	Number of egg bearing cards to omit	Suggested card to remove
29	1	0	0	25 mm "I am hiding in salt marsh"
28	1	1	0	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap"
27	1	2	0	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters"
26	2	2	0	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water"
25	2	3	0	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate"
24	3	3	0	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am ungry for a crab snack"
23	3	3	1	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am hungry for a crab snack", 110 mm black eggs "I am looking for a fishy snack"
22	3	3	2	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am hungry for a crab snack", 110 mm

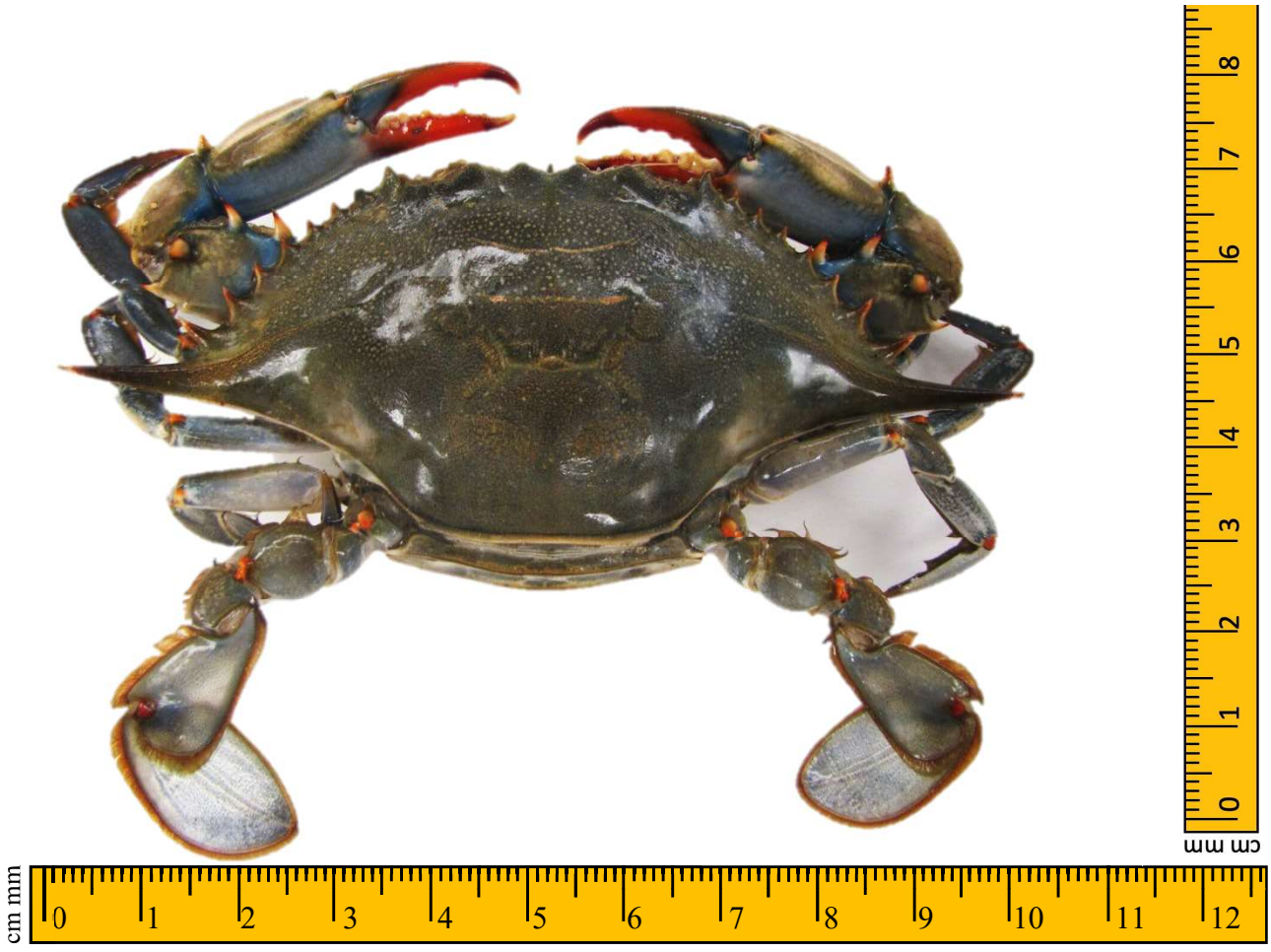
				black eggs "I am looking for a fishy snack", 165 mm brown eggs "Oh no, I think I am lost"
21	3	3	3	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am hungry for a crab snack", 110 mm black eggs "I am looking for a fishy snack", 165 mm brown eggs "Oh no, I think I am lost", 129 mm orange eggs "I just got to the spawning grounds"
20	3	4	3	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am hungry for a crab snack", 110 mm black eggs "I am looking for a fishy snack", 165 mm brown eggs "Oh no, I think I am lost", 129 mm orange eggs "I just got to the spawning grounds", 113 mm "I just mated"
19	4	4	3	25 mm "I am hiding in salt marsh", 98 mm "Oh no, I walked into a trap", 100 mm "I am eating some oysters", 50 mm "I am taking shelter in shallow water", 92 mm "I am looking for a mate", "72 mm I am hungry for a crab snack", 110 mm black eggs "I am looking for a fishy snack", 165 mm brown eggs "Oh no, I think I am lost", 129 mm orange eggs "I just got to the spawning grounds", 113 mm "I just mated", 32 mm "O am hiding in salt marsh"

Group worksheet
Group Life Stage:

Student Names:

Female Blue Crab Question Sheet 1 (in groups)

1. Blue crabs are commonly measured by their carapace width in millimeters (mm). The carapace width is the distance from their lateral spine to lateral spine. What is the size of the blue crab below?



2. Why are there more juvenile crab cards than adult crab cards?

3. Explain the female blue crab migration and how it relates to the blue crab life cycle.

4. What are some examples of abiotic and biotic factors in an estuary that effect blue crab movement? Give an example for at least one abiotic and biotic driver.

5. As a group, calculate the minimum, maximum, mean, and median range of the sizes of the life stage.

   Minimum = the smallest value
   Maximum = the largest value
   Mean = the sum of all values divided by the number of values
   Median = the middle value
   Range = difference between the maximum and minimum value

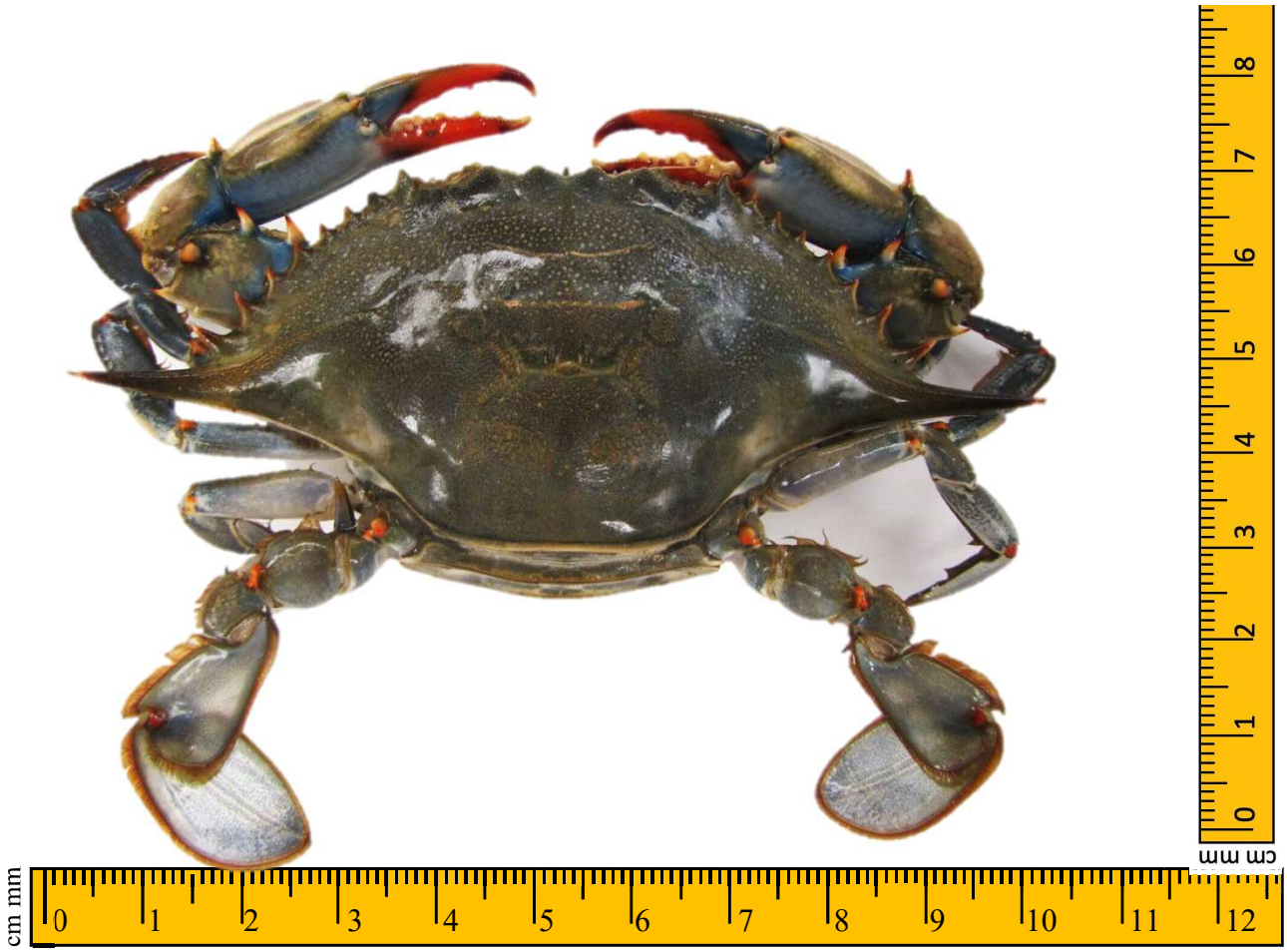
	Minimum Size	Maximum Size	Mean Size	Median Size	Size Range
Juveniles					
Adults					
Orange Eggs					
Brown Eggs					
Black Eggs					

Sheet worksheet key:
Group Life Stage:

Student Names:

Female Blue Crab Question Sheet 01 (in groups)

1. Blue crabs are commonly measured by their carapace width in millimeters (mm). The carapace width is the distance from their lateral spine to lateral spine. What is the size of the blue crab below?



109 mm or 10.9 cm, any value from 108-112 mm or 10.8-11.2 cm should be accepted

2. Why are there more juvenile crab cards than adult crab cards?

There are more juveniles than adults because not all juveniles in a population will survive to adulthood.

3. Explain the female blue crab migration and how it relates to the blue crab life cycle.

Female blue crabs mate in low salinity river waters and then migrate to the spawning grounds where the salinity is higher. They hatch their eggs in high salinities because the larvae need high salinity is to develop properly.

4. Explain the different abiotic and biotic ecosystem drivers of blue crab movement. Give an example for at least one abiotic and biotic driver.

Abiotic – salinity: females seek high salinity, juveniles seek low salinity
Abiotic – temperature: temperature cues migration patterns, warming up in the spring ques mating and migrating
Biotic – Prey/Predator: Juveniles and adult movement in tributaries is driven by a search from for food and hiding from predators
Biotic – habitat: Juveniles seek nursery habitat to seek shelter

5. As a group calculate the minimum, maximum, mean, and median range of the sizes of the life stage.

   Minimum = the smallest value
   Maximum = the largest value
   Mean = the sum of all values divided by the number of values
   Median = the middle value
   Range = difference between the maximum and minimum value

	Minimum Size	Maximum Size	Mean Size	Median Size	Size Range
Juveniles	13	75	43.3333333	44.5	62
Adults	80	160	110.33	100	80
Orange Eggs	128	130	129	129	2
Brown Eggs	120	165	145.333333	147	45
Black Eggs	107	131	116	110	24

Name:
Life Stage:

Female Blue Crab Question Sheet 2 (individually)

1. What location did you put your crab and why?

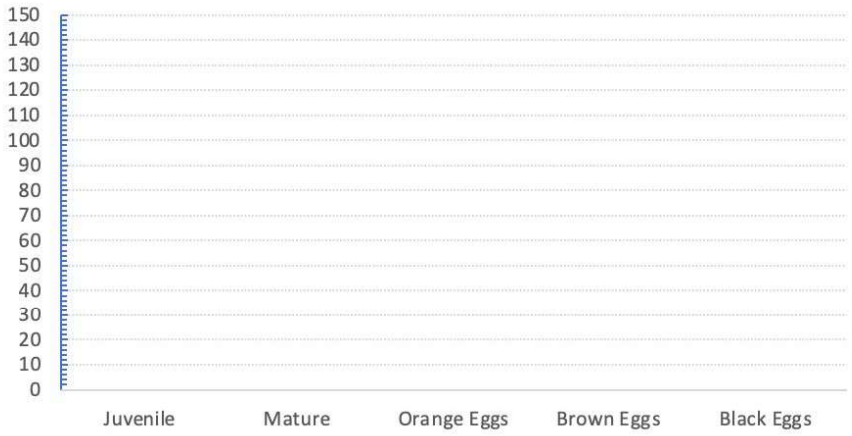
2. How do juvenile blue crabs use habitat in order to survive?

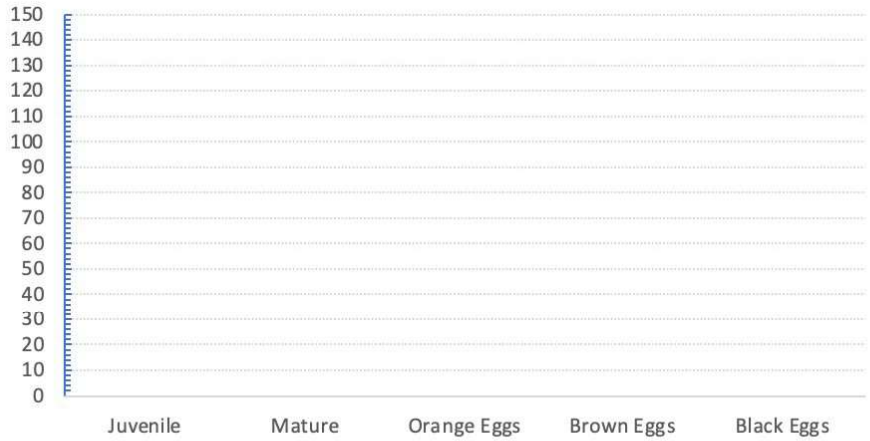
3. If you were a fisher, where might you put a trap if you wanted to catch adult crabs and explain why?

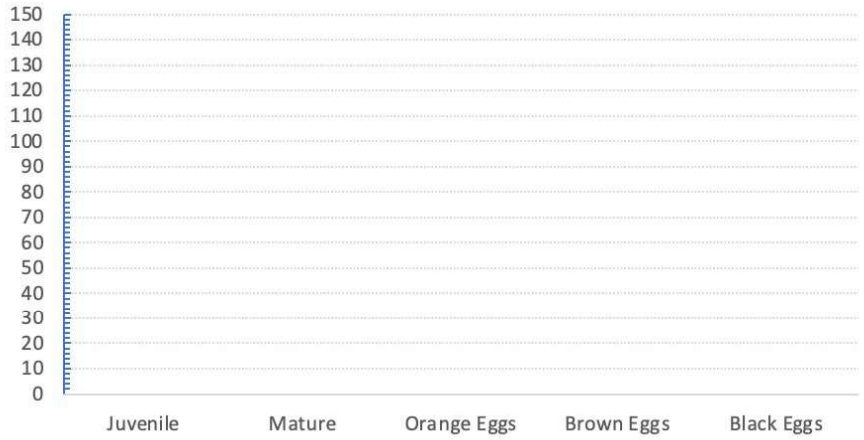
4. If you were a wildlife manager, what blue crab life stage would you protect and why?

Optional Extension:

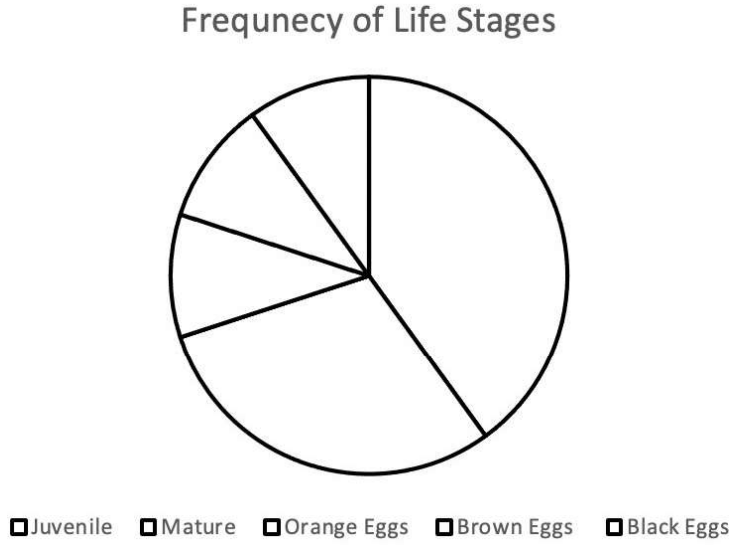
5. Make a bar graph for the mean, minimum and maximum size of each life stage. Do not forget to properly label axis and title. Describe and explain the pattern you see.







6. Calculate the percent that each life stage contributes to the total population and complete a pie chart.



Sheet two key:
Student Name: Answer key

Life Stage:

Female Blue Crab Question Sheet 2 (individually).

1. What location did you put your crab and why?

Juveniles should be within tributaries, away from striped bass predators and as close to structure habitat as possible (oyster reefs, salt marshes, sea grass).
Adults can be placed most places, smaller adults should be away from predators. Adult cards are prompt specific
Egg bearing females should be within the higher salinity areas, orange egg crabs can still be travelling.
Some cards are "oh no" cards and might ask for specifically wrong places, students should explain where they should've been.

2. How does juvenile blue crab use habitat to survive?

Blue crab habitat at life stage is meant to increase their survival, juveniles need structured habitat to protect themselves from predators and to provide them with food.

3. If you were a fisher, where might you put a trap if you wanted to catch adult crabs? Please explain why

Fishers could locate adult crabs in the tributaries (mostly males) or in the mainstem of the Chesapeake Bay where salinity is high (mostly females). A fisher would likely avoid complex habitat like sea grass because these areas would mostly have juvenile crabs.

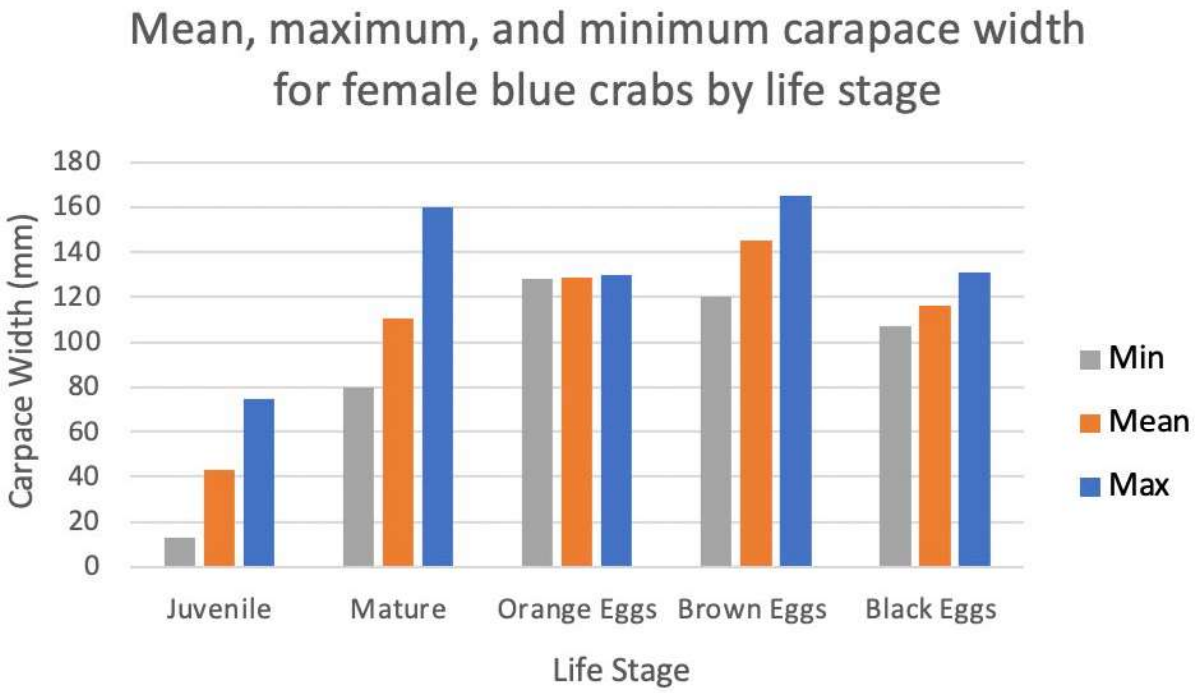
4. If you were a wildlife manager what blue crab life stage would you protect and why?

Any life stage is acceptable if they give a logical reason. For example:
Juveniles: They have higher natural mortality rates from predation and poor environmental conditions, so they should be protected.
Adults: They are the most likely to be eaten by people so they should be protected.
Egg bearing females: They are responsible for continuing the entire population so they should be protected.

Optional Extension:

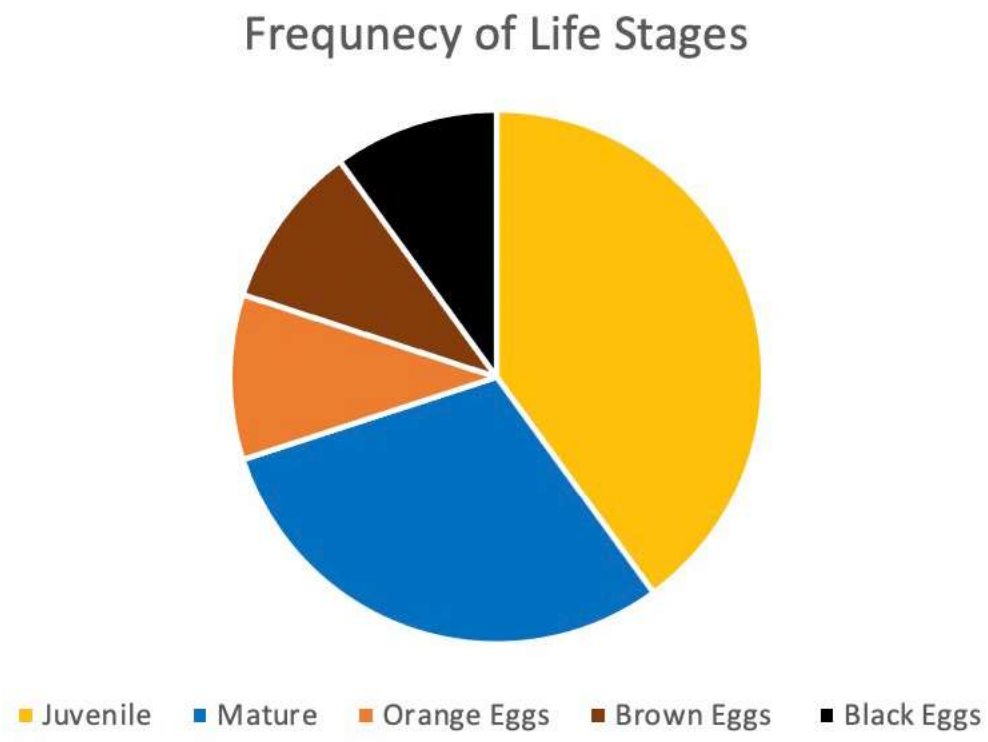
5. Make a bar graph of the mean, minimum and maximum size of each life stage. Do not forget to properly label axis and title. Explain the pattern you see.

Patterns to describe:



Mean size generally increases with life stage. Juveniles have the smallest mean size, 43.33, followed by the mature females and orange egg bearing females. The mature females have a mean size of 110.33 mm and 129 mm, respectively. The brown egg bearing females have the largest mean size, 145.33 mm. The black egg bearing females are an exception to the trend, as their mean size is 116 mm, which is smaller than the brown and orange egg bearing females. There are only slight differences between the mature crabs and the egg bearing crab's size because these crabs are all mature and the females stop growing once they reach maturity. Therefor the females could be any range of sizes greater than 80 mm. On the other hand, juveniles have a limited range of sizes, 0 – 80 mm, so they on average will be smaller than the mature females, even though some juveniles can be 80-100 mm in size. You can see evidence of this by comparing the minimum and maximum of each life stage. The juvenile maximum and adult minimum are quite similar. The mature and egg bearing stages all have means that overlap with the minimums and maximums of the other life stages.

6. Calculate the percent that each life stage contributes to the total population and complete a pie chart.



$$Sum = 12 + 9 + 3 + 3 + 3 = 30$$

$$Juvenile = \frac{12}{30} = 0.4 - 40\%$$

$$Adult = \frac{9}{30} = 0.3 - 30\%$$

$$Orange\ egg = \frac{3}{30} = 0.1 - 10\%$$

$$Brown\ egg = \frac{3}{30} = 0.1 - 10\%$$

$$Black\ egg = \frac{3}{30} = 0.1 - 10\%$$

The probability of mortality is high at young ages due to high predation and cold temperatures. Few juveniles make it to adulthood. Out of those crabs that do make it to adult hood, the female migration can also be difficult, and not all females may make it to the egg-bearing stage. Thus there is a decrease in frequency and percent of the population as you move from juveniles to egg bearing stages.

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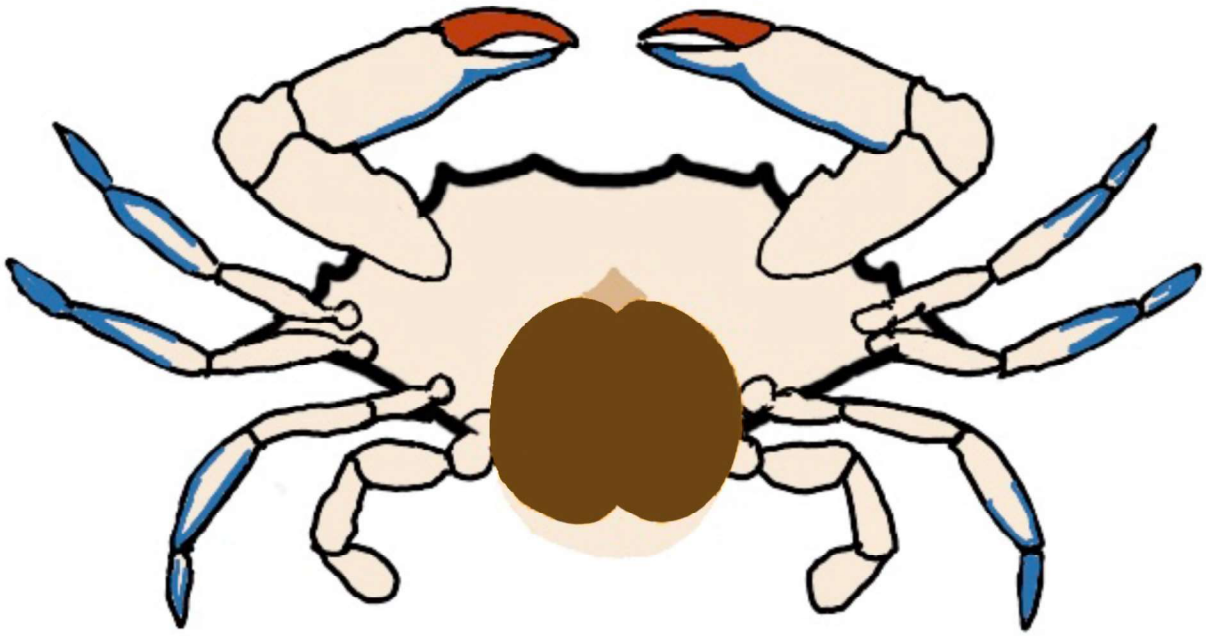

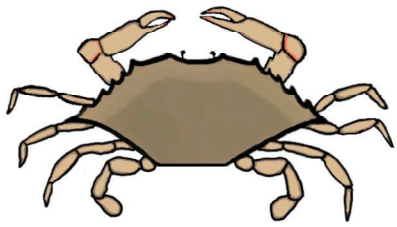

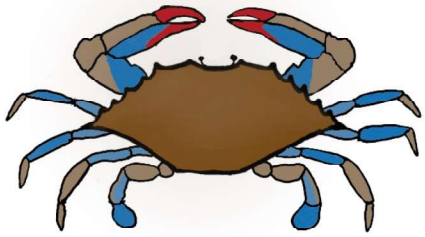

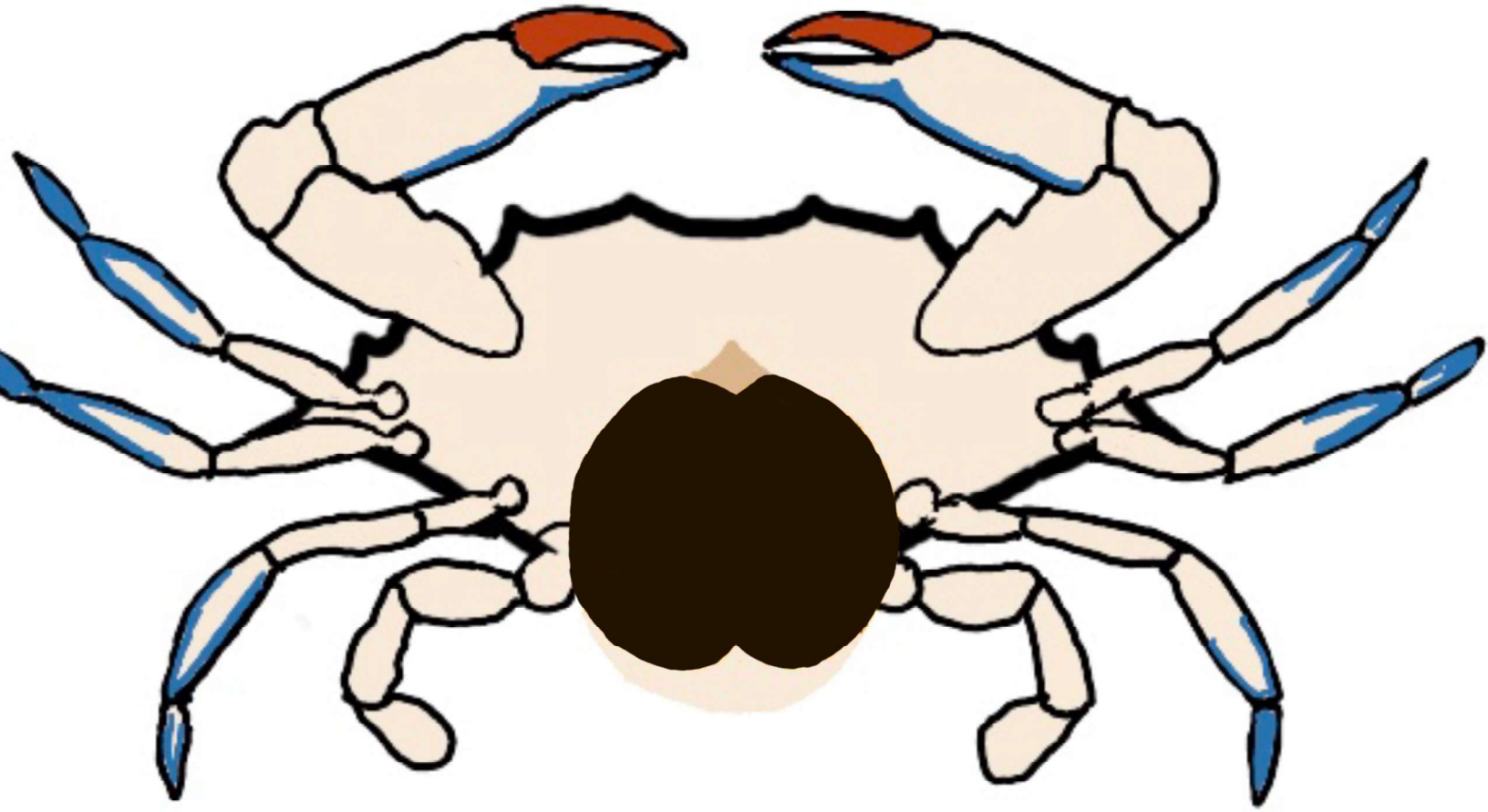

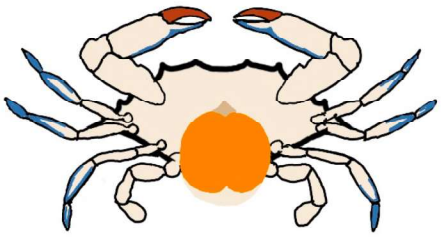

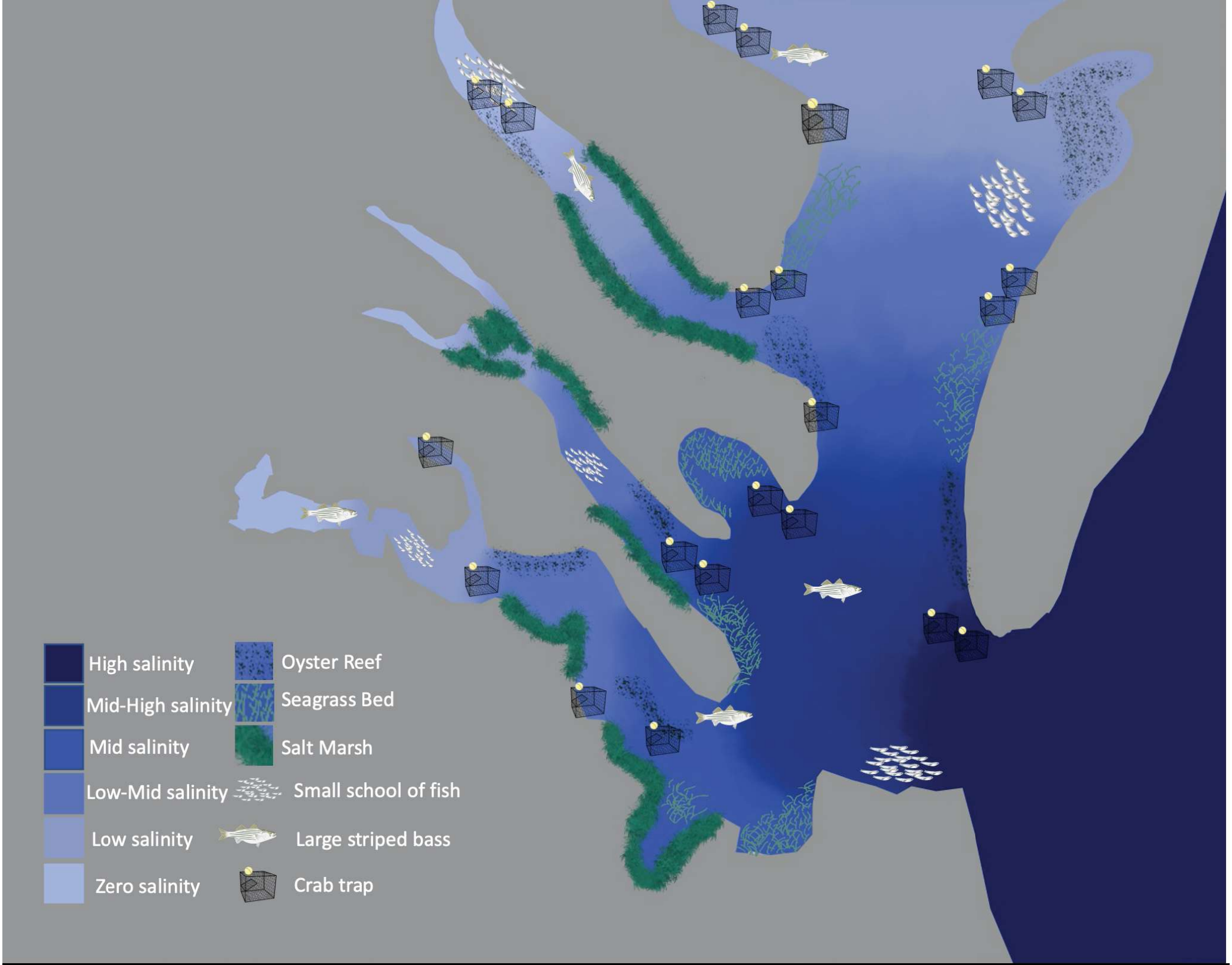
High salinity
Mid-High salinity
Mid salinity
Low-Mid salinity
Low salinity
Zero salinity
Oyster Reef
Seagrass Bed
Salt Marsh
Small school of fish
Large striped bass
Crab trap