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Basic Classification and Identification of Blue Crabs

Objective

This activity helps students to practice knowledge of classification and learn about characteristics and adaptations that determine the classification of organisms by exploring a local organism.

Materials

- Handling blue crab video: <http://www.youtube.com/watch?v=XfsG9SdZwn8>
- Computer access
- Inquiry questions

Duration

- One class period

Grade Levels

- High school

North Carolina Standards

- Bio.3.5.1, Bio.3.5.2

Virginia Standards

- BIO.6.a, BIO.6.e, BIO.7.c, BIO.7.e

Lesson plans were developed with support by:



N.C. Essential Standards

- Bio 3.5 Analyze how classification systems are developed upon speciation.
 - Bio.3.5.1 Explain the historical development and changing nature of classification systems.
 - Bio.3.5.2 Analyze the classification of organisms according to their evolutionary relationships (including: dichotomous keys and phylogenetic trees).

Virginia Standards of Learning

- BIO.6 The student will investigate and understand bases for modern classification systems. Key concepts include
 - a) structural similarities among organisms;
 - b) fossil record interpretation.
 - c) comparison of developmental stages in different organisms; and
 - d) examination of biochemical similarities and differences among organisms.
 - e) systems of classification that are adaptable to new scientific discoveries.
- BIO.7 The student will investigate and understand how populations change through time. Key concepts include
 - a) evidence found in fossil records;
 - b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
 - c) how natural selection leads to adaptations;
 - d) emergence of new species; and
 - e) scientific evidence and explanations for biological evolution.

Procedures:

1. View video on “Blue Crab Handling” to introduce the crab to students
2. Have students write down the characteristics they observe of the blue crab. They can re-watch the video if needed.

Suggestions: Pointy tips of shell and spines to deter predators, number of appendages, eyes on stalks, paddle fins/swim legs, female or male

3. Have students web search characteristics of the subphylum: Crustaceans and compare with what they wrote down for the blue crabs. For characteristics that they did not notice, have them see if they can determine if the blue crabs have this characteristic or not.
4. Have them research to determine the Kingdom, Phylum, Class, Order, Family, Genus and species of the Blue Crab. Have them identify what characteristics cause the blue crab to be classified in the Order that they are, and name one other member of this order. Why do these crabs belong to the family that they do? What is the genus and species?
5. What is the range of these crabs (where are they found in the world)?

Answer: They go as far north as Canada and as far south as Uruguay.

Life Cycle of a Blue Crab

Objective

Understand the different stages of growth of a blue crab and be able to describe the changes that they go through and the different habitats that they are in for different life stages.

Materials

- Life cycle of a crab video

https://www.youtube.com/watch?v=tv_THgwluxM

- Blue crab basics video:

<https://www.youtube.com/watch?v=jZ2Vxx2GV0M&list=UUn3lW59Mn0F9Dd0HlwJAHBg>

- Computer

Duration

- One class period

Grade Levels

- High school

North Carolina Standards

- Bio. 2.1.2, Bio. 2.2.1, Bio.2.2.2

Virginia Standards

- BIO.6.c

Lesson plans were developed with support by:



N.C. Essential Standards

- Bio.2.1 Analyze the interdependence of living organisms within their environments.
 - Bio.2.1.1 Compare the flow of energy and cycling of matter (water, carbon, nitrogen and oxygen) through ecosystems relating the significance of each to maintaining the health and sustainability of an ecosystem.
 - Bio.2.1.2 Analyze the survival and reproductive success of organisms in terms of behavioral, structural, and reproductive adaptations.
 - Bio.2.1.3 Explain various ways organisms interact with each other (including predation, competition, parasitism, mutualism) and with their environments resulting in stability within ecosystems.
 - Bio.2.1.4 Explain why ecosystems can be relatively stable over hundreds or thousands of years, even though populations may fluctuate (emphasizing availability of food, availability of shelter, number of predators and disease)

- Bio. 2.2 Understand the impact of human activities on the environment
 - Bio 2.2.1 Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment.
 - Bio 2.2.2 Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.

Virginia Standards of Learning

- BIO.6 The student will investigate and understand bases for modern classification systems. Key concepts include
 - a) structural similarities among organisms;
 - b) fossil record interpretation.
 - c) comparison of developmental stages in different organisms; and
 - d) examination of biochemical similarities and differences among organisms.
 - e) systems of classification that are adaptable to new scientific discoveries.

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.

Directions

Have students watch the videos and make notes on the different stages of the life cycle of the blue crab, including the different habitats and how old and what abiotic factors triggers the move to the next stage.

Then, using their notes, have students make a flip book on the different stages.

Blue Crabbing

Objective

Students will gain a better understanding of the blue crab industry and catching blue crabs. Students will develop an understanding of the economic aspects and importance of blue crabs in North Carolina.

Materials

- Worksheets
- Calculator

Duration

- Two class periods

Grade Levels

- High School

North Carolina Standards

- Bio.2.2.1, Bio.2.2.2, CE.E.1, EEn.2.8

Virginia Standards

- BIO.8.a, BIO.8.d, CE.1.a

Lesson plans were developed with support by:



N.C. Essential Standards

- Bio 2.2 Understand the impact of human activities on the environment
 - Bio 2.2.1 Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment.
 - Bio 2.2.2 Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.
- CE.E.1 Understand economies, markets and the role economic factors play in making economic decisions.
 - CE.E.1.2 Analyze a market economy in terms of economic characteristics, the roles they play in decision-making and the importance of each role (e.g., private property, free enterprise, circular flow, competition and profit motive, and allocation of resources via the price system.)
- EEn.2.8 Evaluate human behaviors in terms of how likely they are to ensure the ability to live sustainably on Earth.

Virginia Standards of Learning

- BIO.8 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include
 - a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
 - b) nutrient cycling with energy flow through ecosystems;
 - c) succession patterns in ecosystems;
 - d) the effects of natural events and human activities on ecosystems; and
 - e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.
- CE.1 The student will demonstrate knowledge of how economic decisions are made in the marketplace by
 - a) applying the concepts of scarcity, resources, choice, opportunity cost, price, incentives, supply and demand, production, and consumption;
 - b) comparing the differences among traditional, free market, command, and mixed economies;
 - c) describing the characteristics of the United States economy, including limited government, private property, profit, and competition

Blue Crabbing

It was early one morning when John Taylor aimed his boat for the thing floating in the water as he skimmed the surface of the water in the sound. As he slowed the boat down, he expertly eased up to the float, called a buoy, and put the boat in neutral. He stepped out from behind the steering wheel and moved over to the side of the boat that was closest to the buoy. Leaning over the side of the boat, he grabbed the float and stood up, pulling a rope that was attached to the buoy that extended into the water. Reaching around with the opposite arm, he pulled the rope until a wire cage appeared at the surface and he pulled it up to rest on the edge of the boat.

He hoped this was a good haul of crabs. Keeper crabs had to be over 5 inches from point to point- the sharp points that extended on either side of a blue crab's wide shell. He thought at first glance that he had a good haul, and he quickly worked to process his catch. He reached over the cage, which looked like a square box made of chicken wire (wire with holes in it). The cage was called a crab trap or crab pot and one corner was held closed by a bungee. John Taylor unhooked the bungee and flipped the cage so that he could shake the crabs into a shallow wooden tray. About 12 crabs quickly scattered to the edges in all directions trying to get away. John Taylor used his gloved hands to quickly capture about 4 crabs that he knew were too small and quickly eased them over the side of the boat. 2 large crabs he recognized as males or jimmies, he placed in a bucket, and 2 others he compared to a measuring tape he had attached to the side; they were both just over 5 inches wide, so they, too, went into the bucket. 3 more were females, and he carefully checked them for eggs, only one had eggs, and he slipped her over the side, and the other 2 he deposited into his bucket.



Quickly he scooped a mixture of fish heads and parts into another small opening on the trap, this one was a wire tunnel that held the mess, which was how a trap was baited to lure in crabs. He closed the bungee side as he quickly turned back around and holding on to the float, lowered the crab pot into the water. He kept the buoy in his hand to keep it all from tangling and when all the rope was over the side he dropped the buoy and stepped back to the wheel of the boat and accelerated to his next stop.

The boat had stayed pretty much in the same place in the short time it took John Taylor to empty this crab pot.

John Taylor had a set of crab pots to check most mornings; he was a junior at the local school, but had crabbed with his Dad for as long as he remembered. Just in the past year he had finally saved enough money to get his own boat, which was used of course and he worked on it until he had it running and had been setting his own pots for a few months. His set of pots had to be checked in the morning before he headed to school, and his dad would help finish processing his catch so that they could sell them later that day.

Back at the dock, which also included a couple of out buildings on a piece of land that had been in the family for several generations, John Taylor unloaded his catch or haul and put them in the building they kept cool for processing their crabs. Kept on ice the crabs would remain alive and healthy for a long time, which allowed time to process and get them to the fish market where they sold them. He straightened his boat and checked the gas and made sure all his equipment was in place: extra crab pots, buckets, etc. to be ready for the next day. When he got out of school, he would help his Dad finish with any processing that needed to be done. Tomorrow he would start all over again with one of his sets of crab pots.

He made decent money, and it was split 3 ways: a 3rd went to the boat, this meant that it paid for repairs and upkeep on the boat when needed; a 3rd went to dock rent to help his dad keep up their dock and for supplies such as gas and ice; and a 3rd was his profit, which he saved much of for emergencies and hopefully college.

Can anyone catch crabs?

In North Carolina, anyone may crab either with 1 crab pot from their private dock or with chicken parts on a string without a recreational license, but they may not sell their catch. All crabs must be at least 5 inches wide, from sharp point to sharp point on the main crab carapace (shell); both males and immature females. For more details or to check for any updates, check the NC Division of Marine Fisheries website.

Activity

Blue crabs are the North Carolina's # 1 commercially harvested seafood species. From the chart below, it is obvious that it brings in a lot of money and supports local economies along our coast.

Data from NC Division of Marine Fisheries on Blue Crabs harvest in NC between 2000-2012. This is commercial harvest reports only. Complete data can be accessed from their webpage.

	Pounds whole weight	Value
2000	38,890,013	\$32,154,856
2001	29,939,314	\$25,079,142
2002	36,462,070	\$29,349,350
2003	41,644,612	\$32,904,677
2004	32,592,768	\$20,248,333
2005	23,571,451	\$15,374,714
2006	24,408,932	\$14,146,592
2007	20,562,159	\$18,109,497
2008	32,312,449	\$25,414,608
2009	28,815,230	\$24,809,410
2010	29,795,512	\$23,801,421
2011	28,964,473	\$18,016,552
2012	25,989,121	\$20,196,504

Questions

1. Which year brought in the most money? Was it the same year that the most pounds of crab were harvested?
2. How much did a pound of crabs cost in 2012? In 2000?
3. Make a bar graph to show the pounds of crabs each year and the cost of crabs for the year. Do you notice any trends?
4. Check the North Carolina Division of Marine Fisheries website and see if you can determine what is the state's 2nd largest commercial fishery.
5. Using the NCDMF website, look at data for 10 years before 2000 to see if you can see any major events or trends in the numbers of blue crabs.

Next steps

1. What are the rules in North Carolina for crabbing?
2. What are some reasons that crabs have to be a certain size before you can keep them to eat?

Abiotic factor:

Salinity in NC Estuaries

Objective

Students will be analyzing salinity zone maps to determine part of the life history of blue crabs and where they live. Using these maps, students can determine where crabs are found.

Materials

- Salinity zone maps
- Computers for blue crab research
- Lake Matamuskeet gender data map
- Whooping Crane fact sheet

Duration

- Two class periods

Grade Levels

- High School

North Carolina Standards

- Bio.2.2.1, Bio.2.2.2, EEn.2.7.1, EEn.2.4.2

Virginia Standards

- ES.10.a

Lesson plans were developed with support by:



N.C. Essential Standards

- Bio.2.2 Understand the impact of human activities on the environment
 - Bio.2.2.1 Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment.
 - Bio.2.2.2 Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.
- EEn.2.4.2 Evaluate human influences on water quality in North Carolina’s river basins, wetlands and tidal environments.
- EEn.2.7.1 Explain how biotic and abiotic factors interact to create the various biomes in North Carolina

Virginia Standards of Learning

- ES.10 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include
 - a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations;
 - b) importance of environmental and geologic implications;
 - c) systems interactions;
 - d) features of the sea floor as reflections of tectonic processes; and
 - e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

Ocean Science Standards

5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.

For Teachers, Background information

Salinity is the amount of dissolved salts in the water. We know ocean water is salty, but river water is not. Salinity is measured in parts per thousand (ppt) and our ocean water averages about 35ppt. Our estuaries range from 0 salinity to 35 salinity depending on the input of ocean water from tides that come in through inlets and fresh water flowing from rivers. Fortunately for blue crabs, they can tolerate from 0 salinity caused by flooding from rain or storms to >>35 salinity that can occur during droughts and in sounds without input from the rivers.

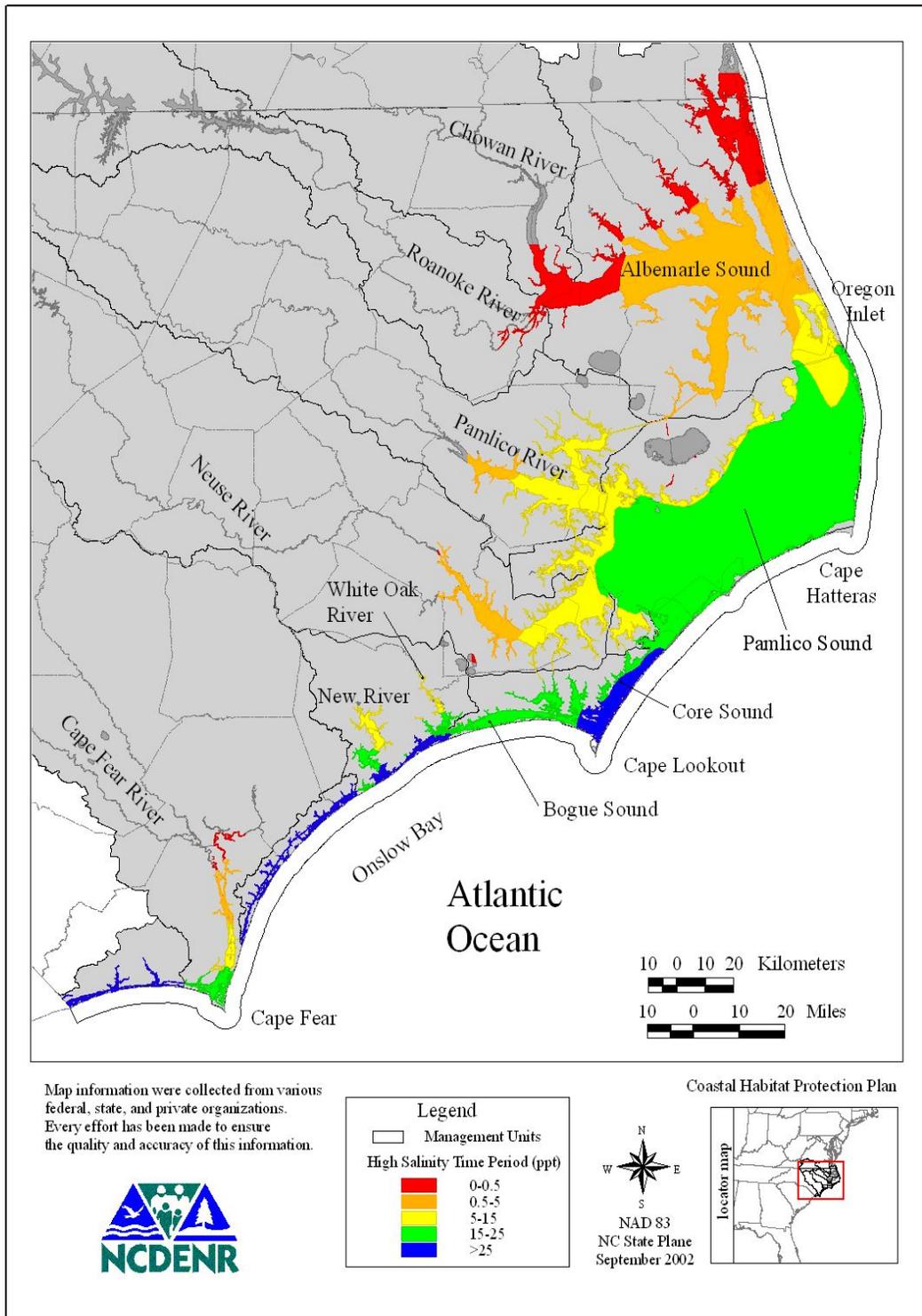
Blue crabs vary by location depending on their gender and stage of life; males prefer lower salinity water while spawning females are found in 22 salinity or higher waters because their eggs and larvae can't survive below that salinity. Spawning females migrate toward the ocean with each clutch of eggs and are found close to inlets. The location of the females allows for released larvae ride the tides out into the coastal ocean and high salinity were they from larval forms to the last larval stage which rides the tides back into the estuaries where they metamorphose to small crabs and continue to molt and grow and develop into their mature forms. Direct students to explore the different locations of the different genders of crabs.

For videos on blue crabs for this project go

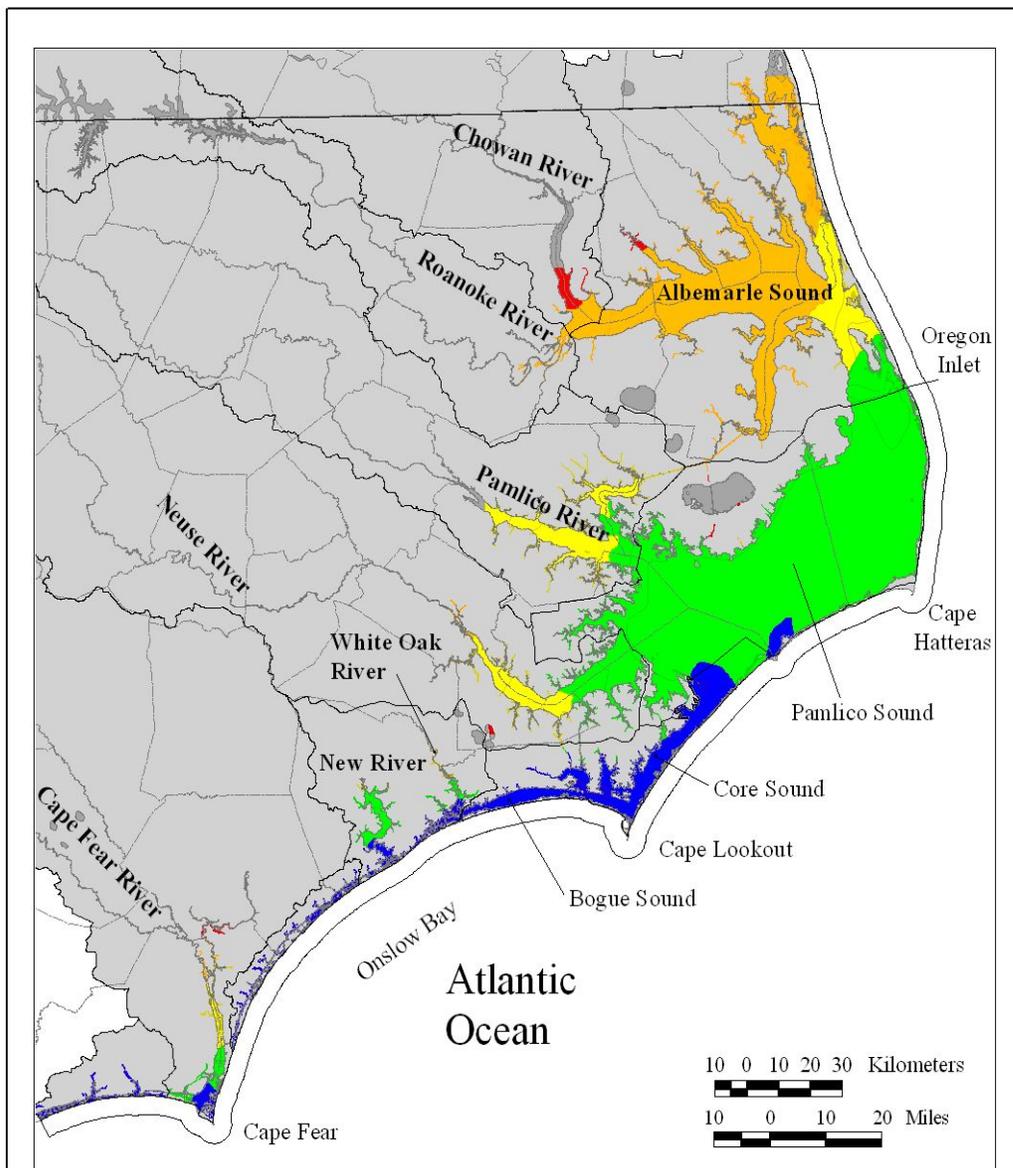
to: https://www.youtube.com/results?search_query=blue+crabs+amy+sauls

Part 1.

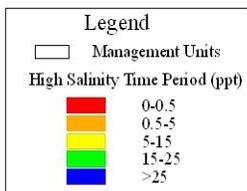
Low salinity: December – late spring



High Salinity: Summer - early Fall October



Map information were collected from various federal, state, and private organizations. Every effort has been made to ensure the quality and accuracy of this information.



Coastal Habitat Protection Plan



Analyzing Data

- 1- Look at the salinity data from the different times of the year. This would be a good time to locate some familiar landmarks. Where are the lighthouses? The inlets? The Aquariums? Your favorite beach.
- 2- List the differences you observe between the 2 maps.
- 3- What factors cause the salinity to be different at different times of the year?
- 4- Research how salinity affects blue crabs and what this means for where blue crabs live. How will this affect where crabs are found at different times of the year. This video might help: https://www.youtube.com/watch?v=tv_THgwluxM
- 5- Where would crabbers go to harvest crabs if they want to harvest mostly male crabs? Would they change the location of their crabpots if they crabbed in May and September?
- 6- Based on the research and the salinity zone maps, where do most crabs mate?
- 7- Where do most crabs spawn?
- 8- How would dams upriver affect the salinity maps?
- 9- The Cape Fear river is known for having some dams in place already, how would the salinity change if they are removed?
- 10- What other factors besides for salinity do you think would affect where the blue crabs live?

Part 2**Lake Mattamuskeet in Hyde County, NC**

Lake Mattamuskeet has a waterway system that can be opened and closed to let salty, Pamlico Sound water into the lake, or keep it out, although the openings are seldom actually changed. Based on the map above of crabs that were sampled (and returned), determine which sites had more males vs. females.

1. Based on part 1 and the data above, where do you think the higher salinity water is located in the lake? Why?
2. Should the managers change the openings in the lake? Why or why not?

Extension

Read the fact sheet on Whooping Cranes and discuss why this might or might not be a good area to try to re-introduce whooping cranes.

Blue Crabs

Callinectes sapidus

Latin name means...

Beautiful swimmer, which is a good description of this crab. The back pair of appendages look like paddles and helps them to swim.

Soft crabs

When these crabs molt they are soft for a short time. Many folks like to eat soft shell crabs!

Eggs

Blue crab females may release 750,000 to 8 million eggs at one time, depending on the size of the crab. The egg mass is called a sponge.

Blue Crab factsheet

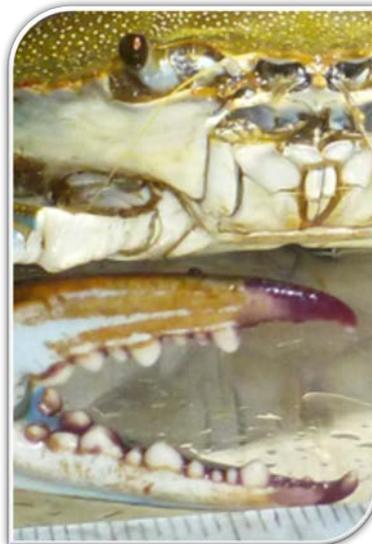
As one of the largest commercially harvested species in North Carolina, this crab can be found from high salinity ocean water to inland waters with low salinity. With over 2 million acres of estuary, this state has lots of habitat for this generalist.

Taxonomy

Phylum Arthropoda
Subphylum Crustacea
Order Decapod
Family Portunidae

Range Blue crabs are found in a wide range of salinity waters. Females are more common in the higher salinity areas close to the open ocean. Larva is released and spend the first part of their life in higher salinity waters, migrating into the sheltered estuaries as they grow. Shallow waters, especially salt marshes and SAV (sub-aquatic vegetation) beds are great places for crabs to grow and live. Males tend to be found in lower salinity areas, in creeks, rivers and the upper areas of bays and sounds further away from the ocean.

They are found on the East Coast as far north as Canada and as far south as Uruguay.



Omnivores

Blue crabs are omnivores and opportunists in their eating habits. They eat anything from shrimp, fish and snails to eelgrass and sea lettuce. They will eat carrion and other crabs (they can be considered cannibals).

Blue crabs are food for many other animals. As larva, they can be eaten by any filter feeders such as menhaden, oysters and large whales. As they grow, other crabs, birds, fish and humans prey on them.



Blue crabs are distinctive in their blue color, especially their claws. Males are often called “jimmys” and females “sally”, “she-crab” or “sook”. They are sexually dimorphic. The females are obvious by the red on their claws and the distinctive wide shape of their apron on the underside, while the males have a thin pointy apron.



Females carry the eggs under this wide apron and once she is carrying eggs, she may be called a sook or sponge crab.

Size: Blue crabs range up to around 8 inches wide. They have 5 sets of appendages; the front set being claws and the back set are flattened into paddle-shaped legs used for swimming. The upper shell is usually a brownish color, but the appendages are usually bright blue.



Molting: Like many other arthropods, blue crabs can regenerate a lost appendage through molting; usually they can have a new full sized leg or claw after 2-3 molts.

Osmoconformers: they adjust the salt content of their cells through osmosis depending on the salinity content of the water they are in.

In NC crabs larger than 5 inches across may be kept for consumption by recreational fishers. For more details go to NC Division of Marine Fisheries website. A soda can, if you don't have a ruler, is 5 inches!

Temperature and age: In the winter most crabs move to deeper water where the water temperatures will not vary as much. They will settle and even dig in the bottom until spring. The life span is 1-3 years.

More on molting and reproduction: after blue crabs cycle through their immature forms and look like an actual crab, they will molt 21-23 times, with males usually molting 2 more than females. Hormones regulate the process and causes a larger, soft shell to form under the existing hard shell.



When the crab is approaching time to molt, they go through some color changes on their paddle legs related to the new shell under the old, and crabbers and shadders for the soft crab industry are good at identifying these changes.

When it is finally time for the crab to molt, it takes in water to spread the existing shell which splits at the back. The crab then backs out of the old shell, leaving behind an empty molt (which includes the gills and intestines and every hair). The new shell is 1/3/ over twice as large 2/3 large as the previous shell, and depending on the temperature and salinity of the water, can take anywhere from 2 days to ten days to complete hardening, obviously the longer it takes to harden, the larger the new shell will be because there was a longer time to expand before it began to harden. While the crab is soft, it is very susceptible to predators including humans. If harvested and removed from the water it will fail to harden.

If the crab is female and has reached maturity, she has been looking for a male to mate with while getting ready to molt, and if she is successful, the male will protect her at the same time will mate with her. If the crabs were the size of humans they would transfer about two gallons of seminal fluid, enough for about 64,000,000 eggs. The female mates until she has a full complement of seminal fluid, stores the sperm and uses the stored sperm to fertilize 3 to over 7 clutches of eggs.



All images from Dr. Rittschof's research project

Whooping Crane

Grus americana

Tall

Tallest American bird. Males can be as tall as 1.5 meters. They are white except for black primary feathers on the wings.

Endangered

Since 1967.

Historic Range

At one time these birds were abundant from the Arctic to Mexico and Utah to the east coast, including North Carolina to Florida .

Did you know there were once Whooping Cranes in North Carolina?

Whooping cranes have declined in population because of many factors

Hunting, loss of habitat and increased pressure from predators have all contributed to the decline in population in the past 80 years. These birds are ground nesters and some of their predators include wolves, bears, eagles, alligators, and bobcats. They are omnivores, but appear to prefer animal prey such as crustaceans. Several studies have shown that the population at Arnansas National Wildlife Refuge primarily depend on blue crabs as their main diet.



Endangered Species

Once a population low of about 22 birds in the 1940s, efforts have increased the population to over 500 today. The International Crane Foundation is one of the primary groups that help monitor both the wild and captive populations and their habitats in hopes of continued success of the population.



The wintering grounds for one of the self sustaining natural whooping crane populations is in the Aransas National Wildlife Refuge on the Texas Gulf coast.

Historically the range of the whooping crane extended to many locations in North America, but because of habitat loss, it is still a challenge to restore their populations. In North Carolina, much of Hyde County remains unpopulated by humans and is still a good winter birding area. A partnership with officials and researchers at Aransas National Wildlife Refuge and at Lake Mattamuskeet in Hyde County, efforts to investigate the viability of attempting to try to restore populations here are underway. At the Texas Aransas site, whooping cranes depend on blue crabs for about 90% (estimate) of their diet. Some of the observations for Lake Matamuskeet is to see how sustainable and healthy the population of blue crabs is at the lake as well as how visibility might affect the cranes feeding on these crabs. Lake Mattamuskeet is a man altered lake that has a very unique dynamic of changing salinities.

