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Chesapeake Bay Life Cycles

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CHESAPEAKE BAY LIFE CYCLES

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Grade Level
4th Grade

Subject Area
Science

VA SEA is a collaborative project between the Chesapeake Bay National Estuarine Research Reserve, the Virginia Institute of Marine Science's Marine Advisory Program, and Virginia Sea Grant. The VA SEA project is made possible through funding from the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.

Title: Chesapeake Bay Life Cycles

Focus: Use reading and comprehension to explore animal and plant life cycles

Simulate a blue crab population

Grade Level: Grade 4

VA Science Standards:

4.1 The student will demonstrate an understanding of scientific and engineering practices by:

- Developing and using models
  - Develop and/or use models to explain natural phenomena
- Obtaining, evaluating, and communicating information
  - Read and comprehend reading-level-appropriate texts and/or other reliable media

4.2 The student will investigate and understand that plants and animals have structures that distinguish them from one another and play vital roles in their ability to survive:

- The survival of plants and animals depends on photosynthesis
- Plants and animals have different structures and processes for obtaining energy
- Plants and animals have different structures and processes for creating offspring

4.3 The student will investigate and understand that organisms, including humans, interact with one another and with the nonliving components in the ecosystem:

- Interrelationships exist in populations, communities, and ecosystems
- Changes in an organism's niche and habitat may occur at various life stages in its life cycle

Learning Objectives:

- ✓ Students will differentiate life stages for plants and animals native to the Chesapeake Bay
- ✓ Students will assemble life cycles for three species (blue crabs, oysters, and eelgrass)
- ✓ Students will predict how changes in plant and animal populations influence each other

Total length of time required for the lesson:

Activity 1: Life cycles: 50-70 minutes total

- Advance preparation of materials: 10 minutes
- Introduction: 10 minutes
- Activity: 35 minutes
- Discussion: 10 minutes

Activity 2: Blue crab simulation: 50-60 minutes total

- Advance preparation of materials: 5 minutes
- Introduction: 5-10 minutes
- Activity: 30 minutes
- Discussion: 10 minutes

Key words, vocabulary:

- **Algae:** microscopic plant-like organisms which are the base of aquatic food webs.
- **Asexual reproduction:** A form of reproduction where new living organisms are created from a single parent. Since there is only one parent, the new individual is genetically similar or identical to the parent. Plants may asexually reproduce through bulbs, producing miniature plants (e.g. mother of thousands plant), or rhizomes.
- **Broadcast spawner:** form of sexual reproduction where sperm and eggs are released into the water by aquatic animals. Oysters use this form of reproduction.
- **Complex life cycle:** An organism has a complex life cycle if there are discrete life stages of the same organism differ in form or function and often occupy different niches.
- **Estuary:** Habitat where fresh water from rivers and streams mixes with the salt water from the ocean. The Chesapeake Bay is a large estuary.
- **Exoskeleton:** "Outside skeleton." Hard external covering that supports and protects animals. Exoskeletons are common in many groups of invertebrates, including oysters and blue crabs.
- **Habitat:** The home or environment occupied a plant, animal, or other organism.
- **Invertebrate:** Animals without a backbone.
- **Larva:** free-swimming and sometimes feeding stage in the early development of some animals. Larvae is the plural form of larva.
- **Life cycle:** sequence of developmental stages an animal passes through from fertilization to reproductive maturity.
- **Megalope**: final larval stage in the blue crab life cycle.
- **Metamorphosis:** transformation from one life stage to another. Transformation from an immature life stage (or stages) to a mature life stage.
- **Molt:** Process of shedding the exoskeleton, which is required for blue crabs to grow. During molting the hardened exoskeleton splits and the crab backs out of the hard shell. Freshly molted crabs have a soft exoskeleton for a period of time.
- **Niche:** The role an organism plays in a community. A species' niche includes physical and environmental conditions it requires and the interactions it has with other species.
- **Nursery habitat:** A subset of habitats where juvenile animals are found which support higher survival and growth.
- **Oyster reef**: large clusters of oysters found in estuaries that provide habitat. Oysters in a reef are physically cemented and attached to one another.
- **Photosynthesis:** process where plants turn light energy into chemical energy for growth. Plants convert sunlight and carbon dioxide into oxygen and sugars (energy).
- **Pollination:** the transfer of pollen to the flower of the plant, enabling fertilization and the production of seeds. Pollination is required for plant reproduction.
- **Protandrous hermaphrodite:** Term that describes animals that develop first as males, but later reproduce as females.

- **Rhizome**: modified, often fleshy, plant stem that grows under the soil. Rhizomes can send out additional roots and leaves, which allows the plant to grow laterally. This is a form of asexual reproduction
- **Shoots:** First stem and leaves that grows from the seed or new growth on a plant.
- **Sexual reproduction:** creating of a new living organism by combining genetic material from two parents.
- **Terminal molt:** The final molt in the blue crab life cycle. Females mate during their terminal molt. After the terminal molt, the crab no longer grows larger.
- **Velum:** ciliated organ used for movement and feeding in larval stages of oysters.
- **Zoeae:** first larval stage in the blue crab life cycle.

Background information:

Eelgrass life cycle:
Eelgrass is a flowering aquatic plant found in the Chesapeake Bay. Just like land plants, eelgrass uses photosynthesis to convert sunlight and carbon dioxide into oxygen and sugars (energy). Eelgrass is able to reproduce through two mechanisms: **sexual** and **asexual reproduction**. For sexual reproduction, eelgrass will produce flowers that are **pollinated** in the water. Pollinated flowers develop into seeds. Mature seeds are released into the water column and sink to the bottom of the river. Seeds will develop their first roots, which anchor the plant, and **shoots**, which perform photosynthesis. The plant will continue to grow. For asexual reproduction, eelgrass will produce **rhizomes**, which expand the plant horizontally. Rhizomes can produce additional roots and shoots.

Eelgrass grows in a meadow, an area primarily covered in grasses. Eelgrass meadows provide important **nursery habitat** in the Chesapeake Bay.

Oyster life cycle:
Eastern oysters have a **complex life cycle** and form complex **oyster reefs** in the Chesapeake Bay. **Adult oysters** live attached to one another on **oyster reefs**. Oyster are **protandrous hermaphrodites**, where they start as males and transition to females. Oysters become sexually mature in their first year and release sperm and eggs into the water. This form of reproduction is called **broadcast spawning**. The fertilized eggs drift into the water and develop into **larval oysters**. Oyster larvae use an organ called the **velum** for feeding on **algae** and swimming. Larvae can swim vertically in the water and ride tidal currents to stay in the **estuary**. After developing for 2 weeks, larvae will swim towards the bottom of the river to find hard substrates. When the larvae find a good habitat, preferably other oysters, they will **metamorphose** to physically attach to the reef as a juvenile oyster. Oysters will spend the rest of their lives wherever they attach.

Oyster reefs are important in the Chesapeake Bay! They help stabilize shorelines, filter water and improve water quality, provide habitat for other animals, and support a valuable fishery in the Chesapeake Bay.

Blue crab life cycle:
Blue crabs have a **complex life cycle** and use a variety of habitats in the Chesapeake Bay throughout their life time. Adult blue crabs live in moderate salinity areas in the Chesapeake Bay (e.g. upper and middle mainstem of the Bay, coastal lagoons). Blue crabs have a hard **exoskeleton,** which must be

molted to grow. Female blue crabs are only able to mate during their **terminal molt**, after which females no longer grow larger. After mating, females will move to higher salinities near the mouth of the Chesapeake bay which are necessary for healthy egg and **larval** development. Females will deposit eggs onto their abdomen, which resembles a sponge. Once the eggs have developed, larval crabs, called **zoeae**, will be hatch into the water column and are transported by currents out of the estuary into high salinity ocean waters. Zoeae feed on **algae** and develop for approximately 30 days before returning to the estuary and **metamorphosing** into **megalope**. Megalope metamorphose into **small juvenile crabs** and live in **nursery habitats,** including seagrass beds and salt marshes.

Blue crabs are an important fishery species and predator in the Chesapeake Bay.

This lesson plan focuses on the value of eelgrass beds as nursery habitat for juvenile crabs and oyster reefs as important adult crab habitat.

Activity 1: Life cycles

Student Handouts:

- Life cycle stories (eelgrass, oyster, blue crab)
- Life cycle worksheets (blank life cycle template)
- Life cycle stages (drawings of life stages)

Materials & Supplies:

- Scissors
- Glue sticks
- Colored pencils (Optional to have students color in life cycle)

Classroom set up:

- Students should work in groups of three students; set up however is best for classroom

Procedure:

Advance preparation of materials: 10 minutes

- Print life cycle stories, worksheets, and life cycle stages.
- Each group should have a set of life cycle stories (eelgrass, oyster, **and** blue crab). Instructor may choose to laminate the life cycle stories for repeated use.
- Each student (or group) should have a set of worksheets (**three** blank life cycle worksheets) and life cycle stages (**one each** for eelgrass, oyster, and blue crabs). The life cycle stage sheets should be cut in half by the instructor. Students will cut out the individual stages. The worksheets and life stages are not intended to be reused.
    - The instructor may choose to provide each group with materials for one species (eelgrass, oyster, or blue crab) and have the groups share information.

Introduction: 10 minutes

- Instructors should load the accompanying PowerPoint presentation and walk through **slides 1-11** as they introduce the lesson (talking points included in notes section).
    - Emphasize
        - Chesapeake Bay is home to diverse plants and animals, which can form habitat
        - differences between plants and animals
        - plants and animals use different strategies to survive and reproduce

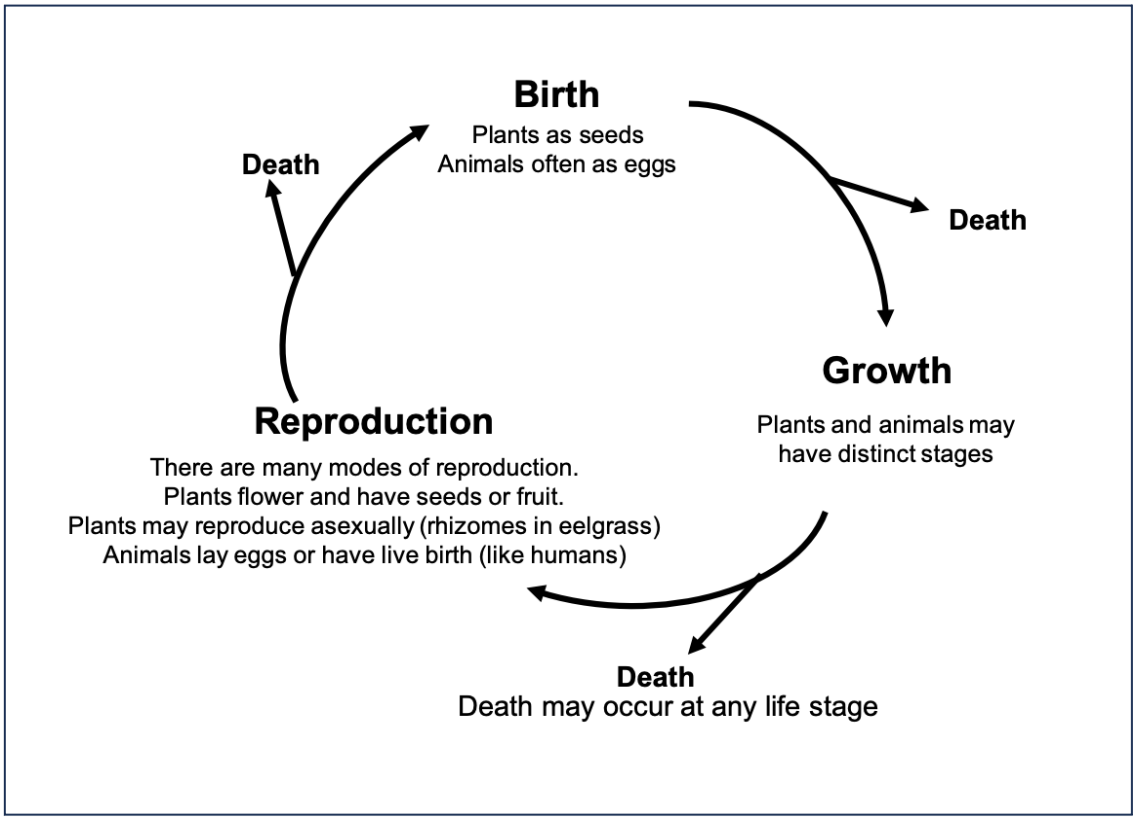
Activity: 35 minutes

- Students will be split into groups of 3
- Students will take turns reading paragraphs of the life cycle stories
- Using the life cycle descriptions, students will find and place the corresponding life stage onto the life cycle worksheet.
- Instructors should have students label each life cycle stage (e.g. adult, egg, larva, young).

Discussion: 10 minutes

The instructor should lead a class discussion with the below questions. Discussion questions are included in the Powerpoint presentation on **slides 12 and 13**. A reference for the model life cycle is on **slide 14,** which is hidden in the presentation.

- How does eelgrass gain energy? Does that change through the life cycle?
    - *Answer: Eelgrass uses photosynthesis throughout the life cycle to gain energy from sunlight*
- How do oysters gain energy? Does what they eat change over their life cycle?
    - *Answer: Oysters gain energy by filtering and consuming algae. They eat algae throughout the life cycle.*
- How do blue crabs gain energy? Does what they eat change over their lifetime?
    - *Answer: Blue crabs gain energy by eating a variety of food items. During the larval stage, they will eat algae. When they grow to young or adult crabs, they transition to eating plants and other animals, such as fish, clams, oysters, and more.*
- Though eelgrass, oysters, and blue crabs are very different, their life cycles have some similarities. If we were to make a general life cycle, what would it look like?
    - *Answer: Teacher should walk students through creating a 'model life cycle' with stages for birth, growth, and reproduction. Death may happen at any time in the life cycle. Example below, but teachers may modify.*



Assessment

Student assessment should be based on group participation, completed life cycle diagrams, and contributions to the class discussion. The specific locations of the life cycle stages does not matter; however, they should be in the order provided in the key.

Activity 2: Blue crab simulation

Materials & Supplies:

- Simulation requires 20 "habitat square" markers. Ideally, these will include two colors or shapes with 10 for each habitat type (eelgrass and oyster reef). Example materials include:
  - Hula hoops
  - Cones
  - Paper plates
  - Rubber squares
  - Printed text "Eelgrass" and "Oyster" on standard computer paper
- The activity is designed with a classroom of ~25 students in mind. Habitat squares should be available for ~80% of class. Instructors may adjust numbers as needed to fit class size.

Classroom set up:

- The preferred location for this activity is an open outdoor space, such as a paved playground or grassy field, but an indoor gymnasium would work if there is poor weather.

Procedure:

Advance preparation of materials: 5 minutes

- Collect "habitat square" markers for simulation (examples provided in above Materials & Supplies section).
- The activity is designed with a classroom of ~25 students in mind. Habitat squares should be available for ~80% of class. Instructors may adjust numbers as needed to fit class size.

Introduction: 5 to 10 minutes

- In the classroom, instructors should load the accompanying PowerPoint presentation as an introduction to the lesson (talking points included in notes section).
    - **If the class completed Activity 1: Life cycles**, walk through **slides 15-30** for Activity 2: Blue crab simulation. Review the blue crab life cycle.
        - Question for students on slide 15: What habitats do blue crabs use during their life cycle?
            - *Answer: As larvae, blue crabs float in the ocean. As juvenile crabs, they use eelgrass as a nursery habitat. As adult crabs, they use oyster reefs and other habitats.*
    - **If the class did NOT complete Activity 1: Life cycles,** walk through **slides 1-10** to learn about the scientist and Chesapeake Bay organisms. Then, walk through **slides 16-30** to prepare students for the blue crab simulation
        - Emphasize
            - Blue crabs have a complex life cycle and describe the stages
            - Discuss how blue crabs use different habitats during their lifetime
- Explain the blue crab population simulation
    - **Goal of simulation**: Students will act as a blue crab population and individuals will attempt to complete the blue crab life cycle without being eaten!
    - Emphasize
        - Populations include all the organisms of the same species in the same place at the same time.
        - Communities all the populations of different species in the same place and same time.
        - Ecosystems include all the living and non-living things in the same area.
        - Blue crab populations depend on a healthy estuarine community, especially healthy populations of eelgrass and oysters.

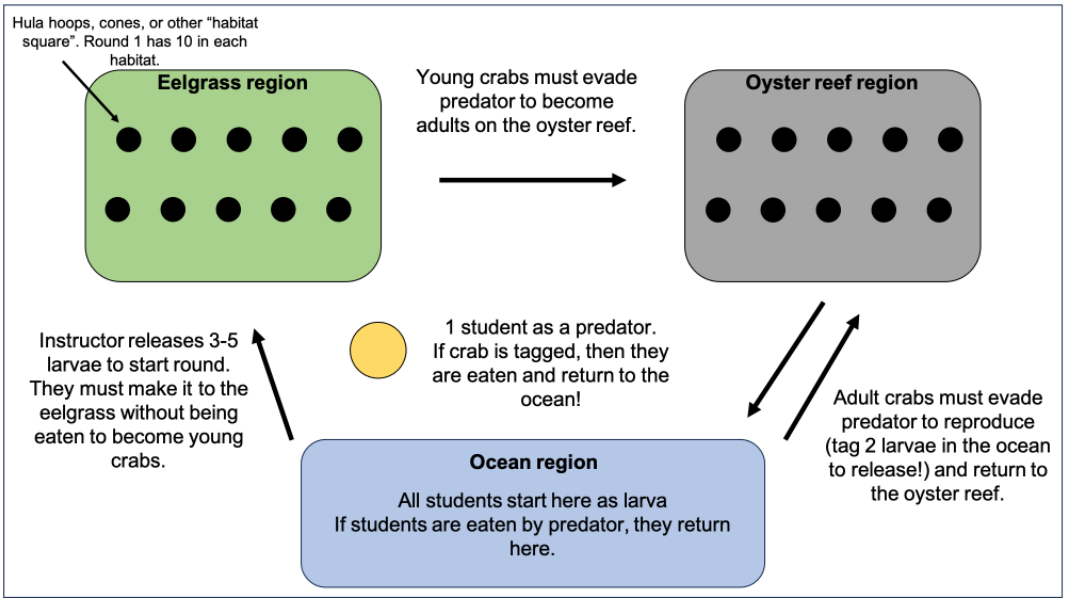
Activity: 30 minutes (~10 minutes per round)

General simulation set up and flow:

- Students will attempt to complete the blue crab life cycle without being eaten!
- Three regions of the playground/field/gymnasium will act as ocean, eelgrass, and oyster habitat.
- Within each habitat there are "habitat squares" which are safe from predators. Individuals cannot be eaten when occupying a habitat square. Habitat squares can only hold one individual at a time.
- When moving between "habitat squares", blue crabs may be eaten (tagged) by predators. If eaten, individuals return to the ocean larvae pool.

Step	Action	Life cycle stage
0	Before going outside, go over slides 26-30 to explain the game. Once outside, the teacher may want to walk students through the game movement.	
1	All students start in ocean region	Students are larvae.
2	Teacher will select a student to be the predator. Then select 3-5 students from the ocean region to start the game. If tagged by a predator, students return to the ocean.	Students are crab larvae returning to the estuary from the ocean. They must evade predators!
3	When released, students run to the eelgrass region. Students count to 3 before moving again.	The crab larvae travel to eelgrass beds to become young blue crabs. They spend time here feeding and growing.
4	Students run to the oyster reef region. Students count to 3 before moving again.	Adult crabs live in moderate salinity habitat, like oyster reefs. They grow and molt until they are ready to reproduce.
5	Students run to the ocean region. Back at the ocean, each student tags 2 "larvae" to release.	Adult crabs migrate to high salinity areas in the mouth of the Chesapeake Bay. Females carry eggs on their abdomen and release larvae into the water.
6	Students who are larvae go to eelgrass region. Students who are adult crabs return to oyster region, if there is space. If there is not space, they must outrun the predator until a space is available!	

Simulation schematic:



- **Round 1: Baseline populations**
  - Provide **10** "habitat squares" in the eelgrass and oyster region
  - Assign 1 student as a predator
- **Round 2: Reduced eelgrass populations**
  - Provide **5 eelgrass** habitat squares and **10 oyster** habitat squares
  - Assign 1 student as a predator
  - **Ask the students to make a prediction:** What do they think will happen to blue crab populations when there is less eelgrass nursery habitat available?
    - *Answer: With less eelgrass nursery habitat available, we would expect fewer juvenile blue crabs to survive. Without eelgrass, juvenile blue crabs will not have access to abundant food sources and protection from predators.*
- **Round 3: Reduced oyster populations**
  - Provide **10 eelgrass** habitat squares and **5 oyster** habitat squares
  - Assign 1 student as a predator
  - **Ask the students to make a prediction**: What do they think will happen to blue crab populations when there is less oyster habitat available?
    - *Answer: With less oyster habitat available, we would expect fewer adult blue crabs to survive. The adult blue crabs will not have access to enough space or food. With fewer adult blue crabs, we would expect fewer blue crab larvae and juveniles.*
- **Round 4: Increased predation (**Optional)
  - Provide 10 eelgrass habitat squares and 10 oyster habitat squares
  - Assign 5 students as predators
  - **Ask the students to make a prediction**: What do they think will happen to blue crab populations when there are more predators in the ecosystem?
    - *Answer: With more predators, fewer crabs will survive to become adults and reproduce. We would expect fewer blue crab larvae and juveniles.*

Tips for Instructors:

- If the simulation gets stuck and students are not moving between habitats, you may incorporate environmental conditions to force movement. Examples:
    - Temperature in the environment is too hot for eelgrass! All juvenile crabs are eaten by predators when the eelgrass dies. (All juvenile crabs are sent back to ocean larval pool.)
    - A large rain event unleashed sediment onto the oyster reefs and buried the oyster! All adult crabs are eaten by predators when the oysters die. (All adult crabs are sent back to the ocean larval pool.)

Discussion: 10 minutes

The instructor should lead a class discussion or think pair share with the following questions:

- What do we need for healthy blue crab populations in the Chesapeake Bay?
    - *Answer: A healthy ecosystem, which includes abundant habitat, food, and good environmental conditions!*
- How do eelgrass populations interact with blue crabs?
    - *Answer: Eelgrasses are plants that provide important habitat for juvenile blue crabs. The grasses provide abundant food and protection from predators.*
- How do oyster populations interact with blue crabs?
    - *Answer: Oysters are animals that build reefs. The reefs provide habitat for adult blue crabs and abundant food for adults.*

Assessment

Student assessment should be based on simulation participation, and contributions to the class predictions and discussion.

References

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Acknowledgments

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