The Salt Marsh Ecosystem

Cultural Resources Education

Created by Jacob Hamill, SCDNR Heritage Trust Archivist (2018).

Grade Levels

K – 7th, High School Biology

Estimated Time

1–1 ½ hours. Additional time may be allotted for optional out-of-class components.

Goal

Students will learn about the ecology of coastal salt marshes and how the location of Fort Lamar near these marshes affected the outcome of the Battle of Secessionville.

Objectives

After completion of the activity and viewing of the *Fort Lamar* documentary, students will be able to:

1. *Observe* historical events featured in the Fort Lamar documentary films.
2. *Summarize* key events of the documentary.
3. *Identify* the location of Fort Lamar and the Battle of Secessionville in South Carolina.
4. *Explain* the significance of the Battle of Secessionville in the context of the Civil War.
5. *Discuss* the unique and vital components of the salt marsh ecosystem.
6. *Distinguish* between a producer, a consumer, and a decomposer.
7. *Construct* a food web for salt marsh organisms and *demonstrate* how food energy is transferred through the ecosystem.
8. *Speculate* what would happen to the ecosystem if an organism went extinct. Similarly, *speculate* what would happen to the ecosystem if it experienced overpopulation.
9. *Create* an accurate visual representation of a salt marsh.

Academic Standards

English

Writing (W)

K-6 Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

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7-6 Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

8-6 Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

Science

K.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

K.L.2 The student will demonstrate an understanding of organisms found in the environment and how these organisms depend on the environment to meet those needs.

1.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

1.L.5 The student will demonstrate an understanding of how the structures of plants help them survive and grow in their environments.

2.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

2.L.5 The student will demonstrate an understanding of how the structures of animals help them survive and grow in their environments.

3.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

3.L.5 The student will demonstrate an understanding of how the characteristics and changes in environments and habitats affect the diversity of organisms.

4.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

4.L.5 The student will demonstrate an understanding of how the structural characteristics and traits of plants and animals allow them to survive, grow, and reproduce.

5.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

5.L.4 The student will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems.

6.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

6.L.4 The student will demonstrate an understanding of how scientists classify organisms and how the structures, processes, and adaptations of animals allow them to survive.

6.L.5 The student will demonstrate an understanding of the structure, processes, and responses that allow protists, fungi, and plants to survive and reproduce.

7.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment.

H.B.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.B.6 The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment.

Social Studies

8-4.5 Compare the military strategies of the North and the South during the Civil War and the fulfillment of these strategies in South Carolina and in the South as a whole, including the attack on Fort Sumter, the Union blockade of Charleston and other ports, the early capture of Port Royal, and the development of the Hunley submarine; the exploits of Robert Smalls; and General William T. Sherman's march through the state.

8-4.6 Compare the differing impact of the Civil War on South Carolinians in each of the various social classes, including those groups defined by race, gender, and age.

USHC-3.2 Summarize the course of the Civil War and its impact on democracy, including the major turning points; the impact of the Emancipation Proclamation; the unequal treatment afforded to African American military units; the geographic, economic, and political factors in the defeat of the Confederacy; and the ultimate defeat of the idea of secession.

Visual Arts

VA.CR-1 I can use the elements and principles of art to create artwork.

VA.CR-2 I can use different materials, techniques, and processes to make art.

VA.P-3 I can improve and complete artistic work using elements and principles.

VA.P-4 I can organize work for presentation and documentation to reflect specific content, ideas, skills, and or media.

VA.C-7 I can relate visual arts ideas to other arts disciplines, content areas, and careers.

Activity Type: In-Class/Out-of-Class

This is intended as an in-class and/or out-of-class activity. The teacher will provide the required materials for the in-class component. Students will need to find resources individually for the out-of-class component.

Materials

- Who Am I? Food Web Activity Materials:
    - Multiple sets of the student index cards (varies depending on class size)
    - Teacher index card set
    - Cutout arrows
- Scratch Paper
- Colored pencils, markers, crayons, etc.
- Scissors
- Optional: Wildlife magazines to cut pictures out of

Fort Lamar Historical Background

- By the spring of 1862, Union forces under the leadership of Brigadier General David Hunter, commander of the Union's Department of the South, were poised to launch an assault on Charleston by way of land. A Union victory at the Battle of Port Royal in November of 1861 provided the Federals an excellent staging area for organizing an attack on the city. Logistical information provided by Robert Smalls, a runaway slave who had commandeered a Confederate steamer, the C.S.S. *Planter*, opened the way for Union troops to advance on James Island.
- Capturing Charleston early into 1862 could have dramatically turned the tide of war in the Union's favor. The North could have utilized Charleston's large harbor and railroad connections to launch large-scale campaigns into the South's interior, potentially forcing the Confederacy to divert its eastern forces away from Virginia.
- To protect Charleston's southern flank, the Confederates, under the command of Major General John C. Pemberton, constructed a string of fortifications on James Island, extending from Fort Pemberton on the Stono River to a small fort built on the neck of the Secessionville peninsula. General Pemberton placed South Carolinian Brigadier General Nathan George "Shanks" Evans in charge of the island's defenses.
- The Secessionville fort, then known as the Tower Battery for the watchtower constructed at the site, was flanked by marsh on both sides and was built on the narrowest portion of the peninsula, which measured only 125 yards wide. Colonel Thomas G. Lamar was placed in command of the fort and tasked with overseeing its construction.

- On June 2, 1862, Union forces under the command of Brigadier General Henry W. Benham, who was placed in charge of the operation by General David Hunter, landed on the southwestern tip of James Island at the Grimball Plantation.
- A few minor skirmishes followed as Union forces began to unload supplies and organize troops, in turn prompting the Confederates to reinforce their fortifications.
- Worried that they did not have enough men to capture Charleston, General Hunter ordered General Benham to not advance on Charleston or Fort Johnson until he received reinforcements or direct orders to attack.
- Despite these instructions, in the early morning of June 16th General Benham launched a surprise attack on the Secessionville fort. This force, totaling around 6,500 men organized into two columns, was expected to easily overwhelm the Confederate garrison of 500.
- As the Union force approached the fort, they had to navigate through overgrown hedge rows and open cotton fields, slowing their advance. As the land approaching the fort narrowed, the left side of the Union column was pushed into the marsh, breaking the line and compressing the center, causing the second wave to run into the first.
- At this point, around 5:00 am, the fort's defenders were alerted to the Union's presence. As the Confederates rushed to their stations, Colonel Lamar took personal command of the 8-inch Columbiad cannon. When the Union lines were within two hundred yards of the fort, they were met with the mighty Columbiad's blast.
- Despite sustaining heavy fire from the fort's cannons, the Union forces managed to climb onto the fort's parapets where they fought hand-to-hand with the Confederate defenders.
- The fort's garrison was quickly reinforced by surrounding Confederate battalions, who were able to repel the Union's foothold.
- The marshes inhibited the Union army from launching a successful flanking maneuver to assist the main assault, as the water and pluff mud proved to be impassable.
- Confederate artillery fire to the Union's flank, in addition to Confederate reinforcements, forced General Benham to order a retreat. Despite the battle only lasting around two and a half hours, losses were heavy.
- The Union sustained nearly 700 causalities, with 107 killed, while the Confederates experienced around 200 causalities, with 52 killed. Most of the battle's causalities occurred either on the narrow peninsula immediately in front of the fort or on the fort itself.
- After the battle, the Secessionville fort, which was referred to as the "Tower Battery" at the time of the battle, was renamed to Fort Lamar in honor of its commander. Colonel Lamar, who was wounded during the battle, died a year later from fever contracted while on serving on the island.
- By July 8th, the Union army vacated James Island and returned to Port Royal.

- For disobeying orders and losing the battle, General Benham was court martialed and demoted.
- Fort Lamar was placed on the National Register of Historic Places in 1979.

Salt Marsh Ecology

- Most abundant in the southeastern United States, the salt marsh **ecosystem** is a coastal **wetland** frequently found between **barrier islands** and along the flanks of large **estuaries**.
- These environments are transected by a winding network of tidal creeks, which flood the marsh with a mix of salt and fresh water at high tide and move the water back into the estuary at low tide.
- Modern salt marshes began to form around 12,000 years ago at the end of the **Pleistocene** when **glaciers** that covered the earth started to melt and sea levels began to rise.
- As the sea level increased, saltwater moved inland, forming bays and lagoons in between the new mainland and the coastal barrier islands.
- Freshwater rivers that emptied into these bays and lagoons deposited sand and other sediments, forming mud flats and sandbars.
- These sand bars and mudflats were dry enough to allow salt tolerant plants an opportunity to grow. The roots and stems from these plants stabilized the deposited sediment, forming the salt marshes we see today.
- The most common salt tolerant plant found in coastal salt marshes is ***Spartina alterniflora*****,** otherwise known as smooth cordgrass.
- *Spartina alterniflora* is an annual plant whose growth and color reflects the changing of the seasons.
    - In the spring, the *Spartina* begins to grow again, exhibiting a brownish green color due to the combination of new *Spartina* and dead *Spartina* from the previous winter.
    - In the summer, the *Spartina*'s brown-green color transitions into a bright green. It is in this season that the plant reaches its maximum height.
    - In the fall, seed heads form on the upper stalks of the *Spartina* plant, dispersing hundreds of seeds roughly the size of a grain of rice.
    - When winter arrives, the *Spartina* stems turn brown and die, breaking off at the base and accumulating on the marsh surface. Decomposition breaks the dead *Spartina* down into an organic substance called **detritus**.
    - Detritus, along with inorganic material, water, and gas, helps to form **pluff (or plough) mud** – a sticky, brownish-grey mud that can be several feet deep in areas.
- Salt marshes are divided into distinct zones, each with a different elevation and level of salinity that affects which plants and animals can be found there.

- The transition zone between the high marsh and the uplands is called the **upland border**. This area remains dry even at high tide, but plants in this zone must be able to tolerate some saltwater and thrive in coarse, sandy soils with little freshwater.
- After the upland border is the **marsh platform**: the flat, broad area extending from the land to the water, and the primary surface of the salt marsh.
- The marsh platform is divided between the high marsh and the low marsh zones.
    - The high marsh zone is only covered by saltwater for approximately one to two hours a day. Its soil is sandier than the low marsh zone and features a variety of salt tolerant plants in addition to *Spartina*, such as black needlerush, saltgrass, and glasswort.
    - The low marsh zone is covered by saltwater for around half the day. The dominant plant in this zone is *Spartina alterniflora* because it is the only plant that can withstand the flooding and salt content of the low marsh. The area is home to many different types of invertebrates, as well as fiddler crabs and ribbed mussels.
- **Tidal creeks**, which transect salt marshes, are the major water links between the marsh and the open estuaries. These secluded waterways are important nursery areas for many species of fish and invertebrates. Many animals we associate with open water spend their lives as juveniles in the tidal creeks before moving to deeper water as adults.
- **Marsh hammocks** are islands in the middle of the salt marsh and can range from less than acre to several hundred acres in size. These secluded islands are often important nesting and feeding areas for small migrating birds, as well as reptiles and larger mammals. The plant life on these islands varies, with some supporting a wide array of species such as live oaks, wax myrtles, saw palmettos, and more.
- An important component of the salt marsh ecosystem is the oyster reef. To mature from a free-floating plankton to a small oyster, called a spat, young oysters must find and attach themselves to a hard surface. Most often, it is the shells of other oysters that are the best surfaces to attach to. As oysters attach and grow off each other they form expansive reefs, and these reefs are important for maintaining the wellbeing of the salt marsh. As filter feeders, oysters improve the water quality by filtering and removing various particles, bacteria, and sediments. They also protect shorelines from erosion and provide a habitat for crabs, worms, and fish. Because of this, oysters are considered to be a **keystone species**, or a species that shapes an ecosystem and on which a number of other species in the ecosystem rely.
- The daily fluctuation of the tide is an important aspect of salt marshes.
- In the Southeast, salt marsh ecosystems experience **semi-diurnal** tides, meaning they experience two high tides and two low tides each day, with each tide lasting around six hours. The **tidal range**, which is the difference between the low and high tide, varies depending on geographic location and the gravitational pull of the sun and the moon.

    - During new and full moons, the sun and moon are nearly in alignment, "adding" their gravitational pull together, resulting in high tides that are higher and low tides that are lower than normal. These are referred to as **spring tides**.
    - When the moon is at its first quarter and third quarter, the sun, earth, and moon form a right angle, and the gravitational pull of the moon on the earth's oceans cancels the gravitational pull of the sun on earth's oceans, resulting in a high tide that is lower and a low tide that is higher than normal. These tides are called **neap tides**.
- More information on salt marsh ecology available at: http://www.saltmarshguide.org/

Vocabulary

- **Barrier Island** – An island off the coast that protects the mainland.
- **Detritus** – Left over organic matter after decomposition (e.g. small pieces of decomposing marsh grass).
- **Ecosystem** – A system formed by the interaction between and among organisms and the physical environment.
- **Estuary** – The area where a river meets the ocean, resulting in a series of mixing zones from freshwater to full strength seawater.
- **Glacier** – A large, slow moving mass of ice.
- **Keystone Species** – A species that plays a vital role in shaping an ecosystem.
- **Marsh Hammock** – An island in the middle of a salt marsh.
- **Marsh Platform** – The primary surface of the salt marsh; a flat, broad area extending from the mainland land to the water.
- **Neap Tide** – A special tide where the tidal range is at its minimum; occurs during the first and third quarters of the moon cycle.
- **Pleistocene** – The first epoch of the Quaternary Period, which lasted from 2.6 million years ago to 11,700 years ago. This time period includes the most recent ice age.
- **Pluff/Plough Mud** – Very fine muddy sediment in the tidal creek and low marsh zones that one can sink in.
- **Semi-diurnal** – Occurring twice a day.
- ***Spartina alterniflora*** – The scientific name for smooth cordgrass, a salt tolerant plant commonly found in salt marshes.
- **Spring Tide** – A special tide where the tidal range is at its maximum; occurs during the full moon and the new moon.
- **Tidal Creek** – Waterways that cut through the salt marsh, connecting them to the open estuary.
- **Tidal Range** – The vertical difference in height between consecutive high and low tides over a tidal cycle.

- **Upland Border** – Transition zone between the high marsh and uplands where plants must be able to tolerate some salt.
- **Wetland** – Marsh or swamp area that is always or frequently wet.

Lesson

1. Give a brief history of Fort Lamar and the Battle of Secessionville.
2. Show the Fort Lamar documentary films.
3. Discuss with the students the importance of salt marshes at the Battle of Secessionville. Use this history discussion to lead into a discussion of the ecology of salt marshes and their status as unique ecosystems of the Carolina coast.
4. Ask students what comes to mind when they think of salt marshes. Review key terminology.
5. Divide students into small groups. Give each group a set of index cards and arrows for the "Who Am I? Salt Marsh Food Web Activity".
6. On each index card is a description of an organism that is a part of the salt marsh ecosystem. In small groups, students are to organize these index cards into a food web, with arrows pointing in the direction of energy transfer.
7. Once all groups are finished, direct your students' attention to the white board. Using the teacher's set of index cards which have both the organism's description and a picture of the organism, read the descriptions out loud and ask students what they think the organism is and where this organism fits in the food web. Stick the cards on the board and use a marker or a piece of chalk to draw arrows indicating the transfer of energy.
8. Discuss with your students the role of each organism in the ecosystem. Who are the producers, consumers, and decomposers? Ask your students what would happen if certain organisms disappeared from the ecosystem. How would that impact other organisms? What would happen if there were too many of a certain organism? Would this be good or bad for the ecosystem?
9. Finish the lesson by distributing paper, markers, crayons, etc. Using what they have learned, have your students draw a scene from a salt marsh featuring appropriate organisms and physical environment. Have your students label different parts of their picture, including organisms, marsh zones, tides, etc.
10. Optional. To extend the lesson plan for upper level classes, have your students research and write a short paper on a single organism that belongs to the salt marsh ecosystem. Papers should discuss the biology of the organism, its place in the salt marsh ecosystem, and conservation efforts to protect this species and its habitat.

Salt Marsh Food Web Activity: Who Am I?

Instructions

In this activity students will learn about organisms that live in a salt marsh, how these organisms interact with each other, and how energy is transferred through the ecosystem. Using the descriptions below, make several sets of index cards for your students to use, as well as a "teacher set" for yourself. The student sets will only contain a brief description of the organism and a blank space for the students to write what they think the organism is (**Example 1**). Students will then organize the cards into a food web, using arrows to point in the direction energy is transferred. The teacher set will also include a brief description of the organism, in addition to its name and a picture of the organism (**Example 2**). This set will be used at the end of the activity to demonstrate the correct organization of the food web and facilitate class discussion. Additional organisms may be added to the ones provided. Students do not need to write the specific species of each organism. For example: writing "snail" for the marsh periwinkle card is sufficient.

Example 1: Student Card Layout

My ability to survive in salty environments makes me the dominant plant of the low marsh zone. I grow and change color with the seasons, and when I die, I help form an organic material called detritus. What am I?

_____

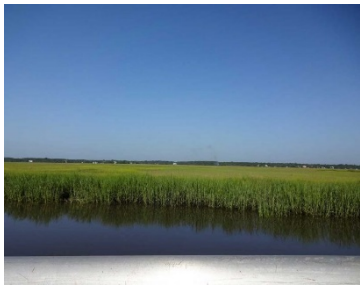
Example 2: Teacher Card Layout (Front)

My ability to survive in salty environments makes me the dominant plant of the low marsh zone. I grow and change color with the seasons, and when I die, I help form an organic material called detritus. What am I?

Smooth cordgrass or *Spartina alterniflora*

Example 3: Teacher Card Layout (Back)

Smooth cordgrass



Descriptions

Description	Organism	Image
My ability to survive in salty environments makes me the dominant plant of the low marsh zone. I grow and change color with the seasons, and when I die, I help form an organic material called detritus.	Smooth cordgrass (*Spartina alterniflora*)	
I live in a long, gray shell alongside dozens of other organisms just like me, forming a reef. We are a keystone species because we filter particles out of the water and create important habitats for a variety of fish and invertebrates.	Eastern Oyster (*Crassostrea virginica*)	
I am a small organism that lives in a pointed shell. I feed on detritus and algae, and I am an important decomposer in the salt marsh ecosystem. My major predator is the blue crab.	Marsh Periwinkle (*Littoraria irrorata)*	

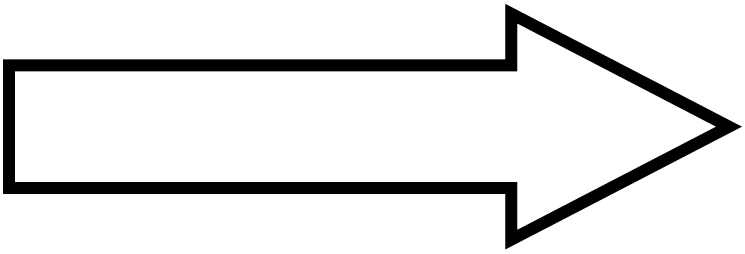
I am nearly transparent and am only around 2 inches in size. I have many legs and two very tiny claws. I like to live in tidal creeks where I can feed on algae and detritus. I am food for a variety of fish that also live in the tidal creeks.	Grass Shrimp *(Palaemonetes vulgaris)*	
I have five pairs of legs and two large claws, and I can walk on land as well as swim. I must periodically shed my exoskeleton in order to grow. I like to eat snails, clams, worms, shrimp, and small fish, but I am consumed by larger fish, mammals, and birds.	Blue Crab *(Callinectes sapidus)*	
I live in the tidal creeks of salt marshes where I feed on worms, small shrimps, and insects. Members of my species like to gather in large groups called schools, and we occasionally travel to deeper waters in the estuary. I am an important food source for birds, crabs, and mammals.	Mummichog *(Fundulus heteroclitus)*	

While I do not normally live in the salt marsh, it is possible to find me there. I have a flat body that is usually gray in color, and a long tail with a venomous spine attached to it. I like to live on the bottoms of creeks and estuaries where I can hunt for shrimp, crab, small fish, oysters, and clams. My major predators are sharks and large fish.	Atlantic Stingray *(Dasyatis sabina)*	
I like to live in warm estuaries and occasionally travel into tidal creeks. Unlike bony fish, my skeleton is made of cartilage, which is the same material your ear lobes are made of. I can grow up to 4 feet in length and I have a dorsal fin that tends to poke out of the water. I like to eat crab, shrimp, and small fish.	Bonnethead Shark *(Sphyrna tiburo)*	

I have a long, cylindrical body with a tail, brown fur, and whiskers. My webbed feet make me an excellent swimmer. I spend most of my time in or around water where I prey on crayfish, crabs, fish, turtles, and aquatic birds.	North American River Otter *(Lontra canadensis)*	
I have four legs and a hard shell I can retract into in case of danger. I am the only species of my kind found in North American estuaries, where I like to eat snails, worms, crabs, and clams. Raccoons and birds are my major predators.	Diamondback Terrapin *(Malaclemys terrapin)*	
I am a large reptile with a broad head and sharp teeth. I like to live in coastal wetlands, and although I prefer freshwater, I occasionally hunt for food in salt marshes. I am an apex predator and I like to eat birds, deer, raccoons, and crab.	American Alligator *(Alligator mississippiensis)*	

I have a band of black fur around my eyes that resembles a mask. I live throughout South Carolina and will travel into salt marshes in search of food. I am an omnivore, and will eat clams, frogs, turtles, and bird eggs, as well as berries and acorns.	Racoon *(Procyon Iotor)*	
I am a microscopic plant organism that exists in both fresh and salt water. I am a producer and I help form the base of the aquatic food chain.	Phytoplankton	
I am one of the largest of my kind on the east coast of the United States. I like to nest in coastal areas away from the high tide and predatory mammals like raccoons. I only eat fish which I scoop up with my long bill and pouch.	Brown Pelican *(Pelecanus occidentalis)*	
I have long legs and large feet which help me traverse the salt marsh. I like to build my nest near the water, but despite living in the salt marsh, I am nocturnal and secretive. I like to eat shrimp, crab, and fish.	Clapper Rail *(Rallus longirostris)*	

Arrow Indicating Transfer of Energy:



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