

Salt Marsh Scientists:

Middle School Curriculum for Grades 6-8



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Hampton Roads Academy
Plant BLOOME Funding Final Report
September 1, 2026

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Curriculum Overview

Program title: Salt Marsh Scientists

Grade levels: 6–8

Target audience: 40–50 students

Setting: Middle school classroom, laboratory, school grounds, and approved Hampton Roads field site

Total duration: 17 class periods of 50 minutes, plus preparation, plant-growth monitoring, and an optional field-trip block

Estimated direct instructional time: 14 hours and 10 minutes

Preparation: Approximately 45 minutes before each module, plus site-specific planning for Module 6

Program Description and Rationale

Salt marshes are highly productive coastal ecosystems that provide habitat, filter pollutants, store carbon, reduce flooding, and protect shorelines from erosion. The Hampton Roads region of Virginia contains extensive tidal wetlands influenced by the Chesapeake Bay, the James River, the Elizabeth River, the York River, the Nansemond River, Back Bay, and the Atlantic Ocean.

In this inquiry-based curriculum, students investigate salt marsh plants, wildlife, ecological relationships, human impacts, and restoration methods. Students use models, experiments, research, GIS mapping, plant propagation, and field-based restoration to connect classroom science with a local environmental challenge.

The program is designed for large classes. Students work in stable teams with rotating roles, use station-based instruction, maintain science notebooks, and contribute evidence to a culminating restoration project.

Connection to Hampton Roads, Virginia Salt Marshes

Students study local marshes as living systems rather than distant examples. Depending on site availability, investigations may reference or visit marshes and restoration sites associated with:

- Chesapeake Bay shorelines
- Elizabeth River tributaries
- Lynnhaven River

- Back Bay National Wildlife Refuge
- False Cape State Park
- First Landing State Park
- Great Dismal Swamp watershed
- James River and York River estuaries
- Nansemond River and surrounding coastal wetlands

Local marshes vary in salinity, elevation, tidal influence, sediment type, plant community, and degree of human disturbance. Students should understand that “salt marsh” is not a single uniform habitat. Conditions can change over short distances and across seasons.

Overall Goals and Learning Outcomes

By the end of the program, students will be able to:

1. Describe how salt marsh plants and animals are adapted to tidal, saline, waterlogged, and changing environments.
2. Compare plant root systems and explain how specialized structures support survival and growth.
3. Design and conduct controlled investigations of erosion and plant growth.
4. Analyze data and construct evidence-based scientific explanations.
5. Model food webs, energy flow, predator-prey relationships, and species interdependence.
6. Use GIS tools to investigate relationships between human activity and marsh ecosystems.
7. Explain how environmental conditions and genetic variation influence organism growth and survival.
8. Demonstrate basic plant-propagation techniques.
9. Participate responsibly in a restoration activity.
10. Communicate recommendations for protecting Hampton Roads salt marshes.

Recommended Program Schedule

Module	Less ons	Class Time	Suggested Placement
Module 1: Welcome to the Salt Marsh	3	150 minutes	Weeks 1–2

Module	Less ons	Class Time	Suggested Placement
Module 2: Erosion Control Experiments	3	150 minutes	Weeks 2–3
Module 3: Salt Marsh Wildlife	3	150 minutes	Weeks 3–4
Module 4: Threats to Salt Marshes	3	150 minutes	Weeks 5–6
Module 5: Propagating Salt Marsh Grasses	3	150 minutes	Weeks 6–8
Module 6: Restoration Project	2	100 minutes, plus monitoring	Weeks 8–9

Plant observations should continue between Modules 1, 2, 5, and 6.

Standards Alignment

Next Generation Science Standards

MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Students address this standard by examining specialized salt marsh plant structures, connecting plant structure to survival and reproduction, studying animal behaviors, and using evidence from observations and investigations.

MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Students address this standard through plant-growth experiments, erosion investigations, propagation activities, environmental comparisons, and analysis of how salinity, water availability, sediment, light, temperature, and variation among plants influence growth.

Virginia Science Standards

VA.SCI.2018.LS.5: The student will investigate and understand that biotic and abiotic factors affect an ecosystem.

VA.SCI.2018.LS.5.B: Energy flow is represented by food webs and energy pyramids.

VA.SCI.2018.LS.5.C: Relationships exist among producers, consumers, and decomposers.

VA.SCI.2018.LS.6: The student will investigate and understand that populations in a biological community interact and are interdependent.

VA.SCI.2018.LS.6.A: Relationships exist between predators and prey, and these relationships are modeled in food webs.

VA.SCI.2018.LS.7: The student will investigate and understand that adaptations support an organism's survival in an ecosystem.

VA.SCI.2018.LS.7.A: Biotic and abiotic factors define land, marine, and freshwater ecosystems.

VA.SCI.2018.LS.7.B: Physical and behavioral characteristics enable organisms to survive within a specific ecosystem.

VA.SCI.2018.LS.8: The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time.

VA.SCI.2018.LS.8.C: Large-scale changes such as eutrophication, climate change, and catastrophic disturbances affect ecosystems.

VA.SCI.2018.LS.9: The student will investigate and understand that relationships exist between ecosystem dynamics and human activity.

VA.SCI.2018.LS.9.A: Changes in habitat can disturb populations.

VA.SCI.2018.LS.9.B: Disruptions in ecosystems can change species competition.

VA.SCI.2018.LS.9.C: Variations in biotic and abiotic factors can change ecosystems.

VA.SCI.2018.G6.9: The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment.

VA.SCI.2018.LS.11.C: Populations of organisms can change over time; environmental factors and genetic variation influence survivability and diversity of organisms.

Note: Teachers should verify current Virginia Department of Education wording, identifiers, and local pacing requirements before formal curriculum adoption.

Materials and Resources

General Materials

- Student science notebooks or digital portfolios
- Pencils, colored pencils, markers, rulers, and clipboards
- Chart paper, poster paper, index cards, and sticky notes
- Student folders or portfolio binders
- Measuring tapes and metric rulers
- Digital or classroom scales

- Plastic trays and tubs
- Hand lenses
- Disposable gloves
- Paper towels and cleaning supplies
- Timers
- Labels and waterproof markers
- Reusable containers
- Student role cards
- Printed maps and local aerial imagery
- Field guides and locally appropriate species references

Technology Requirements

- Projector or interactive display
- Student devices, ideally one per pair
- Reliable internet access
- Spreadsheet software
- Camera or tablet for documenting plants and fieldwork
- GIS mapping access for Module 4
- Shared digital folder or learning-management system
- Optional handheld GPS units
- Optional salinity, temperature, pH, dissolved oxygen, or turbidity probes

Living Materials and Growing Supplies

- Locally appropriate salt marsh grass seeds, plugs, or cuttings obtained through an approved partner
- Native grass seed or comparison grass
- Potting medium or clean soil
- Sand and gravel
- Planting trays or recycled containers with drainage
- Labels
- Spray bottles or measured watering containers
- Grow lights or a sunny growing area
- Catch trays

- Freshwater and, only when directed by a restoration partner, prepared brackish water
- Rulers for measuring shoots
- Optional conductivity meter or prepared salinity solutions

Do not collect or transport plants, animals, soil, or sediment from a marsh without permission from the land manager and applicable agencies. Avoid introducing non-native species.

Safety Considerations

- Review field-trip permissions, emergency contacts, medical information, and school procedures.
- Use gloves when handling soil, sediment, plants, and outdoor materials.
- Wash hands after all investigations and before eating.
- Do not taste or intentionally touch water, soil, or plants.
- Use eye protection during erosion experiments.
- Keep water away from electrical equipment.
- Secure containers to prevent spills and slipping hazards.
- Do not allow students to enter deep water, unstable banks, mudflats, channels, or areas with sharp debris.
- Check tides, weather, heat index, storm conditions, and site advisories before fieldwork.
- Require closed-toe shoes, sun protection, drinking water, and appropriate clothing.
- Teach students to avoid wildlife and never handle animals.
- Watch for oysters, broken shells, glass, fishing hooks, poison ivy, biting insects, and slippery surfaces.
- Follow all school, site, transportation, and partner safety requirements.
- Obtain approval before planting at any site. Restoration must be supervised by qualified personnel.

Optional Supplementary Resources

- Local university extension offices
- Chesapeake Bay education resources
- Local watershed organizations
- Virginia Department of Conservation and Recreation materials
- Virginia Institute of Marine Science education resources
- National Oceanic and Atmospheric Administration coastal-wetland resources
- National Estuarine Research Reserve materials

- Local parks and wildlife refuge education programs
- Historical maps, photographs, and oral histories from local communities

Assessment Overview

Formative Assessment Strategies

Use frequent, low-stakes checks:

- Entry questions and exit tickets
- Science notebook observations
- “Notice and wonder” image analysis
- Vocabulary sketches
- Think-pair-share responses
- Claim-evidence-reasoning paragraphs
- Prediction revisions
- Group whiteboards
- Data-table checks
- Teacher conferencing
- Model explanations
- Peer feedback protocols
- One-minute oral explanations
- Digital polls or response forms

Summative Assessment Opportunities

- Module investigation reports
- Organism profile card and food-web explanation
- GIS impact-analysis product
- Propagation-growth portfolio
- Restoration project performance assessment
- Final public-service presentation or community action plan

Performance-Based Assessments

Students demonstrate learning by:

1. Designing and conducting an erosion investigation.
2. Constructing and explaining a salt marsh food web.
3. Interpreting GIS evidence about human impacts.
4. Propagating and monitoring marsh grasses.
5. Participating in a restoration activity.
6. Defending a conservation recommendation with evidence.

Student Portfolio Suggestions

Each portfolio should include:

- Initial salt marsh concept map
- Vocabulary organizer
- Grass-adaptation observation sheet
- Root-system comparison
- Plant-growth data tables and graphs
- Erosion experimental design
- Erosion claim-evidence-reasoning response
- Organism profile card
- Food-web photograph or diagram
- GIS map or screenshot with written interpretation
- Conservation action plan
- Propagation log
- Restoration reflection
- Final “How my thinking changed” response

Grading Considerations for 40–50 Students

Use common rubrics, team roles, and short checkpoints rather than grading every worksheet.
Suggested weighting:

Category	Suggested Weight
Science notebooks and formative work	20%
Investigations and data analysis	25%
Food web and organism research	15%
GIS analysis and action plan	15%
Propagation and restoration performance	15%

Category	Suggested Weight
Reflection and communication	10%

Grade individual accountability within team projects using role logs, individual reflections, peer ratings, and brief conferences.

Recommended Team Structure

Create 8–10 teams of 5 students. Assign rotating roles:

- Facilitator
- Materials manager
- Recorder
- Data analyst
- Reporter or safety monitor

For fieldwork, add a buddy system and adult chaperone group assignments.

Module 1: Welcome to the Salt Marsh

Duration: 3 lessons, 50 minutes each

Preparation time: Approximately 45 minutes

Module Overview

Students explore salt marsh grasses through images, video, observations, and hands-on activities. They learn how specialized structures and physiological processes help plants survive tides, salinity, flooding, low-oxygen soils, and changing conditions. Students compare root systems and begin a long-term classroom growing investigation.

Standards Addressed

- MS-LS1-4
- VA.SCI.2018.LS.7
- VA.SCI.2018.LS.7.A
- VA.SCI.2018.LS.7.B

Learning Objectives

Students will:

- Identify common salt marsh grasses found in Hampton Roads.
- Explain structural and physiological adaptations that support survival.
- Compare fibrous, branching, and deeper root systems.
- Describe the historical and ecological significance of local marshes.
- Begin a controlled classroom grass-growing investigation.
- Develop an evidence-based explanation connecting plant structures to survival and reproduction.

Vocabulary

Term	Student-Friendly Definition
Salt marsh	A wetland regularly flooded by tides and influenced by salty or brackish water
Estuary	A place where freshwater and saltwater mix
Tidal	Related to the regular rise and fall of ocean water
Salinity	The amount of dissolved salt in water

Term	Student-Friendly Definition
Adaptation	A characteristic that helps an organism survive and reproduce
Rhizome	A horizontal underground stem that can produce roots and shoots
Root system	All of a plant's roots and their connected structures
Aerenchyma	Plant tissue with air spaces that helps move oxygen through waterlogged tissues
Spartina	A group of grasses commonly associated with salt marshes
Abiotic factor	A nonliving environmental factor, such as light, water, temperature, or salinity

Materials Needed

Lesson 1

- Local salt marsh photographs
- Short, age-appropriate salt marsh video
- Hampton Roads map
- Projector
- Student notebooks
- Sticky notes
- Chart paper
- Local historical photographs or maps
- Observation guide

Lesson 2

- Fresh and salt-tolerant plant images or specimens
- Hand lenses
- Prepared root-system photographs or safe plant samples
- Salt, freshwater, cups, and labels for a teacher demonstration
- Adaptation cards
- Whiteboards or paper
- Exit tickets

Lesson 3

- Clear cups or planting containers
- Drainage trays

- Potting soil
- Sand
- Gravel
- Seeds or approved grass plugs
- Labels
- Rulers
- Watering containers
- Gloves
- Student planting protocol
- Growth-data sheet
- Optional grow lights

Preparation

1. Establish 8–10 teams of 5 students.
2. Prepare a Hampton Roads map showing rivers, shorelines, and nearby marsh locations.
3. Select accessible, captioned visuals.
4. Prepare historical photographs or maps showing changes in local shorelines and wetlands.
5. Set up observation stations with images, root samples, or models.
6. Prepare planting containers and label team locations.
7. Establish a consistent light, watering, and measurement routine.
8. Review plant sources with a local restoration partner.
9. Create a class chart titled “What Plants Need to Survive.”
10. Prepare safety reminders for water, soil, and handwashing.

Lesson 1: Introduction to Salt Marshes

Engagement/Hook — 10 minutes

Display two contrasting images: a developed shoreline and a healthy salt marsh. Ask students to silently record:

- What do you notice?
- What do you wonder?
- What living and nonliving features do you see?

Students place responses on a class chart.

Direct Instruction — 15 minutes

Introduce:

- The meaning of salt marsh
- Tidal flooding
- Estuaries
- Hampton Roads geography
- Major ecosystem services
- Local history and changing human relationships with marshes

Emphasize that marshes have sometimes been drained, filled, diked, or developed, while current restoration efforts recognize their value for wildlife, water quality, flood reduction, and shoreline protection.

Guided Practice — 15 minutes

Teams rotate through four stations:

1. **Map station:** Locate local rivers, bays, and marshes.
2. **Visual station:** Identify living and nonliving features.
3. **History station:** Compare historical and present-day images.
4. **Ecosystem-services station:** Match marsh benefits with evidence.

Teams record one observation and one question at each station.

Independent Practice and Closure — 10 minutes

Students complete a quick-write:

Why might a community want to protect a salt marsh?

Collect responses as a baseline assessment.

Teacher Notes

Avoid presenting marshes as “empty” or “unused” land. Highlight that coastal wetlands have ecological, cultural, economic, and community importance.

Differentiation

- Provide labeled maps and visual word banks.
- Allow oral or recorded responses.
- Offer challenge prompts about tradeoffs between development and conservation.
- Pair multilingual learners with supportive peers.
- Use mixed-readiness teams with assigned roles.

Lesson 2: Salt Marsh Grass Adaptations

Engagement — 5 minutes

Show a healthy grass clump and ask:

How can a plant survive when its roots are flooded and surrounded by salty water?

Students make an initial claim.

Mini-Lesson — 12 minutes

Teach adaptations such as:

- Salt exclusion at roots
- Salt excretion through specialized leaf structures in some species
- Thick or narrow leaves that reduce water loss
- Flexible stems that bend with wind and water
- Extensive roots and rhizomes that stabilize sediment
- Air spaces that help move oxygen through waterlogged tissues
- Clonal growth that allows plants to spread
- Flowering and seed production timed to environmental conditions

Clarify that an adaptation is a heritable characteristic that improves survival or reproduction over generations; a temporary response is not automatically an adaptation.

Adaptation Card Sort — 18 minutes

Teams match plant structures or traits to environmental challenges:

- Saltwater exposure
- Low-oxygen sediment

- Tidal currents
- Waves and wind
- Changing water levels
- Soft sediment
- Competition for light

Teams explain two matches using the sentence frame:

“The structure helps the plant because...”

Evidence Discussion — 10 minutes

Students examine photographs or prepared specimens and identify observable evidence. They distinguish direct observations from inferences.

Closure — 5 minutes

Students revise their opening claim and cite one observation.

Lesson 3: Root Systems and Growing Grasses

Engagement — 5 minutes

Display images of a fibrous root system, a taproot system, and a rhizome-connected grass system. Students predict which would best hold loose sediment.

Investigation — 15 minutes

Students examine root-system models or safe plant samples. They sketch and label:

- Main roots
- Branching roots
- Fine roots
- Rhizomes, if present
- Aboveground shoots

Discuss how root architecture affects water uptake, anchoring, nutrient access, and sediment stability.

Planting Activity — 25 minutes

Each team plants at least two labeled containers using a common protocol.

Suggested variables:

- Grass type
- Growing medium
- Watering condition
- Light condition

Keep at least one factor consistent across comparison groups. Students record:

- Date planted
- Plant type
- Medium
- Number of seeds or plugs
- Starting height, if applicable
- Watering amount
- Light location
- Prediction

Closure — 5 minutes

Students submit a prediction:

Which plant will grow best, and what evidence would support that conclusion?

Management Tips

- Proportion materials in bins.
- Use one supply manager per team.
- Assign planting stations to reduce crowding.
- Place trays on waterproof surfaces.
- Keep a class watering calendar.
- Photograph plants weekly from the same angle.

Formative Assessment Strategies

- Observation and wonder chart
- Map-labeling check
- Adaptation card-sort explanations
- Root-system sketches
- Prediction statements
- Teacher questioning
- Notebook checks
- Exit ticket: “One structure, one environmental challenge, and one explanation”

Differentiation

Struggling Learners

- Provide partially completed diagrams.
- Use picture-based vocabulary cards.
- Model one example before team work.
- Offer sentence frames and word banks.
- Reduce the number of required adaptations while maintaining conceptual rigor.

Advanced Learners

- Compare salt marsh grasses with mangroves or freshwater wetland plants.
- Investigate clonal growth and rhizomes.
- Design a follow-up test involving salinity, light, or water level.
- Research how marsh elevation affects plant distribution.

English Language Learners

- Preview vocabulary with visuals and gestures.
- Use bilingual glossaries when available.
- Provide structured partner talk.
- Accept labeled drawings and oral explanations.
- Avoid idioms during direct instruction.

Accommodations for Large Classes

- Use 8–10 identical stations.
- Display procedures visually.
- Assign timed rotations.
- Use team captains for material pickup.
- Post a “finished early” task at each station.
- Have one teacher or adult supervise planting and water management.

Extension Activities

- Compare a marsh grass with a lawn grass.
- Create a local marsh field guide.
- Analyze historical shoreline maps.
- Build a root-system model with straws or pipe cleaners.
- Maintain a time-lapse photo record of plant growth.

Connections to Next Module

Students’ root-system observations and plant-growth predictions become evidence for Module 2. They will test whether vegetation and growing medium influence erosion control.

Name _____ Date _____

Salt Marsh Investigation Lab:

Introduction to Salt Marshes Module 1 Lesson 1

Background and Observation Activity

A salt marsh is a coastal wetland that is regularly flooded by salty water from tides. Salt marshes often grow near estuaries, where river water mixes with ocean water. In Hampton Roads, rivers such as the James, York, and Elizabeth flow toward bays and the Chesapeake Bay. Marshes include living, or biotic, features such as marsh grasses, birds, fish, crabs, and bacteria. They also include nonliving, or abiotic, features such as salty water, mud, sunlight, rocks, and tides. Tidal flooding brings water into the marsh and later carries water away. Salt marshes provide ecosystem services, which are benefits people receive from nature. Marsh plants can filter some pollution from water, provide habitat for wildlife, reduce flooding, and help protect shorelines from waves. In the past, some marshes were drained, filled, diked, or developed for human uses. Today, many communities restore and protect marshes because of their important benefits. Observation task: Compare a developed shoreline image with a healthy salt marsh image. Record notices and wonders, then identify living and nonliving features.

Lab Notes: Fill in the Blank

Word Bank: estuary, tidal flooding, ecosystem services, biotic, restoration

1. Living features, such as birds and marsh grass, are called _____.
2. A place where river water mixes with ocean water is an _____.
3. Regular movement of salty water into and out of a marsh is called _____.
4. Flood reduction, wildlife habitat, and cleaner water are _____.
5. Repairing or improving a damaged marsh is called _____.

Station Investigation Questions

Complete the four stations with your team. At every station, record one observation and one question in your lab notebook. Then choose the best answer for each question below.

1. Map Station: Which group of waterways is associated with the Hampton Roads region?
 - A. James River, York River, and Elizabeth River
 - B. Colorado River, Great Salt Lake, and Pacific Ocean
 - C. Mississippi River, Lake Superior, and Gulf of Mexico
 - D. Amazon River, Atlantic Ocean, and Chesapeake Bay
2. Visual Station: Which feature is abiotic in a salt marsh?
 - A. A heron
 - B. Marsh grass
 - C. Mud
 - D. A crab
3. History Station: Which action could reduce the area of a salt marsh?
 - A. Restoring native marsh plants
 - B. Filling land for development
 - C. Protecting wildlife habitat
 - D. Reducing pollution entering water
4. Ecosystem-Services Station: Which evidence best supports the claim that marshes reduce flooding?
 - A. Marsh plants slow moving water during storms.
 - B. Marshes contain many types of birds.
 - C. Marsh mud is often dark and wet.
 - D. Tides move water into and out of marshes.
5. Why is a healthy salt marsh different from a developed shoreline?
 - A. A salt marsh has no nonliving features.
 - B. A salt marsh can provide habitat and shoreline protection.
 - C. A developed shoreline always contains more wildlife.
 - D. A developed shoreline cannot be near water.

Lab Reflection and Quick-Write

Answer in complete sentences. Use evidence from the background information, images, or station activities.

1. Compare the developed shoreline and the healthy salt marsh. Describe one notice and one wonder. Include at least one living or nonliving feature.

2. Choose one station. State one observation from that station and one question your team could investigate next.

3. Quick-Write: Why might a Hampton Roads community want to protect or restore a salt marsh? Use at least two ecosystem services in your response.

Answer Key

Fill in the Blank

1. biotic
2. estuary
3. tidal flooding
4. ecosystem services
5. restoration

Multiple Choice

1. A
2. C
3. B
4. A
5. B

Open-Ended Example Responses

1. Example response: I notice that the healthy salt marsh has marsh grass and open, wet areas, while the developed shoreline has more buildings or hard surfaces. I wonder how the hard surfaces change where wildlife can live. Marsh grass is biotic, and salty water is abiotic.
2. Example response: At the map station, I observed that the James, York, and Elizabeth Rivers connect with bays near Hampton Roads and the Chesapeake Bay. My question is: How does water from these rivers affect nearby salt marshes?
3. Example response: A Hampton Roads community might protect a salt marsh because it provides habitat for wildlife and helps reduce flooding. Marsh plants can also help filter pollution from water and protect shorelines from waves.

Name _____ Date _____

Salt Marsh Grass Adaptions:

Introduction to Salt Marshes Module 1 Lesson 2

Background Information

Salt marsh grasses live in places where salty water floods the soil regularly. These plants face difficult conditions, including saltwater exposure, low-oxygen sediment, strong winds, waves, and changing water levels. An adaptation is a heritable characteristic that improves an organism's survival or reproduction over many generations.

Salt marsh grasses have several adaptations that help them survive. Some roots exclude salt before it enters the plant. Some species release extra salt through specialized structures on their leaves. Thick or narrow leaves can reduce water loss. Flexible stems bend with wind and moving water instead of breaking.

Many marsh grasses also have extensive roots and rhizomes. Rhizomes are underground stems that can grow new plants. Roots and rhizomes hold soft sediment in place and help the plant spread through clonal growth. Air spaces inside plant tissues move oxygen to roots growing in waterlogged, low-oxygen soil. Flowering and seed production may occur when environmental conditions support successful growth.

During this lab, you will examine images or specimens and identify evidence of salt marsh grass adaptations. Remember: an **observation** is something you directly notice, while an **inference** is an explanation based on observations.

Initial Claim

How can a salt marsh grass survive when its roots are flooded and surrounded by salty water?

My initial claim:

Adaptation Card Sort

Match each plant structure or trait with the environmental challenge it helps address.

Plant Structure or Trait	Environmental Challenge	The Structure Helps the Plant Because...
Salt exclusion at roots		
Air spaces in tissues		
Flexible stems		
Extensive roots and rhizomes		
Thick or narrow leaves		

Challenge Choices: saltwater exposure; low-oxygen sediment; tidal currents, waves, and wind; soft sediment; water loss

Evidence Notes

Record direct observations from photographs or prepared specimens. Then write an inference about a possible adaptation.

Observable Feature	Direct Observation	Inference: How Might This Help the Grass?
Leaves		
Stems		
Roots or rhizomes		

Fill in the Blank

Fill in the blank with the correct words.

1. A heritable characteristic that improves survival over generations is an _____.
2. Underground stems that can grow new plants are called _____.
3. Spaces inside plant tissues can move _____ to waterlogged roots.
4. Roots and rhizomes can help stabilize soft _____.
5. A statement based on evidence and reasoning is an _____.

Word Bank: inference, oxygen, sediment, adaptation, rhizomes

Multiple Choice Questions

Choose the correct answer from the choices for each question.

1. Which adaptation most directly helps a salt marsh grass survive salty water?
 - A. Salt exclusion at roots
 - B. Brightly colored flowers
 - C. Large woody trunks
 - D. Deep shade under leaves
2. Why are air spaces inside salt marsh grass tissues useful?
 - A. They make leaves absorb more salt.
 - B. They move oxygen to roots in low-oxygen soil.
 - C. They prevent all tidal flooding.
 - D. They turn roots into seeds.
3. Which environmental challenge is best matched with flexible stems?
 - A. Competition for light
 - B. Saltwater exposure
 - C. Waves, wind, and tidal currents
 - D. Low-oxygen sediment
4. Which statement is a direct observation rather than an inference?
 - A. The grass has narrow leaves.
 - B. The narrow leaves reduce water loss.
 - C. The roots probably exclude salt.
 - D. The plant is adapted to survive flooding.
5. Why can rhizomes be helpful to salt marsh grasses?
 - A. They allow the plant to spread and stabilize sediment.
 - B. They remove all salt from the water.
 - C. They stop tides from reaching the marsh.
 - D. They change saltwater into freshwater.

Open-Ended Questions

Answer the following questions in complete sentences.

1. Choose one salt marsh grass adaptation. Explain the environmental challenge it addresses and how it helps the plant survive.

2. Write one direct observation you could make from a salt marsh grass specimen. Then write one inference based on that observation.

3. Revise your initial claim. How can salt marsh grass survive flooded, salty conditions? Cite at least one observation as evidence.

Answer Key

Fill in the Blank

1. adaptation
2. rhizomes
3. oxygen
4. sediment
5. inference

Multiple Choice Questions

1. A
2. B
3. C
4. A
5. A

Open-Ended Example Responses

1. Flexible stems help salt marsh grass survive waves, wind, and tidal currents. The stems bend with moving water instead of breaking easily.
2. Direct observation: The grass has narrow leaves. Inference: The narrow leaves may reduce water loss in salty conditions.
3. Salt marsh grass can survive flooded, salty conditions because it has adaptations such as salt exclusion at its roots and air spaces in its tissues. For example, I observed narrow leaves, which may help the plant reduce water loss.

Review this closely for accuracy, especially in math, as AI may have limitations.

Name _____ Date _____

Root Systems and Growing Grasses:

Introduction to Salt Marshes Module 1 Lesson 3

Reading Passage

Plants depend on root systems for water, nutrients, and support. A fibrous root system has many thin roots that spread outward through the soil. This wide network can hold loose sediment because many roots grip particles near the surface. A taproot system has one large main root that grows deep, with smaller branching roots. Taproots can anchor a plant deeply and reach water below the surface. Some grasses also spread through rhizomes, which are horizontal stems that grow underground. Rhizomes connect shoots and can produce new roots and plants. A rhizome-connected grass system may stabilize a large area because its roots and underground stems form an interconnected network. Fine roots absorb much of a plant's water and nutrients. Root architecture, or the arrangement of roots, affects how well a plant takes in resources, stays anchored, and protects soil from moving. During a planting investigation, compare two labeled containers. Choose one variable, such as grass type, growing medium, watering condition, or light condition. Keep at least one other factor the same so your comparison is fair. Record your materials, conditions, and prediction. Growth evidence may include plant height, number of shoots, leaf color, and survival over time.

Fill in the Blank

Word Bank: anchoring, fibrous, fine roots, rhizomes, taproot

1. A root system with many thin roots spreading through the soil is called _____.
2. One large main root that grows deep is a _____.
3. Underground horizontal stems that connect grass shoots are _____.
4. Most water and nutrient absorption happens through _____.
5. A deep root can improve a plant's _____.

Multiple Choice Questions

Choose the correct answer from the choices for each question.

1. Which root system is described as having many thin roots that spread outward near the soil surface?
 - a. Fibrous root system
 - b. Taproot system
 - c. Rhizome only
 - d. Aboveground shoot
2. Why can a fibrous root system help hold loose sediment?
 - a. Its wide network grips many soil particles.
 - b. It has no fine roots.
 - c. It grows only aboveground.
 - d. It prevents all water from entering soil.
3. What is the main function of fine roots?
 - a. Producing flowers
 - b. Absorbing water and nutrients
 - c. Making light for the plant
 - d. Moving sediment across the ground
4. Which structure helps some grasses spread and form connected underground networks?
 - a. Leaves
 - b. Rhizomes
 - c. Petals
 - d. Seeds
5. A team compares grass types in two containers. Which action makes the comparison fair?
 - a. Change grass type and watering amount at the same time.
 - b. Use different light locations without recording them.
 - c. Keep the medium and watering amount the same.
 - d. Label only one container.

Open-Ended Questions

Answer the following questions in complete sentences. Use the reading passage and your investigation observations.

1. Predict which root system—fibrous, taproot, or rhizome-connected grass—would best hold loose sediment. Explain your reasoning using root architecture.

2. Examine a root-system model or safe plant sample. Describe the labels you would add to a sketch, including main roots, branching roots, fine roots, rhizomes when present, and aboveground shoots. Explain how two labeled structures help the plant.

3. Plan your team planting investigation. State the variable you will test, one factor you will keep consistent, and the information you will record. Then predict which plant will grow best and name evidence that would support your conclusion.

Answer Key

Fill in the Blank Answers

1. fibrous
2. taproot
3. rhizomes
4. fine roots
5. anchoring

Multiple Choice Answers

1. A. Fibrous root system
2. A. Its wide network grips many soil particles.
3. B. Absorbing water and nutrients
4. B. Rhizomes
5. C. Keep the medium and watering amount the same.

Open-Ended Example Responses

1. A rhizome-connected grass system may best hold loose sediment because underground stems, roots, and shoots create an interconnected network across a large area. A fibrous root system is also a strong prediction because its many thin roots grip soil near the surface.
2. My sketch would label the main root, branching roots, fine roots, rhizomes if present, and aboveground shoots. Fine roots absorb water and nutrients. Branching roots and the main root help anchor the plant. Rhizomes can connect shoots and help grasses spread.
3. Our team will test grass type. We will keep the growing medium, watering amount, light location, and planting date the same. We will record the date planted, plant type, medium, number of seeds or plugs, starting height when applicable, watering amount, light location, and prediction. I predict the grass with the stronger root network will grow best. Evidence could include greater height, more shoots, greener leaves, and better survival.

Module 2: Erosion Control Experiments

Duration: 3 lessons, 50 minutes each

Preparation time: Approximately 45 minutes

Module Overview

Students investigate how vegetation and sediment type affect erosion. Teams design model marshes using soil, sand, or gravel and compare how well planted and unplanted systems withstand simulated rainfall, runoff, waves, or flooding.

Standards Addressed

- MS-LS1-4
- MS-LS1-5
- VA.SCI.2018.LS.7
- VA.SCI.2018.LS.9
- VA.SCI.2018.G6.9

Learning Objectives

Students will:

- Design a controlled erosion experiment.
- Identify independent, dependent, and controlled variables.
- Explain how roots and stems can reduce erosion.
- Analyze erosion data.
- Explain how marshes can reduce flooding and protect shorelines.
- Use evidence to support a scientific claim.

Vocabulary

Term	Student-Friendly Definition
Erosion	The movement of soil or sediment by water, wind, or ice
Sediment	Small pieces of rock, soil, or organic material
Runoff	Water that flows over land
Deposition	The dropping or settling of moved sediment
Flooding	Water covering land that is usually dry

Term	Student-Friendly Definition
Shoreline	The boundary between land and a body of water
Variable	A factor that can change in an investigation
Control	A comparison condition used to understand the effect of a variable
Evidence	Information collected through observation or measurement
Resilience	The ability to withstand or recover from disturbance

Materials Needed

For 8–10 teams:

- Large shallow trays or bins
- Soil, sand, and gravel
- Grass plugs or established class-grown plants
- Unplanted comparison materials
- Watering cans with similar openings
- Cups or graduated containers
- Catch basins
- Coffee filters or mesh screens
- Digital scales, if available
- Metric rulers
- Stopwatch
- Eye protection
- Gloves
- Towels
- Data sheets
- Graph paper or spreadsheet software
- Optional fan for wind comparison
- Optional blocks for creating a controlled slope

Preparation

1. Decide which variables teams will compare.
2. Prepare equal quantities of soil, sand, and gravel.
3. Create a test tray setup with a consistent slope.
4. Establish a safe water-delivery method.

5. Label control and experimental trays.
6. Test the setup before class to prevent leaks.
7. Prepare a sample data table.
8. Review fair-test expectations.
9. Assign team roles.
10. Place cleanup materials near the experiment area.

Lesson 1: Understanding Erosion and Experimental Design

Engagement — 8 minutes

Show images of an eroding shoreline, a planted marsh edge, and a hardened seawall. Ask:

What forces could move sediment from one place to another?

Direct Instruction — 12 minutes

Explain:

- Erosion and deposition
- Runoff and waves
- The role of roots in anchoring sediment
- The role of stems in slowing water
- The difference between a model and a real marsh
- Independent, dependent, and controlled variables
- The importance of repeated trials

Model Demonstration — 10 minutes

Use two identical trays, one planted and one unplanted. Apply equal amounts of water. Invite students to identify what should be measured.

Team Design Challenge — 15 minutes

Each team develops a testable question, such as:

How does vegetation affect the amount of sediment moved from a sloped tray?

Teams identify:

- Independent variable
- Dependent variable
- Control condition
- Constants
- Number of trials
- Measurement method
- Prediction

Closure — 5 minutes

Teams submit a one-page experimental plan for approval.

Lesson 2: Conducting Erosion Experiments

Setup and Safety Briefing — 8 minutes

Review:

- Eye protection
- No running water
- Careful lifting
- Spill response
- Equal water amounts
- Accurate measurement
- Keeping hands clear of moving water and equipment

Investigation — 30 minutes

Teams construct model plots and conduct trials. Possible procedure:

1. Add equal depths of sediment to the tray.
2. Create the same slope for every trial.
3. Add plants to designated plots.
4. Apply a measured amount of water for a fixed time.
5. Collect runoff and sediment.
6. Measure sediment movement by mass, volume, depth, or visual scoring.
7. Repeat the trial.
8. Record observations and unexpected events.

Cleanup — 7 minutes

Teams return materials, wipe surfaces, and check that all data are recorded.

Closure — 5 minutes

Students write one observation and one question raised by the data.

Lesson 3: Data Analysis and Conclusions

Data Organization — 10 minutes

Teams check units, calculate averages if appropriate, and identify anomalous trials. Do not delete unexpected data; explain it.

Graphing — 15 minutes

Students create a graph showing erosion under different conditions. Select a graph type appropriate to the data.

Claim-Evidence-Reasoning — 15 minutes

Students respond:

- **Claim:** Which condition reduced erosion most effectively?
- **Evidence:** What measurements support the claim?
- **Reasoning:** How do roots, stems, or sediment properties explain the result?

Peer Review — 5 minutes

Pairs exchange reports and use a checklist:

- Is the claim clear?
- Is evidence numerical or observational?
- Does reasoning connect evidence to plant structure?
- Are limitations acknowledged?

Closure — 5 minutes

Students explain one way marsh restoration may benefit nearby communities.

Formative Assessment Strategies

- Experimental-plan conference
- Variable-identification check
- Safety observation
- Data-table review
- Graphing checkpoint
- CER paragraph
- Oral defense of the experimental design

Differentiation

Diverse Learners

- Provide an experimental-design template.
- Offer preselected variables for students needing more structure.
- Permit data collection through photographs or qualitative scales when scales are unavailable.
- Use tactile materials and physical demonstrations.
- Provide extension calculations for students ready for deeper analysis.

Large-Class Management

- Run two investigation rounds if space is limited.
- Set up materials in labeled bins.
- Use a materials manager and safety monitor.
- Require teams to obtain teacher approval before adding water.
- Assign cleanup jobs before beginning.
- Display a projected timer.

Extension Activities

- Test different slopes.
- Compare freshwater and simulated brackish conditions.
- Model wave action using a fan or repeated water pulses.
- Investigate how marsh width influences flood reduction.
- Compare planted plots with rock or artificial shoreline protection.

- Research living shoreline designs.

Connections to Next Module

Students have studied plant structures and physical processes. Module 3 expands the system to animals and asks how plants, prey, predators, and decomposers depend on one another.

Understanding Erosion and Experimental Design Lab: Erosion Control Module 2 Lesson 1

Reading Passage

Erosion is the movement of sediment, such as soil, sand, or small rocks, from one location to another. Water, waves, wind, and gravity can cause erosion. Deposition happens when moving sediment slows down and settles in a new place. Along shorelines, runoff and waves can carry sediment away from the land.

Plants can reduce erosion in some environments. Roots anchor sediment by holding soil particles together below the surface. Stems can slow moving water, giving sediment more time to settle instead of being carried away. A planted marsh edge may reduce sediment movement differently than an unplanted shoreline or hardened seawall.

Scientists often use models to study natural systems safely and fairly. A tray of soil can model part of a marsh, but it is not exactly like a real marsh. Real marshes have changing tides, weather, animals, and larger areas of land. Models help scientists test one question at a time.

A fair experiment includes an independent variable, a dependent variable, and controlled variables. The independent variable is the factor changed on purpose. The dependent variable is the result measured. Controlled variables, also called constants, are factors kept the same. Repeated trials improve confidence because they show whether results are consistent.

Fill in the Blank

Fill in each blank with the correct word from the word bank.

1. The movement of sediment from one place to another is called _____.
2. When sediment settles in a new location, the process is called _____.
3. In an experiment, the factor changed on purpose is the _____ variable.

4. Plant roots can help prevent erosion by _____ sediment in place.
5. Repeating an experiment helps scientists check whether their results are _____.

Word Bank: consistent, deposition, erosion, independent, anchoring

Multiple Choice Questions

Choose the correct answer for each question.

1. Which force could move sediment along a shoreline?
 - A. Waves
 - B. Leaf color
 - C. Root length alone
 - D. Plant labels
2. What is the main role of roots in reducing erosion?
 - A. Roots produce waves near the shore.
 - B. Roots hold sediment particles together.
 - C. Roots remove all water from the soil.
 - D. Roots change sand into rock.
3. In a tray investigation, which measurement could show how much erosion occurred?
 - A. The number of students in the group
 - B. The amount of sediment collected below the tray
 - C. The color of the tray
 - D. The time students entered class
4. A team tests planted and unplanted trays. What should remain the same for a fair comparison?
 - A. The amount of water applied to each tray
 - B. Whether each tray has vegetation
 - C. The team's prediction
 - D. The type of question being investigated
5. Why should scientists complete repeated trials?
 - A. To make the experiment less organized
 - B. To change every variable each time
 - C. To determine whether results are consistent
 - D. To avoid measuring the dependent variable

Open-Ended Questions

Answer each question in complete sentences.

1. Explain the difference between erosion and deposition. Include one example involving water or waves.

2. A model tray has soil and grass plants. Explain one way roots may affect sediment movement and one limitation of using this model.

3. Write a testable question for a tray investigation about vegetation and erosion. Then identify the independent variable, dependent variable, one control condition, two constants, and the number of trials.

Testable Question: _____

Independent Variable: _____

Dependent Variable: _____

Control Condition: _____

Constants: _____

Number of Trials: _____

Prediction: _____

Team Experimental Plan

Use this section to prepare your one-page plan for teacher approval.

Investigation Component	Team Plan
Testable question	
Independent variable	
Dependent variable and measurement method	
Control condition	
Constants to keep the same	
Number of repeated trials	
Materials needed	
Prediction and scientific reasoning	

Answer Key

Fill in the Blank Answers

1. erosion
2. deposition
3. independent
4. anchoring
5. consistent

Multiple Choice Answers

1. A. Waves
2. B. Roots hold sediment particles together.
3. B. The amount of sediment collected below the tray
4. A. The amount of water applied to each tray
5. C. To determine whether results are consistent

Open-Ended Example Responses

1. Erosion is the movement of sediment from one location to another. Deposition occurs when sediment settles after moving water slows down. For example, waves may erode sand from one shoreline area and deposit it farther down the shore.
2. Roots may reduce sediment movement because they hold soil particles together beneath the surface. This tray model has limitations because a real marsh includes tides, weather, animals, and much larger areas.
3. **Testable question:** How does vegetation affect the amount of sediment moved from a sloped tray?
Independent variable: Presence or absence of vegetation.
Dependent variable: Amount of sediment collected after water is applied.
Control condition: An unplanted tray.
Constants: Same tray size, soil amount, slope, and water amount.
Number of trials: Three trials for each condition.
Prediction: The planted tray will lose less sediment because roots anchor soil and stems slow water movement.

Name _____ Date _____

Conducting Erosion Experiments:

Erosion Control Module 2 Lesson 2

Reading Passage

Name _____ Date _____

Investigation Erosion and Marsh Vegetation:

Erosion Control Module 2 Lesson 3

Reading Passage

Erosion is the movement of sediment, such as soil, sand, or small rocks, from one place to another. Runoff flowing downhill and waves along a shoreline can move sediment. Deposition happens when moving water slows and drops sediment in a new location. Marsh vegetation can reduce erosion. Roots anchor sediment by holding it together below the surface. Stems slow moving water, which can reduce the water's ability to carry sediment. Scientists can use a model marsh, such as a sloped sediment tray, to test one part of a real marsh system. A model is useful, but it does not include every condition found outdoors, including changing tides, weather, wildlife, and larger wave patterns. In a fair test comparing planted and unplanted trays, the independent variable is whether vegetation is present. The dependent variable is the amount of sediment moved. Constants, or controlled variables, include the tray slope, sediment depth, water amount, and water application time. The unplanted tray is the control condition because it provides a comparison. Repeated trials make results more reliable. Teams should measure and record sediment movement carefully, including unexpected or anomalous results. An anomalous trial should not be deleted; it should be explained as a possible limitation. After organizing data, scientists choose a graph that clearly compares erosion across conditions. They then write a claim supported by evidence and reasoning about how roots and stems affected erosion. Marsh restoration can also help nearby communities by reducing shoreline erosion and protecting habitats.

Fill in the Blank

Word Bank: control condition, deposition, dependent variable, erosion, repeated trials

1. The movement of sediment from one place to another is called _____.
2. When water slows and drops sediment in a new location, the process is _____.
3. In a planted-versus-unplanted tray investigation, the amount of sediment moved is the _____.
4. The unplanted tray used for comparison is the _____.
5. Scientists conduct _____ to make their results more reliable.

Multiple-Choice Questions

Choose the best answer for each question.

1. Which process can move sediment down a sloped tray during an investigation?
 - A. Runoff flowing across the sediment
 - B. Roots holding sediment in place
 - C. Deposition after water stops moving
 - D. Recording a measurement
2. How can marsh roots help reduce erosion?
 - A. They increase the slope of the shoreline.
 - B. They anchor and hold sediment together.
 - C. They cause water to move faster.
 - D. They remove all sediment from the marsh.
3. Which variable should remain constant to make a planted-versus-unplanted tray test fair?
 - A. Whether vegetation is present
 - B. The amount of sediment moved
 - C. The amount of water applied
 - D. The conclusion written by the team
4. A team gets one result that is very different from its other trials. What should the team do?
 - A. Delete the result so the data look consistent.
 - B. Record the result and explain a possible cause.
 - C. Change the result to match the average.
 - D. Stop measuring sediment movement.
5. Which graph would best show average sediment moved in planted and unplanted trays?
 - A. A bar graph with one bar for each condition
 - B. A map showing the classroom layout
 - C. A drawing of the plant roots
 - D. A list of safety rules

Open-Ended Questions

Answer each question in complete sentences. Use details from the reading and investigation scenario.

1. Design a fair test comparing planted and unplanted sloped sediment trays. State a testable question, the independent variable, dependent variable, control condition, two constants, number of trials, measurement method, and prediction.

2. Describe how your team should collect and record erosion data safely and accurately. Include equal water amounts, safety steps, repeated trials, observations, and what to do with an anomalous trial.

3. Write a claim-evidence-reasoning conclusion for a result in which planted trays moved less sediment than unplanted trays. Name an appropriate graph, include one limitation of the model, and explain one way marsh restoration may benefit nearby communities.

Answer Key

Fill in the Blank

1. erosion
2. deposition
3. dependent variable
4. control condition
5. repeated trials

Multiple-Choice Questions

1. A
2. B
3. C
4. B
5. A

Open-Ended Example Responses

1. Example response: A testable question is, “How does vegetation affect the mass of sediment moved from a sloped tray?” The independent variable is vegetation presence, and the dependent variable is sediment mass moved. The unplanted tray is the control condition. Constants include the tray slope and sediment depth, as well as the water amount and application time. We would complete three trials for each condition and measure collected sediment mass. I predict planted trays will lose less sediment because roots anchor sediment and stems slow water.
2. Example response: We should wear eye protection, lift trays carefully, keep hands clear of moving water and equipment, and clean spills promptly. We should add the same measured water amount for the same time in every trial. We should record sediment measurements, units, observations, and unexpected events after each repeated trial. If one trial is anomalous, we should keep it in the data and describe a possible cause, such as an uneven slope or a spill.
3. Example response: Claim: Planted trays reduced erosion most effectively. Evidence: The planted trays moved less sediment than the unplanted trays across repeated trials. A bar graph can compare the average sediment moved in each condition. Reasoning: Roots held sediment together, and stems slowed the water, so the water carried less sediment away. One limitation is that a tray model does not include real marsh tides, weather, wildlife, or large waves. Marsh restoration may reduce shoreline erosion and help protect nearby habitats and communities.

Module 3: The Wonderful World of Salt Marsh Wildlife

Duration: 3 lessons, 50 minutes each

Preparation time: Approximately 45 minutes

Module Overview

Students research a salt marsh organism and create a profile card describing its role, diet, predators, adaptations, and habitat needs. The class connects cards with yarn to construct a food web and models the consequences of species loss.

Standards Addressed

- MS-LS1-4
- MS-LS1-5
- VA.SCI.2018.LS.5.B
- VA.SCI.2018.LS.5.C
- VA.SCI.2018.LS.6
- VA.SCI.2018.LS.6.A

Learning Objectives

Students will:

- Identify organisms found in Hampton Roads salt marshes.
- Describe organism adaptations and ecological roles.
- Distinguish producers, consumers, and decomposers.
- Construct a food web.
- Explain energy flow and interdependence.
- Predict effects of species loss or population change.

Vocabulary

Term	Student-Friendly Definition
Organism	A living thing
Species	A group of similar organisms that can reproduce with one another
Population	Members of one species living in an area
Community	All the interacting populations in an area

Term	Student-Friendly Definition
Habitat	The place where an organism lives
Niche	An organism's role and way of using resources
Producer	An organism that makes its own food, usually through photosynthesis
Consumer	An organism that obtains energy by eating other organisms
Decomposer	An organism that breaks down dead material and returns nutrients
Food web	A model showing connected feeding relationships
Trophic level	A feeding position in a food chain or web
Interdependence	A condition in which organisms rely on one another

Materials Needed

- Species research cards
- Reliable print and digital sources
- 40–50 index cards or card templates
- Markers and colored pencils
- Yarn or string
- Clothespins or tape
- Organism photographs
- Food-web role labels
- Research organizer
- Citation guide
- Large open classroom area
- Sticky notes
- Optional projector for local species images

Preparation

1. Create 8–10 teams of 5 students.

2. Assign or allow selection of organisms while ensuring representation of:
 - Producers
 - Herbivores
 - Carnivores
 - Omnivores
 - Detritivores
 - Decomposers
 - Birds
 - Fish
 - Invertebrates
 - Microorganisms
3. Prepare backup organisms for students who need a less complex topic.
4. Verify sources and age appropriateness.
5. Prepare profile-card templates.
6. Establish color coding:
 - Green: producers
 - Blue: consumers
 - Brown: decomposers or detritivores
7. Prepare yarn lengths or spools.
8. Arrange desks to create a central food-web space.

Lesson 1: Introduction to Wildlife and Research

Engagement — 8 minutes

Display local wildlife images without labels. Students identify visible structures and make habitat predictions.

Mini-Lesson — 12 minutes

Review:

- Producers and consumers
- Detritus-based food webs
- Predators and prey
- Adaptations

- Habitat and niche
- Energy movement through feeding relationships

Emphasize that many salt marsh food webs begin with both living plant material and dead plant matter, called detritus.

Organism Assignment — 10 minutes

Assign one organism to each student or pairs of students. For 40–50 students, use duplicates only when students investigate different questions or create different perspectives.

Suggested profile categories:

- Smooth cordgrass
- Salt meadow hay
- Black needlerush
- Glasswort
- Ribbed mussel
- Fiddler crab
- Blue crab
- Marsh periwinkle
- Eastern oyster
- Atlantic killifish
- Mummichog
- Striped bass
- Atlantic menhaden
- Fundulus species
- Diamondback terrapin
- Great blue heron
- Snowy egret
- Clapper rail
- Osprey
- Red-winged blackbird
- Marsh wren
- Muskrat
- Raccoon
- River otter

- Saltmarsh sparrow
- Mosquito larvae
- Dragonfly
- Grass shrimp
- Amphipod
- Polychaete worm
- Bacteria
- Fungi
- Phytoplankton
- Zooplankton

Research Workshop — 15 minutes

Students begin collecting:

- Habitat
- Food
- Predators
- Adaptations
- Role in the ecosystem
- One local or conservation fact
- Source information

Closure — 5 minutes

Students share one surprising fact with a partner.

Lesson 2: Creating Organism Profile Cards

Model — 8 minutes

Show a sample card with:

- Common and scientific name, if appropriate
- Illustration
- Habitat
- Diet
- Predators

- Adaptations
- Ecosystem role
- Food-web connections
- Sources

Work Period — 30 minutes

Students create cards using concise language and accurate arrows or labels. Require students to distinguish between evidence from a source and their own inference.

Peer Review — 7 minutes

Students use a checklist:

- Is the organism correctly identified?
- Are diet and predators included?
- Is at least one adaptation explained?
- Is the ecological role clear?
- Are sources listed?

Closure — 5 minutes

Students predict which organism would be most affected by a decline in marsh grass.

Lesson 3: Building the Classroom Food Web

Setup — 5 minutes

Students stand or sit in a large circle with profile cards visible.

Food-Web Construction — 25 minutes

Begin with producers and decomposers. Students connect organisms with yarn using the direction:

Energy or food moves from the organism being eaten to the organism that eats it.

Every connection must be verbally justified.

Interdependence Scenarios — 15 minutes

Introduce scenarios:

- Marsh grass declines.
- Pollution reduces plankton.
- A predator population increases.
- An invasive species arrives.
- A storm removes habitat.
- Sea-level rise changes marsh elevation.

Students holding affected cards gently pull or lower yarn. The class observes how one change can affect multiple relationships.

Closure — 5 minutes

Students write:

What does the food web show that a single food chain does not?

Formative Assessment Strategies

- Research organizer checks
- Source-quality conferences
- Profile-card peer review
- Vocabulary questioning
- Food-web connection explanations
- Species-loss prediction
- Individual written reflection

Differentiation

- Offer a choice of organism complexity.
- Provide curated sources and simplified readings.
- Use audio or text-to-speech resources.
- Supply sentence frames.
- Permit digital or orally recorded profile cards.
- Challenge advanced students to include detrital pathways, competition, or seasonal changes.
- Assign peer research partners for students needing organizational support.

Extension Activities

- Build a digital food web.
- Add arrows showing energy flow.
- Compare a marsh food web with a forest or pond food web.
- Research an endangered or declining species.
- Analyze how a restoration project may affect several trophic levels.
- Create a “species loss” news report.

Connections to Next Module

Students’ food-web scenarios provide a foundation for studying threats. Module 4 examines how development, pollution, climate change, and policy can alter the conditions that support the web.

Name _____ Date _____

Introduction to Wildlife and Research:

The World of Salt Marsh Wildlife Module 3 Lesson 1

Reading Passage

Name _____ Date _____

Creating Salt Marsh Organism Profile Cards:

The World of Salt Marsh Wildlife Module 3 Lesson 2

Reading Passage

Scientists use organism profile cards to organize information about living things in an ecosystem. A strong profile card clearly identifies an organism using its common name and, when available, its scientific name. The card may include an illustration with labels that show important body structures.

Each card should explain the organism's habitat, diet, predators, adaptations, and ecosystem role. A habitat is the place where an organism lives. Diet describes what an organism eats. Predators are organisms that hunt or eat another organism. Adaptations are body structures or behaviors that help an organism survive.

A profile card should also show food-web connections. Arrows in a food web show the direction that energy moves. An arrow points from the organism being eaten to the organism that receives energy. For example, an arrow from marsh grass to a marsh periwinkle shows that the periwinkle receives energy by eating the grass.

Students should use concise language, which means using clear and brief words. They must also separate evidence from inference. Evidence is information directly supported by a reliable source. An inference is a logical idea based on evidence, but it is not directly stated in the source. For example, a source might state that an organism eats marsh grass. A student could infer that a decline in marsh grass may reduce that organism's food supply.

Sources should be listed on every profile card. Source information helps readers check where facts came from. During peer review, students check that the organism is correctly identified, its diet and predators are included, an adaptation is explained, its ecosystem role is clear, and sources are listed.

Fill in the Blank

Fill in each blank using a word from the word bank.

1. The place where an organism lives is its _____.
2. A body structure or behavior that helps an organism survive is an _____.
3. Information directly supported by a reliable source is called _____.
4. A logical idea based on evidence is called an _____.
5. In a food web, an arrow shows the direction that _____ moves.

Word Bank: adaptation, energy, evidence, habitat, inference

Multiple-Choice Questions

Choose the best answer for each question.

1. Which item should be included on an organism profile card?
 - A. A list of unrelated classroom supplies
 - B. The organism's habitat and diet
 - C. The student's favorite sport
 - D. A prediction without any research
2. What does an arrow from marsh grass to a marsh periwinkle show?
 - A. The grass receives energy from the periwinkle.
 - B. The periwinkle receives energy from the grass.
 - C. The grass is a predator of the periwinkle.
 - D. The periwinkle does not need food.
3. Which statement is evidence?
 - A. "My source states that marsh periwinkles eat marsh grass."
 - B. "I think every periwinkle eats the same amount of grass."
 - C. "The periwinkle is probably the strongest organism in the marsh."
 - D. "I believe the periwinkle can live anywhere."
4. Which statement is an inference?
 - A. "The source lists the blue crab's habitat as a salt marsh."
 - B. "The source states that an osprey eats fish."
 - C. "A decline in marsh grass may reduce food for organisms that eat it."
 - D. "The source gives the common name of the organism."

5. Why should a student list sources on a profile card?
- A. To help readers check where the information came from
 - B. To replace the need for accurate facts
 - C. To make the card longer without adding information
 - D. To avoid explaining the organism's role

Open-Ended Questions

Answer each question in complete sentences.

1. Choose one salt marsh organism, such as smooth cordgrass, ribbed mussel, fiddler crab, blue crab, or great blue heron. Describe the information you would include on its profile card.

2. Write one evidence statement and one inference about an organism that eats marsh grass. Clearly label each statement.

Evidence: _____

Inference: _____

3. Predict which type of organism could be affected by a decline in marsh grass. Explain how the decrease in grass could affect energy movement through the food web.

Answer Key

Fill in the Blank

1. habitat
2. adaptation
3. evidence
4. inference
5. energy

Multiple-Choice Questions

1. B
2. B
3. A
4. C
5. A

Open-Ended Example Responses

1. I would create a profile card for a fiddler crab. The card would include its common name, an illustration, its salt marsh habitat, its diet, predators, adaptations, and ecosystem role. I would also show its food-web connections with arrows and list the sources used for research.
2. **Evidence:** A reliable source states that a marsh periwinkle eats marsh grass.
Inference: If marsh grass declines, marsh periwinkles may have less available food.
3. An organism that eats marsh grass could be affected by a decline in marsh grass. It would receive less energy because less plant material would be available as food. Predators that eat that organism could also be affected because there may be fewer prey organisms in the food web.

Name _____ Date _____

Building a Classroom Salt Marsh Food Web:

The World of Salt Marsh Wildlife Module 3 Lesson 3

Reading Passage

A food web shows the many feeding relationships in an ecosystem. Unlike a single food chain, a food web includes several connected paths for energy movement. In a salt marsh, energy begins with producers, such as smooth cordgrass, glasswort, and phytoplankton. Producers use sunlight to make food.

Energy also enters many marsh food webs through detritus. Detritus is dead plant material and other organic matter. Decomposers, including bacteria and fungi, break down detritus. Small consumers, such as amphipods, worms, and grass shrimp, may feed on detritus or the organisms that break it down. Larger consumers, such as fish, crabs, herons, and ospreys, receive energy by eating smaller organisms.

In a food web, arrows show the direction energy moves. An arrow points from the organism being eaten to the organism that eats it. For example, an arrow from phytoplankton to zooplankton shows that zooplankton receives energy by eating phytoplankton.

A food web also shows interdependence. Interdependence means organisms rely on one another and on their habitat. If marsh grass declines, organisms that use it for food or shelter may be affected. Pollution can reduce plankton, which may affect animals that eat plankton. A storm, invasive species, predator increase, or sea-level rise can also change many relationships in the web. Scientists use food webs to predict how one environmental change may affect an entire ecosystem.

Fill in the Blank

Fill in each blank using a word from the word bank.

1. A group of connected feeding relationships is called a _____.
2. Organisms such as smooth cordgrass that make food using sunlight are called _____.
3. Dead plant material and other organic matter are called _____.

4. In a food web, arrows show the direction that _____ moves.
5. When organisms rely on one another and their habitat, they show _____.

Word Bank: detritus, energy, food web, interdependence, producers

Multiple-Choice Questions

Choose the best answer for each question.

1. Which arrow correctly shows energy movement when a blue crab eats a grass shrimp?
 - A. Blue crab → grass shrimp
 - B. Grass shrimp → blue crab
 - C. Salt marsh → grass shrimp
 - D. Blue crab → phytoplankton
2. Which organism is most likely a producer in a salt marsh food web?
 - A. Great blue heron
 - B. Fiddler crab
 - C. Phytoplankton
 - D. River otter
3. Why are bacteria and fungi important in a detritus-based food web?
 - A. They make sunlight for producers.
 - B. They break down dead organic matter.
 - C. They hunt large fish and birds.
 - D. They remove all water from the marsh.
4. What may happen if pollution reduces the amount of plankton in a marsh?
 - A. Organisms that eat plankton may have less food.
 - B. All predators will immediately leave the ecosystem.
 - C. Marsh grass will become a consumer.
 - D. Energy will stop moving through every food web.
5. What does a food web show that a single food chain does not?
 - A. Only one organism in an ecosystem
 - B. The names of every student in class
 - C. Multiple connected feeding relationships
 - D. One path of energy movement only

Open-Ended Questions

Answer each question in complete sentences.

1. Describe two possible energy pathways in a salt marsh food web. Use arrows to show the direction of energy movement.

2. Predict how a decline in marsh grass could affect at least two other organisms in the food web. Explain your reasoning.

3. Explain what a food web can show that a single food chain cannot. Include the idea of interdependence in your response.

Answer Key

Fill in the Blank

1. food web
2. producers
3. detritus
4. energy
5. interdependence

Multiple-Choice Questions

1. B
2. C
3. B
4. A
5. C

Open-Ended Example Responses

1. One possible pathway is:

Phytoplankton → zooplankton → Atlantic killifish → great blue heron

Another possible pathway is:

Smooth cordgrass → marsh periwinkle → blue crab → striped bass

In each pathway, energy moves from the organism being eaten to the organism that eats it.

2. A decline in marsh grass could affect marsh periwinkles because they may have less plant material available for food. It could also affect fiddler crabs, fish, and birds because marsh grass provides shelter and supports smaller organisms. Predators may have less prey if populations of smaller consumers decrease.
3. A food web shows several connected feeding relationships instead of only one path. It shows interdependence because one organism may provide food or habitat for several other organisms. If one part of the food web changes, multiple organisms may be affected.

Module 4: Threats to Salt Marshes

Duration: 3 lessons, 50 minutes each

Preparation time: Approximately 45 minutes

Module Overview

Students investigate pollution, habitat destruction, climate change, altered hydrology, invasive species, and other threats to salt marshes. Using GIS mapping tools, they examine the relationship between human activity and local marshes, then develop evidence-based conservation plans.

Standards Addressed

- MS-LS1-5
- VA.SCI.2018.LS.8.C
- VA.SCI.2018.LS.9
- VA.SCI.2018.LS.9.A
- VA.SCI.2018.LS.9.B
- VA.SCI.2018.LS.9.C
- VA.SCI.2018.G6.9

Learning Objectives

Students will:

- Identify major threats to salt marshes.
- Use GIS layers to analyze land use and marsh location.
- Explain how human activity changes biotic and abiotic factors.
- Evaluate evidence about ecosystem disruption.
- Propose realistic solutions.
- Explain how individuals can influence public policy and environmental decisions.

Vocabulary

Term	Student-Friendly Definition
Pollution	Harmful material introduced into the environment
Habitat destruction	The removal or serious alteration of an organism's living place
Land use	How people use a piece of land
GIS	A digital system for displaying and analyzing geographic information
Watershed	Land area that drains water to a common body of water
Nutrient pollution	Excess nutrients that can cause harmful ecosystem changes
Eutrophication	Excess nutrient enrichment that can reduce oxygen and harm aquatic life
Climate change	Long-term changes in climate patterns
Sea-level rise	A long-term increase in average sea level
Conservation	The protection and responsible use of natural resources
Policy	A rule, plan, or decision used by an organization or government

Materials Needed

- Student devices, one per pair when possible
- Projector
- Internet access
- GIS platform approved by the school
- Printed local maps as a backup
- Land-use and marsh-boundary layers
- Historical and current imagery
- Threat scenario cards
- Data-analysis organizer
- Headphones, if needed
- Presentation materials
- Optional water-quality data
- Citation and source-evaluation guide

Preparation

1. Confirm student access to GIS software.
2. Create or bookmark a local Hampton Roads map.
3. Preload suitable layers, such as:
 - Wetland or marsh boundaries
 - Roads
 - Buildings
 - Population density
 - Shoreline
 - Land cover
 - Flood-risk or elevation information
 - Watersheds
4. Test student logins and device compatibility.
5. Create a non-digital map packet.
6. Prepare a demonstration map.
7. Establish rules for zooming, layer visibility, and saving work.
8. Prepare a troubleshooting station.
9. Identify local conservation policies or restoration initiatives.
10. Review data limitations and avoid implying that map overlap alone proves causation.

Lesson 1: Human Threats to Salt Marshes

Engagement — 8 minutes

Present four scenarios:

- A road is built beside a marsh.
- Fertilizer enters a creek.
- A storm damages a marsh edge.
- A marsh is restored with native plants.

Students predict which biotic and abiotic factors may change.

Direct Instruction — 15 minutes

Discuss:

- Development and habitat loss
- Dredging and shoreline modification
- Pollution and stormwater runoff
- Excess nutrients and low oxygen
- Trash and plastics
- Invasive species
- Sea-level rise
- Increased storm intensity
- Reduced sediment supply
- Altered tidal flow

Frame climate change and development as interacting pressures rather than isolated causes.

Evidence Sort — 17 minutes

Teams classify evidence as:

- Direct observation
- Measurement
- Historical record
- Map evidence
- Scientific explanation
- Opinion or unsupported claim

Students then connect each threat to a changed ecosystem condition.

Closure — 10 minutes

Students complete:

A human activity can affect a salt marsh by changing _____, which may cause _____.

Lesson 2: GIS Mapping and Impact Analysis

Demonstration — 10 minutes

Model how to:

1. Open the map.
2. Turn layers on and off.
3. Locate a marsh.
4. Add a reference layer.
5. Compare areas.
6. Record observations.
7. Distinguish pattern from proof.

Team Investigation — 30 minutes

Teams select or receive a local study area. They answer:

- Where are marshes located?
- What human activities occur nearby?
- What waterways connect the marsh to surrounding land?
- What patterns appear across current and historical imagery?
- What evidence suggests risk or protection?
- What additional data would strengthen the conclusion?

Students produce an annotated map and short evidence statement.

Troubleshooting and Closure — 10 minutes

Teams save or export work according to school procedures. Students complete a backup paper interpretation if technology fails.

Lesson 3: Conservation Solutions and Action Plans

Solution Brainstorm — 10 minutes

Students categorize solutions as:

- Individual actions

- School actions
- Community actions
- Government or policy actions
- Restoration actions
- Engineering or planning actions

Action-Plan Workshop — 25 minutes

Each team develops a proposal including:

- Threat addressed
- Evidence
- Proposed action
- People or organizations involved
- Materials or resources
- Possible benefits
- Possible tradeoffs
- Measure of success
- Communication strategy

Public-Comment Simulation — 10 minutes

Students deliver a one-minute statement to a simulated planning committee. Classmates ask evidence-based questions.

Closure — 5 minutes

Students write one action they can take and one policy or community action they support.

Formative Assessment Strategies

- Threat-evidence sort
- Map-reading questions
- GIS observation log
- Teacher conferences
- Solution feasibility checklist
- Public-comment feedback
- CER response

Differentiation

- Provide a printed map pathway for students who need reduced technology demands.
- Use step-by-step GIS screenshots.
- Pair students strategically.
- Provide recorded directions.
- Offer preselected study areas.
- Use accessible color palettes and alternative text.
- Let students submit audio explanations.
- Challenge advanced students to compare multiple dates or datasets.
- Provide sentence frames for policy statements.

Extension Activities

- Conduct a school stormwater audit.
- Map impervious surfaces around the school.
- Write to a local representative.
- Compare living shorelines with hardened shorelines.
- Interview a local conservation professional.
- Create a public-service announcement.
- Analyze a local environmental-impact decision.

Connections to Next Module

Students identify restoration needs and conditions. Module 5 addresses how native grasses can be propagated and prepared for restoration.

Name _____ Date _____

Human Threats to Salt Marshes:

Threats to Salt Marshes Module 4 Lesson 1

Reading Passage

Salt marshes are coastal wetlands that provide habitat, protect shorelines, and support food webs. However, human activities and environmental changes can damage these important ecosystems. Development, such as building roads, homes, or parking areas near a marsh, can remove habitat and change how water flows through the area.

Dredging and shoreline modification can also affect salt marshes. Dredging removes sediment from waterways, while seawalls and other structures can change tidal flow. When less sediment reaches a marsh, the marsh may have difficulty building up its surface as sea level rises.

Pollution and stormwater runoff can carry fertilizer, oil, trash, and other materials into creeks and marshes. Excess fertilizer adds nutrients to the water. Too many nutrients can cause algae to grow quickly. When algae die and decompose, oxygen levels in the water may decrease. Low oxygen can harm fish, crabs, and other aquatic organisms.

Other threats include invasive species, stronger storms, and sea-level rise. An invasive species is an organism that is not native to an area and may harm native organisms or habitats. Strong storms can damage marsh edges, while rising sea levels can flood marsh areas more often. These pressures can interact. For example, development may reduce habitat while sea-level rise and storms make the remaining marsh more vulnerable.

Scientists use evidence to understand these changes. Direct observations include seeing trash or damaged plants. Measurements may include oxygen levels or water depth. Historical records show changes over time, while maps can show habitat loss. Scientific explanations use evidence to describe why ecosystem conditions change. Opinions or unsupported claims do not include enough reliable evidence.

Fill in the Blank

Fill in the blank with the correct words:

1. The removal of marsh habitat for roads or buildings is called habitat _____.
2. Water flowing over land after rain can carry pollution into a marsh. This is called stormwater _____.
3. Too many nutrients in water can lead to low _____ levels.
4. A species that is not native and may harm an ecosystem is called an _____ species.
5. Rising water levels and stronger storms can increase pressure on a salt _____.

Word Bank: invasive, loss, marsh, oxygen, runoff

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. How could a road built beside a salt marsh affect the ecosystem?
 - A. It may remove habitat and change water flow.
 - B. It will cause all plants to become producers.
 - C. It will add more native species automatically.
 - D. It will stop tides from occurring.
2. What can happen when excess fertilizer enters a creek near a marsh?
 - A. Water oxygen levels may decrease after algae die.
 - B. All marsh plants become invasive species.
 - C. Sediment immediately turns into rock.
 - D. Tides stop moving through the marsh.
3. Which example is a direct observation?
 - A. A map shows marsh area has decreased since 1990.
 - B. A scientist measures low oxygen in creek water.
 - C. A student sees plastic bottles along the marsh edge.
 - D. A person says pollution is never a problem.

4. Which type of evidence would best show whether marsh habitat changed over many years?
- A. A historical record or map
 - B. One person's unsupported opinion
 - C. A drawing without labels
 - D. A list of classroom supplies
5. Why can development and climate change be considered interacting pressures?
- A. They always affect only one organism.
 - B. They can combine to make marsh habitats more vulnerable.
 - C. They prevent all storms from reaching coasts.
 - D. They cause every ecosystem to change in the same way.

Open-Ended Questions

Answer the following questions in complete sentences:

1. Explain how stormwater runoff from a developed area could affect a salt marsh. Include one changed abiotic factor and one possible effect on organisms.

2. A student says, "A storm damaged the marsh because storms are always harmful." Is this a scientific explanation or an unsupported claim? Explain what additional evidence would make the statement stronger.

3. Complete the sentence below. Then explain how the changes could affect the salt marsh food web.

A human activity can affect a salt marsh by changing _____,

which may cause_____

_____.

Answer Key

Fill in the Blank

1. loss
2. runoff
3. oxygen
4. invasive
5. marsh

Multiple-Choice Questions

1. A
2. A
3. C
4. A
5. B

Open-Ended Example Responses

1. Stormwater runoff can carry fertilizer, oil, or trash into a salt marsh. Excess fertilizer can change the nutrient level in the water. Algae may grow quickly, and oxygen levels may decrease when the algae die. Fish, crabs, and other aquatic organisms may be harmed by low oxygen.
2. The statement is an unsupported claim because it does not explain what damage occurred or provide evidence. The student could use photographs, measurements of marsh-edge loss, records of storm intensity, or observations of damaged plants to strengthen the explanation.
3. A human activity can affect a salt marsh by changing **water quality**, which may cause **lower oxygen levels**. Low oxygen can harm small fish, crabs, and other organisms. If these organisms decrease, predators may have less food, affecting several connections in the food web.

GIS Mapping and Salt Marsh Impact Analysis:

Threats to Salt Marshes Module 4 Lesson 2

Reading Passage

Geographic Information Systems, or GIS, help scientists study places using digital maps. A GIS map can show different layers of information. One layer may show salt marsh boundaries. Another layer may show roads, waterways, buildings, or historical images. Students can turn layers on and off to compare information.

Scientists use GIS to locate marshes and identify nearby human activities. For example, a map may show a road, parking lot, or neighborhood beside a marsh. Waterways can connect the marsh to surrounding land. Rainwater may carry sediment, fertilizer, oil, or trash through these waterways.

Maps can show patterns, which are repeated features or changes. For example, current and historical images may show that a marsh edge has moved inland over time. This pattern suggests that erosion or sea-level rise may be affecting the marsh. However, a pattern is not complete proof of one cause. Scientists need additional evidence before making a strong conclusion.

Additional evidence may include water-quality measurements, records of storms, sediment measurements, field observations, or maps from several years. Teams can use their evidence to create an annotated map. An annotated map includes labels, arrows, notes, and a clear title. It helps explain what the map shows and what questions still need investigation.

Map Investigation Scenario

A team compares a current map and a historical map of Harbor Creek Marsh.

- The historical map from 2005 shows a wide marsh edge beside Harbor Creek.
- The current map from 2025 shows a narrower marsh edge in the same area.
- A new road and parking lot appear near the marsh on the current map.
- A drainage ditch connects the parking lot area to Harbor Creek.
- The maps do not show water-quality measurements or storm records.

Fill in the Blank

Fill in the blank with the correct words:

1. A digital system that helps scientists study places using map layers is called _____.
2. Information, such as roads, waterways, or marsh boundaries, can be shown on map _____.
3. A repeated feature or change shown on a map is called a _____.
4. Labels, arrows, and notes added to a map are called _____.
5. Scientists need more evidence before deciding that a pattern is complete _____.

Word Bank: annotations, GIS, layers, pattern, proof

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. Which GIS layer would best help a team locate salt marshes?
A. A marsh boundary layer
B. A classroom seating-chart layer
C. A student attendance layer
D. A music playlist layer
2. What change appears in the Harbor Creek Marsh scenario?
A. The marsh edge became wider from 2005 to 2025.
B. The marsh edge became narrower from 2005 to 2025.
C. The road disappeared from the current map.
D. The creek no longer connects to the marsh.
3. Why should scientists distinguish between a pattern and proof?
A. A pattern may suggest an explanation, but more evidence is needed.
B. A pattern always proves one cause immediately.
C. Maps cannot show changes over time.
D. Evidence is not needed when studying marshes.
4. Which feature could carry runoff from the parking lot area toward Harbor Creek?
A. The drainage ditch
B. The marsh boundary
C. The historical map date
D. The map title

5. Which additional data would most strengthen a conclusion about possible runoff pollution?

- A. Water-quality measurements from Harbor Creek
- B. The names of each team member
- C. A drawing of a school hallway
- D. A list of computer passwords

Open-Ended Questions

Answer the following questions in complete sentences:

1. Describe two GIS layers that would help a team investigate possible threats to a salt marsh. Explain what each layer could show.

2. Write an evidence statement about Harbor Creek Marsh. Include one pattern shown by the maps and explain why the pattern does not prove one specific cause.

3. Describe how your team would create an annotated map of Harbor Creek Marsh. Include a title, at least two labels or arrows, one observation, and one question for further research.

Answer Key

Fill in the Blank

1. GIS
2. layers
3. pattern
4. annotations
5. proof

Multiple-Choice Questions

1. A
2. B
3. A
4. A
5. A

Open-Ended Example Responses

1. A marsh boundary layer would show where the salt marsh is located and how much area it covers. A roads and buildings layer would show development near the marsh. These layers could help students identify places where human activity may affect the marsh.
2. The maps show that the marsh edge became narrower between 2005 and 2025. The current map also shows a new road, parking lot, and drainage ditch near Harbor Creek. This pattern suggests that development or changing water flow may be connected to marsh change. However, the maps do not prove the cause because they do not include water-quality data, storm records, or sediment measurements.
3. Our map could be titled “Changes Near Harbor Creek Marsh, 2005–2025.” We would label the marsh edge, the new road, the parking lot, and the drainage ditch. An arrow could show that the ditch connects the parking lot area to Harbor Creek. One observation is that the marsh edge is narrower on the current map. One question is whether runoff from the parking lot changes water quality in the creek.

Name _____ Date _____

Conservation Solutions and Salt Marsh Action Plans:

Threats to Salt Marshes Module 4 Lesson 3

Reading Passage

Salt marshes can be protected through many types of conservation solutions. Some solutions are individual actions. For example, people can reduce litter, use less fertilizer, and keep trash out of storm drains. School actions may include organizing a campus cleanup, teaching others about marsh habitats, or reducing single-use plastics.

Community actions involve groups working together. A community might hold a shoreline cleanup or support a local marsh-monitoring program. Government or policy actions can create rules that protect wetlands, limit pollution, or guide where new buildings are built. These actions can affect larger areas than one person can protect alone.

Restoration actions help repair damaged habitats. Planting native marsh grasses can help stabilize sediment and provide shelter for wildlife. Engineering or planning actions may include improving stormwater systems, creating living shorelines, or avoiding construction in areas that flood often.

A strong action plan begins with a specific threat, such as pollution, habitat loss, erosion, or sea-level rise. The plan should include evidence that the threat exists. It should explain the proposed action, the people or organizations involved, needed materials, and possible benefits. Good plans also consider tradeoffs. A tradeoff is a cost, challenge, or possible negative result connected to a choice.

Teams should decide how they will measure success. For example, they may measure the amount of trash collected, the number of native plants that survive, or changes in water quality. Finally, teams need a communication strategy. They may share their proposal through a presentation, poster, letter, public comment, or social media message. During a public-comment simulation, speakers should make clear claims and support them with evidence.

Fill in the Blank

Fill in the blank with the correct words:

1. A choice that has both benefits and possible costs is called a _____.
2. Planting native marsh grass to repair a damaged habitat is a _____ action.
3. Rules that protect wetlands or limit pollution are examples of government or _____ actions.
4. Information that supports a claim about a threat is called _____.
5. A plan for sharing an idea with others is a communication _____.

Word Bank: evidence, policy, restoration, strategy, tradeoff

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. Which action is most likely an individual conservation action?
 - A. Creating a state wetland-protection law
 - B. Keeping litter out of storm drains
 - C. Building a public living shoreline
 - D. Approving a regional construction plan
2. Which action is an example of marsh restoration?
 - A. Paving part of a marsh for parking
 - B. Adding more fertilizer near a creek
 - C. Planting native grasses along a damaged marsh edge
 - D. Throwing away water-quality records
3. Which item would best measure the success of a shoreline cleanup?
 - A. The number of trash bags collected
 - B. The name of the planning committee
 - C. The color of students' backpacks
 - D. The length of the public comment
4. Why should an action plan include possible tradeoffs?
 - A. Every solution has no challenges or costs.
 - B. Teams should consider possible drawbacks before choosing an action.
 - C. Tradeoffs replace the need for evidence.
 - D. Tradeoffs prove that conservation cannot work.

5. Which statement is best supported by evidence?
- A. "We should restore the marsh because restoration is always perfect."
 - B. "Our plan will work because our team likes native plants."
 - C. "Water-quality measurements show high nutrient levels near the drainage ditch."
 - D. "Pollution is the only possible cause of every marsh change."

Open-Ended Questions

Answer the following questions in complete sentences:

1. Select one salt marsh threat from the reading. Create a short action plan that names the threat, gives one type of evidence, and proposes one action.

2. Explain one possible benefit and one possible tradeoff of planting native marsh grass along a damaged shoreline.

3. Write a one-minute public-comment statement for a planning committee. State one conservation action you support, include evidence, and explain how success could be measured.

Answer Key

Fill in the Blank

1. tradeoff
2. restoration
3. policy
4. evidence
5. strategy

Multiple-Choice Questions

1. B
2. C
3. A
4. B
5. C

Open-Ended Example Responses

1. One threat is pollution from stormwater runoff. Evidence could include water-quality measurements showing high nutrient levels near a drainage ditch. Our proposed action is to install stormwater filters and teach residents to keep fertilizer and trash out of drains.
2. One benefit is that native marsh grass can hold sediment in place and provide habitat for wildlife. One tradeoff is that planting and monitoring the grass requires time, money, and volunteers. Some plants may not survive if storms or flooding occur.
3. I support planting native marsh grass along the damaged shoreline. The marsh edge has become narrower, and the area has less plant cover than nearby sections. Native grass roots can help hold sediment in place. We can measure success by recording how many plants survive and measuring changes in the marsh edge over time.

Module 5: Propagating Salt Marsh Grasses

Duration: 3 lessons, 50 minutes each

Preparation time: Approximately 45 minutes

Module Overview

Students learn how propagation supports restoration. They plant approved seeds, plugs, or cuttings; establish controlled growing conditions; and monitor growth over time. Students analyze how environmental factors and plant variation influence success.

Standards Addressed

- MS-LS1-5
- VA.SCI.2018.LS.11.C

Learning Objectives

Students will:

- Define propagation.
- Explain why restoration projects use seeds, plugs, or cuttings.
- Demonstrate safe and appropriate planting techniques.
- Monitor and record plant growth.
- Explain how environmental factors influence growth.
- Recognize that variation among plants can affect survival and growth.
- Connect classroom propagation to real restoration projects.

Vocabulary

Term	Student-Friendly Definition
Propagation	Producing new plants from seeds, cuttings, roots, or other plant parts
Germination	The beginning of growth from a seed
Seedling	A young plant grown from a seed
Cutting	A plant piece used to grow a new plant
Plug	A small established plant with roots and growing medium
Growth factor	An environmental condition that affects growth

Term	Student-Friendly Definition
Germination rate	The proportion of seeds that begin growing
Control group	A group used for comparison in an investigation
Restoration	Helping a damaged ecosystem recover
Genetic variation	Differences in inherited traits among organisms
Monitoring	Repeatedly observing and recording changes

Materials Needed

For 8–10 teams:

- Approved native salt marsh grass seeds, plugs, or cuttings
- Planting containers
- Potting medium
- Sand or approved sediment mixture
- Labels
- Measuring rulers
- Spray bottles or measured watering containers
- Drainage trays
- Gloves
- Growth logs
- Digital camera or tablet
- Balance, if available
- Grow lights or consistent window space
- Optional conductivity meter
- Optional temperature and moisture probes
- Plant-care schedule

Preparation

1. Confirm plant materials and permissions.
2. Determine whether the classroom investigation uses seeds, plugs, or both.
3. Review species-specific growing requirements with a qualified partner.
4. Prepare labeled containers.
5. Establish a consistent light and temperature area.

6. Create a watering and monitoring schedule.
7. Prepare a baseline data sheet.
8. Decide which environmental factors will be compared.
9. Avoid using salt concentrations that could create unsafe spills or damage classroom surfaces.
10. Prepare a replacement activity if germination is slow or unsuccessful.

Lesson 1: Introduction to Propagation and Restoration

Engagement — 8 minutes

Show photographs of a damaged marsh and a restored marsh. Ask:

What would need to happen for the damaged area to become a functioning ecosystem again?

Mini-Lesson — 15 minutes

Explain:

- Natural recovery
- Assisted restoration
- Seed propagation
- Vegetative propagation
- Plugs and nursery-grown plants
- Site preparation
- Matching plants to elevation and salinity
- Genetic and environmental influences on growth

Emphasize that planting alone does not guarantee restoration. Successful restoration requires appropriate species, hydrology, sediment, monitoring, and long-term care.

Case Study — 17 minutes

Students examine a short restoration case. They identify:

- Original problem
- Restoration action
- Environmental conditions
- Evidence of success

- Remaining uncertainties

Closure — 10 minutes

Students define propagation in their own words and identify one factor that might affect plant growth.

Lesson 2: Planting and Propagation Techniques

Demonstration — 10 minutes

Model:

- Labeling
- Preparing the medium
- Planting at the correct depth
- Avoiding compaction
- Watering consistently
- Recording starting conditions
- Cleaning tools

Hands-On Planting — 30 minutes

Teams plant according to a common protocol. Each student records individual observations or contributes to a team log.

Possible design:

- One seed or plug type in two media
- Two plant types under the same conditions
- Same plant type under two light or water conditions

Only one major variable should differ between comparison groups.

Cleanup — 5 minutes

Students clean tools and place containers in assigned locations.

Closure — 5 minutes

Teams submit a labeled photograph and planting record.

Lesson 3: Monitoring Growth and Care

Protocol Training — 12 minutes

Teach students to measure consistently:

- Height from medium surface to tallest point
- Number of shoots or leaves
- Germination or survival
- Color and condition
- Moisture condition
- Date and time

Students should not pull up plants to inspect roots unless the teacher has designated a separate sample.

Baseline Data Collection — 20 minutes

Teams record starting data and photograph each container from the same angle.

Care Planning — 10 minutes

Teams create a rotating care schedule. A student should never water without recording the action.

Closure — 8 minutes

Students write a prediction about how growth will change and identify what evidence would support it.

Formative Assessment Strategies

- Propagation vocabulary check
- Procedure sequencing
- Planting observation
- Baseline-data review
- Monitoring practice
- Prediction-and-evidence response
- Teacher conference

Differentiation

- Use pictorial protocols.
- Provide measurement guides.
- Assign students specific monitoring tasks.
- Offer digital data entry.
- Permit oral observations.
- Provide extension analysis involving germination rates, averages, or environmental comparisons.
- Use peer mentors for procedural support.

Extension Activities

- Calculate germination or survival percentages.
- Compare growth curves.
- Photograph root development using a transparent container.
- Research nursery propagation methods.
- Investigate genetic diversity in restoration plantings.
- Develop a plant-care guide for younger students.

Connections to Next Module

The strongest plants and appropriate planting materials may be considered for the restoration project, subject to partner approval. Students will use monitoring skills at the field site.

Name _____ Date _____

Introduction to Propagation and Marsh Restoration:

Propagating Salt Marsh Grasses Module 5 Lesson 1

Reading Passage

A damaged salt marsh can sometimes recover naturally. Natural recovery happens when plants, sediment, and water conditions allow an ecosystem to rebuild without direct planting. However, some damaged marshes need assisted restoration. Assisted restoration is when people take actions to help an ecosystem recover.

One restoration method is propagation, which is growing new plants. Seed propagation begins with seeds that grow into new plants. Vegetative propagation uses a piece of an existing plant, such as a stem or root section, to grow another plant. Restoration teams may also use plugs, which are small groups of nursery-grown plants placed into the marsh.

Planting alone does not guarantee successful restoration. Teams must prepare the site and choose plants that match local conditions. Elevation affects how often an area floods. Salinity is the amount of salt in water or soil. A plant that grows well at one elevation or salinity level may not survive in another location.

Plant growth is also affected by genetic and environmental influences. Genetic influences are traits passed from parent plants. Environmental influences include sunlight, water, salt levels, sediment, temperature, and storms. Successful restoration requires appropriate plant species, healthy water flow, enough sediment, monitoring, and long-term care.

Case Study: Restoring Pine Creek Marsh

Pine Creek Marsh lost plant cover after repeated storms damaged its shoreline. The damaged area flooded often, and loose sediment washed away during high water. A restoration team prepared the site by adding sediment and planting nursery-grown smooth cordgrass plugs. The team chose smooth cordgrass because it can grow in regularly flooded, salty conditions.

For two years, the team measured plant survival and observed the marsh edge. Many plants survived, and the roots helped hold sediment in place. The restored area had more plant cover than it did before planting. However, the team was still unsure how future storms and rising sea levels would affect the new plants. They planned to continue monitoring the site.

Fill in the Blank

Fill in the blank with the correct words:

1. The process of growing new plants is called _____.
2. Growing a new plant from seeds is called _____ propagation.
3. Small groups of nursery-grown plants used in restoration are called _____.
4. The amount of salt in water or soil is called _____.
5. Checking a restored site over time is called _____.

Word Bank: monitoring, plugs, propagation, salinity, seed

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. What is assisted restoration?
 - A. Allowing all damaged ecosystems to recover without help
 - B. Taking actions to help an ecosystem recover
 - C. Building roads through a marsh
 - D. Removing all plants from a wetland
2. Which example shows vegetative propagation?
 - A. Growing a plant from a seed
 - B. Measuring the amount of salt in water
 - C. Growing a new plant from part of an existing plant
 - D. Moving sediment with stormwater
3. Why should restoration teams match plants to elevation and salinity?
 - A. Plants need conditions that support their growth and survival.
 - B. Every marsh plant grows best in the same location.
 - C. Elevation and salinity do not affect plant growth.
 - D. Plants can only grow in dry soil.
4. What evidence suggested that the Pine Creek Marsh restoration was helping?
 - A. The team stopped collecting data after one day.
 - B. Many plants survived, and more plant cover developed.
 - C. The marsh no longer had any water or sediment.
 - D. Every future storm was prevented.

5. Which factor is still uncertain in the Pine Creek Marsh case study?
- A. Whether future storms and sea-level rise will affect the plants
 - B. Whether the team used any plants
 - C. Whether the damaged area had loose sediment
 - D. Whether smooth cordgrass was planted

Open-Ended Questions

Answer the following questions in complete sentences:

1. Define propagation in your own words. Then explain the difference between seed propagation and vegetative propagation.

2. Describe two factors that restoration teams should consider before planting in a damaged salt marsh. Explain why each factor matters.

3. Use the Pine Creek Marsh case study to identify the original problem, restoration action, evidence of success, and one remaining uncertainty.

Answer Key

Fill in the Blank

1. propagation
2. seed
3. plugs
4. salinity
5. monitoring

Multiple-Choice Questions

1. B
2. C
3. A
4. B
5. A

Open-Ended Example Responses

1. Propagation is the process of growing new plants. Seed propagation grows plants from seeds. Vegetative propagation grows new plants from a piece of an existing plant, such as a stem or root section.
2. Teams should consider elevation because it affects how often a marsh area floods. They should also consider salinity because plants need salt conditions that support their growth. Teams may also consider sediment, water flow, sunlight, and storm conditions.
3. The original problem was that repeated storms damaged the shoreline, removed plant cover, and caused sediment to wash away. The restoration action included adding sediment and planting nursery-grown smooth cordgrass plugs. Evidence of success included plant survival, increased plant cover, and roots holding sediment in place. One remaining uncertainty was how future storms and sea-level rise could affect the restored plants.

Name _____ Date _____

Planting and Propagating Techniques:

Propagating Salt Marsh Grasses Module 5 Lesson 2

Reading Passage

Successful plant propagation requires careful planning and consistent procedures. Propagation is the process of growing new plants from seeds, cuttings, or nursery-grown plugs. During a planting investigation, teams must label containers clearly so they can identify each plant type and condition.

Before planting, students prepare the growing medium. The medium is the material that supports plant growth, such as soil or a soil mixture. Students should plant seeds or plugs at the correct depth. Planting too deeply may prevent a seedling from reaching the surface. Planting too shallowly may leave roots exposed.

Students should avoid compaction, which happens when the growing medium is pressed too tightly. Compacted medium has fewer spaces for air and water. Teams should water plants consistently and record starting conditions, including the plant type, medium, light condition, water amount, and planting date.

A fair comparison changes only one major variable. For example, a team could grow the same seed type in two different media. The plant type, container size, light, water amount, and planting depth should stay the same. Students can then compare how the medium affects growth. Teams should clean tools, return containers to assigned locations, and submit a labeled photograph and planting record.

Fill in the Blank

Fill in the blank with the correct words:

1. The process of growing new plants is called _____.
2. The material that supports plant growth, such as soil, is called the growing _____.
3. Pressing soil too tightly can cause _____.
4. A fair test changes only one major _____ at a time.

5. Students should record the planting date and other starting _____.

Word Bank: compaction, conditions, medium, propagation, variable

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. Why should students label planting containers clearly?
 - A. To identify the plant type and growing condition
 - B. To make the containers heavier
 - C. To avoid recording observations
 - D. To change the amount of sunlight
2. What may happen if a seed is planted too deeply?
 - A. It may have trouble reaching the surface.
 - B. It will receive too much sunlight.
 - C. It will become a different plant type.
 - D. It will not need water.
3. Which action helps prevent compaction?
 - A. Pressing the medium as tightly as possible
 - B. Leaving space for air and water in the medium
 - C. Adding a different plant to every container
 - D. Skipping the planting record
4. A team tests the same plant type in two different growing media. Which factor should remain the same?
 - A. The growing medium
 - B. The plant type
 - C. The major variable being tested
 - D. The comparison group
5. Which information belongs in a planting record?
 - A. The plant type, planting date, and water condition
 - B. A list of unrelated school supplies
 - C. A prediction with no plant information
 - D. Only the names of team members

Open-Ended Questions

Answer the following questions in complete sentences:

1. Describe the steps your team should follow when planting a seed or plug. Include labeling, planting depth, watering, and tool cleanup.

2. Design a fair comparison using one plant type in two different growing media. Identify the variable that changes and at least three conditions that should stay the same.

3. Explain why students should record starting conditions and individual observations during a planting investigation.

Answer Key

Fill in the Blank

1. propagation
2. medium
3. compaction
4. variable
5. conditions

Multiple-Choice Questions

1. A
2. A
3. B
4. B
5. A

Open-Ended Example Responses

1. Our team should first label each container with the plant type, condition, and date. Next, we should prepare the growing medium without pressing it too tightly. We should plant the seed or plug at the correct depth and water it consistently. After planting, we should record the starting conditions, clean the tools, and place the container in its assigned location.
2. We could plant the same type of seed in two different growing media. The variable that changes is the growing medium. The plant type, container size, planting depth, light condition, water amount, and observation schedule should remain the same.
3. Starting conditions help students know how each plant was treated at the beginning of the investigation. Individual observations help teams track changes in plant growth over time. These records can help students explain why one group grew differently from another group.

Name _____ Date _____

Monitoring Plant Growth and Care:

Propagating Salt Marsh Grasses Module 5 Lesson 3

Reading Passage

Scientists monitor plant growth by making careful observations over time. To compare plants fairly, students must measure each plant in the same way. Plant height should be measured from the surface of the growing medium to the tallest point of the plant. Students should not measure from the bottom of the container because containers may have different depths.

Teams can also record the number of shoots or leaves on each plant. A shoot is a new stem growing from the plant. For seeds, students may record germination. Germination happens when a seed begins to grow. For plugs or seedlings, students may record survival by noting whether each plant is alive and growing.

Plant condition includes color, leaf shape, and signs of stress. Healthy plants may have green leaves and firm stems. Plants may show stress if leaves turn yellow or brown, droop, or dry out. Students should also check the moisture condition of the growing medium. They can describe it as dry, slightly moist, or very wet.

Every observation should include the date and time. Teams should photograph each container from the same angle so changes are easier to compare. Students should not pull plants from the medium to inspect roots unless the teacher provides a separate sample for that purpose.

Plants need consistent care. Teams can make a rotating care schedule so each student knows when to check the plants. A student should never water a plant without recording the action. The care log should include the date, time, amount of water, and the student's name. Careful records help teams explain changes in plant growth.

Fill in the Blank

Fill in the blank with the correct words:

1. Plant height should be measured from the surface of the growing _____ to the tallest point.
2. When a seed begins to grow, the process is called _____.
3. A new stem growing from a plant is called a _____.

4. Students should record the date and _____ with each observation.
5. A written record of watering and plant care is called a care _____.

Word Bank: germination, log, medium, shoot, time

Multiple-Choice Questions

Choose the correct answer from the choices for each question:

1. Why should teams measure plant height from the medium surface?
 - A. It helps students use the same starting point for each measurement.
 - B. It makes every plant grow at the same speed.
 - C. It prevents students from recording data.
 - D. It shows the exact size of the plant's roots.
2. Which observation best describes plant condition?
 - A. The plant has green leaves and firm stems.
 - B. The container is on a classroom table.
 - C. The student likes the plant's name.
 - D. The team has completed a worksheet.
3. What should students do before watering a plant?
 - A. Pull the plant from the medium.
 - B. Record the watering action in the care log.
 - C. Change several growing conditions at once.
 - D. Remove the container label.
4. Why should teams photograph containers from the same angle?
 - A. It makes changes in plant growth easier to compare.
 - B. It guarantees every plant will survive.
 - C. It changes the moisture condition of the medium.
 - D. It removes the need to measure height.
5. Which action should students avoid unless the teacher provides a separate sample?
 - A. Counting leaves
 - B. Recording the date and time
 - C. Pulling up a plant to inspect its roots
 - D. Checking whether the medium is dry

Open-Ended Questions

Answer the following questions in complete sentences:

1. Describe how your team should measure and record plant growth consistently. Include height, one other observation, and the date and time.

2. Create a simple care-plan entry for one day. Include the student's name, date, time, moisture condition, watering action, and amount of water used.

3. Write a prediction about how your plant may change during the next week. Identify at least two types of evidence that would support your prediction.

Answer Key

Fill in the Blank

1. medium
2. germination
3. shoot
4. time
5. log

Multiple-Choice Questions

1. A
2. A
3. B
4. A
5. C

Open-Ended Example Responses

1. Our team should measure each plant from the surface of the growing medium to its tallest point. We should also count the number of leaves or shoots and describe the plant's color and condition. We should record every observation with the date and time.
2. On March 12 at 10:15 a.m., Jordan checked Container A. The growing medium was slightly dry. Jordan added 20 mL of water and recorded the action in the care log.
3. I predict that our plant will grow taller and produce more leaves during the next week. Evidence would include an increase in measured height and a higher number of leaves or shoots. Green leaves and firm stems would also support the prediction that the plant is healthy.

Module 6: Implementing the Restoration Project

Duration: 2 lessons, 50 minutes each, plus optional field-trip time

Preparation time: Approximately 45 minutes, with additional site planning

Module Overview

Students apply their learning in an authentic restoration experience. With qualified supervision and land-manager approval, students plant native salt marsh grasses at an appropriate site, document the work, establish monitoring procedures, and reflect on ecological stewardship.

Standards Addressed

- MS-LS1-5
- VA.SCI.2018.LS.9
- VA.SCI.2018.G6.9

Learning Objectives

Students will:

- Apply knowledge of adaptations, erosion, food webs, threats, and propagation.
- Follow an approved restoration plan.
- Plant native marsh grasses safely and appropriately.
- Establish a monitoring protocol.
- Explain how restoration may affect ecosystem conditions.
- Communicate the importance of conservation.
- Reflect on personal and community responsibility.

Vocabulary

Term	Student-Friendly Definition
Restoration site	A location selected for ecological improvement
Native species	A species that occurs naturally in a region
Planting plan	A map or set of directions showing where plants will be placed
Stewardship	Responsible care for the environment
Baseline	Initial information used for later comparison
Monitoring protocol	A consistent method for repeated observations

Term	Student-Friendly Definition
Survival rate	The proportion of planted organisms still alive after a period of time
Restoration success	Evidence that ecological conditions or functions are improving

Materials Needed

Fieldwork Supplies

- Approved native plants
- Planting tools approved by the site manager
- Gloves
- Waders or waterproof footwear only when approved
- Closed-toe shoes
- Eye protection if required
- Clipboards
- Field notebooks
- Waterproof labels
- Measuring tapes
- Flags or approved markers
- Water
- Sunscreen
- Insect protection
- First-aid supplies
- Trash bags
- Hand sanitizer
- Emergency communication device
- Camera or tablet
- Site map
- Student team lists
- Emergency contacts
- Weather and tide information

Classroom Supplies

- Restoration plan
- Site maps
- Monitoring forms
- Reflection prompts
- Presentation materials
- Certificates or celebration materials

Preparation

1. Select a site with a qualified restoration partner.
2. Obtain written permission and confirm planting dates.
3. Verify that the selected plant species are appropriate for site conditions.
4. Complete school field-trip approval.
5. Arrange transportation and chaperones.
6. Collect medical, emergency, and permission information.
7. Conduct a site risk assessment.
8. Check tides, weather, heat, water conditions, and site advisories.
9. Prepare a student safety briefing.
10. Divide students into supervised field teams.
11. Confirm tools, plants, water, and cleanup supplies.
12. Establish boundaries and no-entry areas.
13. Identify a first-aid and emergency meeting location.
14. Coordinate with the site manager about planting depth, spacing, elevation, and acceptable disturbance.
15. Prepare a monitoring schedule for the weeks following planting.

Lesson 1: Restoration Project Implementation

Pre-Field Briefing — 10 minutes

Review:

- Site purpose
- Planting plan
- Native species

- Proper tool use
- Wildlife protection
- Buddy system
- Boundaries
- Tide and weather conditions
- Leave-no-trace expectations

Students repeat key safety expectations before departure.

Site Orientation — 10 minutes

At the site, the partner explains:

- Marsh zones
- Tidal conditions
- Restoration goals
- Existing species
- Human impacts
- Why the location was selected

Students record baseline observations.

Planting — 25 minutes

Teams:

1. Locate the assigned planting zone.
2. Inspect the area without disturbing wildlife.
3. Plant according to partner instructions.
4. Label or map plantings if permitted.
5. Record plant type, location, and starting condition.
6. Photograph the completed area.
7. Remove all materials and debris.

Closure — 5 minutes

Each team shares one observation and one question about long-term restoration success.

Field Management Tips

- Use small supervised zones.
- Keep students moving through assigned stations.
- Never allow students to work alone.
- Place an adult at each boundary.
- Use visual signals for attention.
- Keep a live attendance count.
- Stop work immediately for lightning, unsafe tides, heat illness, or other hazards.

Lesson 2: Monitoring, Reflection, and Celebration

Monitoring Review — 10 minutes

Students review baseline data and learn how to compare future observations fairly.

Possible measures:

- Number of living plants
- Plant height
- Number of shoots
- Evidence of grazing
- Erosion or sediment movement
- Standing water
- Nearby species
- Signs of human disturbance

Data and Reflection — 20 minutes

Students complete:

- What did we do?
- What evidence did we collect?
- What changed?
- What might explain the change?
- What limitations affected our conclusions?
- What should happen next?

Communication Product — 15 minutes

Teams prepare a short presentation, poster, or digital report including:

- Site problem
- Restoration action
- Scientific reasoning
- Evidence
- Expected benefits
- Monitoring plan
- Recommendation

Celebration — 5 minutes

Recognize contributions such as:

- Careful observer
- Reliable data collector
- Safety leader
- Thoughtful communicator
- Collaborative scientist

Summative Assessment

Final Restoration Project Rubric

Criterion	4 — Advanced	3 — Proficient	2 — Developing	1 — Beginning
Scientific understanding	Accurately connects adaptations, growth, ecosystem relationships, and restoration	Explains major connections accurately	Includes partial or unclear connections	Shows limited understanding
Evidence and reasoning	Uses multiple relevant observations or data and explains their significance	Uses relevant evidence with reasonable explanation	Uses limited evidence or weak reasoning	Provides little evidence
Restoration practice	Follows procedures independently and protects site conditions	Follows procedures with minor reminders	Needs frequent reminders	Does not consistently follow procedures

Criterion	4 — Advanced	3 — Proficient	2 — Developing	1 — Beginning
Monitoring plan	Includes clear, repeatable measures and timing	Includes appropriate measures	Measures are incomplete or inconsistent	Monitoring plan is missing or impractical
Collaboration	Consistently supports team and fulfills role	Participates responsibly	Participation is inconsistent	Rarely contributes appropriately
Communication	Clear, accurate, organized, and audience-appropriate	Clear and accurate	Some organization or accuracy problems	Difficult to follow or incomplete
Reflection	Thoughtfully evaluates impact, limitations, and next steps	Identifies impact and next steps	Gives a basic reflection	Provides minimal reflection

Differentiation

- Provide field roles matched to student strengths.
- Offer seated observation or mapping roles when mobility is limited.
- Provide visual safety instructions.
- Use audio-recorded reflections.
- Pair students with trained peers.
- Offer alternative virtual or schoolyard restoration activities if fieldwork is not accessible.
- Invite advanced students to design a monitoring schedule or analyze site data.

Extension Activities

- Monitor the site monthly.
- Compare planted and unplanted areas.
- Conduct a shoreline photo-point study.
- Share findings with families or a community partner.
- Create a school salt-marsh stewardship campaign.
- Present recommendations to a local environmental committee.
- Develop a long-term student restoration team.

Program Conclusion and Reflection

Conclude the program with a Salt Marsh Scientists symposium. Students display:

- Root-system models
- Erosion data
- Food webs
- GIS maps
- Propagation logs
- Restoration photographs
- Conservation action plans

Suggested reflection prompts:

1. How did your understanding of salt marshes change?
2. Which investigation provided the strongest evidence?
3. How are plants, animals, and people connected to marsh health?
4. What restoration challenge remains unanswered?
5. What action should Hampton Roads communities prioritize?
6. How can students influence environmental decisions?

Invite families, administrators, local scientists, parks staff, watershed groups, and restoration partners. Students may present brief evidence-based talks or host interactive stations.

Appendix

Hampton Roads Salt Marsh Species List

Plants and Producers

- Smooth cordgrass
- Salt meadow hay
- Black needlerush
- Glasswort
- Saltwort
- Sea lavender
- Seashore saltgrass
- Sea oxeye
- Phytoplankton
- Algae

Invertebrates

- Ribbed mussel
- Eastern oyster
- Blue crab
- Fiddler crab
- Grass shrimp
- Marsh periwinkle
- Mud snail
- Amphipod
- Polychaete worm
- Mosquito larvae
- Dragonfly
- Damselfly
- Clam
- Barnacle

Fish

- Mummichog
- Atlantic killifish
- Striped bass
- Atlantic menhaden
- Sheepshead minnow
- Fundulus species
- Pipefish
- Juvenile bluefish

Reptiles and Amphibians

- Diamondback terrapin
- Eastern mud turtle
- Green frog
- Bullfrog
- Northern water snake

Birds

- Saltmarsh sparrow
- Clapper rail
- Great blue heron
- Great egret
- Snowy egret
- Osprey
- Red-winged blackbird
- Marsh wren
- Belted kingfisher
- Willet
- Greater yellowlegs
- Terns
- Gulls

Mammals

- Muskrat
- Raccoon
- River otter
- Virginia opossum
- White-tailed deer
- Red fox
- Feral or domestic animals as human-impact examples

Decomposers and Microorganisms

- Bacteria
- Fungi
- Detritivorous worms
- Microbial communities in sediment

Teachers should verify species presence at the selected local site and clarify that some organisms use marshes seasonally or during only part of their life cycle.