

GROWING THE FUTURE: **A YOUTH-LED SEAGRASS RESTORATION MODEL**



AMIKIDS

**EMPOWERING YOUTH TO BE
ENVIRONMENTAL ADVOCATES**



AMI KIDS



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INTRODUCTION

Florida's coastal ecosystems are among the most biologically diverse and economically valuable in the world, supporting a wide range of marine life and providing critical services such as carbon sequestration, water filtration, and coastal protection.

Seagrass meadows play a critical role in maintaining the health of these coastlines by stabilizing sediments, reducing erosion, and protecting against storm surges. The loss of seagrass habitats has led to increased vulnerability to coastal erosion and flooding, issues that are exacerbated by rising sea levels and more frequent and intense storms.

Extreme weather events and rising sea levels pose significant threats to communities in Florida, exacerbating existing social and economic disparities. Many communities are located in low-lying areas that are particularly susceptible to flooding, making citizens at risk of displacement and property damage during extreme weather events. With limited access to resources, including financial aid and emergency services, residents often struggle to rebuild after storms or adapt to changing conditions.

Restoring aquatic environments, particularly seagrass meadows, presents a myriad of challenges:

Initiating restoration projects can require substantial financial investment for activities such as transplanting seagrasses, monitoring ecosystems, and managing water quality, but the returns on these investments can be significant.

Additionally, the dynamic nature of aquatic environments makes it difficult to maintain restored areas, as they are susceptible to changes in water levels and salinity, which can undermine restoration initiatives. Engaging local communities and incorporating traditional ecological knowledge are also critical for successful restoration, yet these approaches can be challenging to implement effectively.

Therefore, a holistic and adaptive management strategy is essential to overcome these hurdles and ensure the long-term recovery of seagrass meadows.

YOUTH ACCESS TO EXPERIENTIAL LEARNING & STEM EDUCATION

Youth face significant barriers to accessing experiential STEM learning opportunities. **Fewer than 20% of U.S. high school seniors show proficiency or interest in STEM careers** (National Science Board, 2021).

Studies have shown that hands-on, experiential learning is crucial for deep understanding and retention of STEM concepts, yet many youth still face limited access to these opportunities.

THE OPPORTUNITY: ADDRESSING ENVIRONMENTAL AND EDUCATIONAL NEEDS

The degradation of Florida's seagrass meadows is a critical challenge but also a chance to address environmental and educational needs. **Engaging youth in hands-on restoration efforts not only combats this crisis but also provides valuable STEM learning opportunities.** Seagrass restoration has proven effective, with some projects achieving 80% recovery in five years through proper techniques and community involvement. Additionally, restoring seagrass benefits other coastal ecosystems like mangroves, dunes, and wetlands, boosting biodiversity and ecosystem resilience.

RELEVANCE TO FLORIDA AND COASTAL ECOSYSTEMS

Florida's coastal ecosystems are essential to the state's economy and quality of life, supporting over 21 million residents and 100 million annual visitors. Seagrass meadows play a key role by stabilizing sediments, reducing erosion, and protecting against storm surges. However, their loss increases vulnerability to erosion, flooding, and the intensifying impacts of climate change.

Restoring seagrass meadows is critical not only for environmental health but also for safeguarding communities and Florida's economy. Engaging youth in these efforts bridges this environmental need with a critical gap in STEM education. **Hands-on restoration projects provide real-world STEM experiences, preparing the next generation for careers in science and conservation.**

With support from Florida Sea Grant, AMIkids created the *Youth-Led Seagrass Restoration Model*. This replicable framework enables youth-serving organizations to restore critical ecosystems sustainably while empowering young people as environmental stewards, ensuring a healthier future for Florida and beyond.



Experiential learning is crucial for deep understanding and retention of STEM concepts

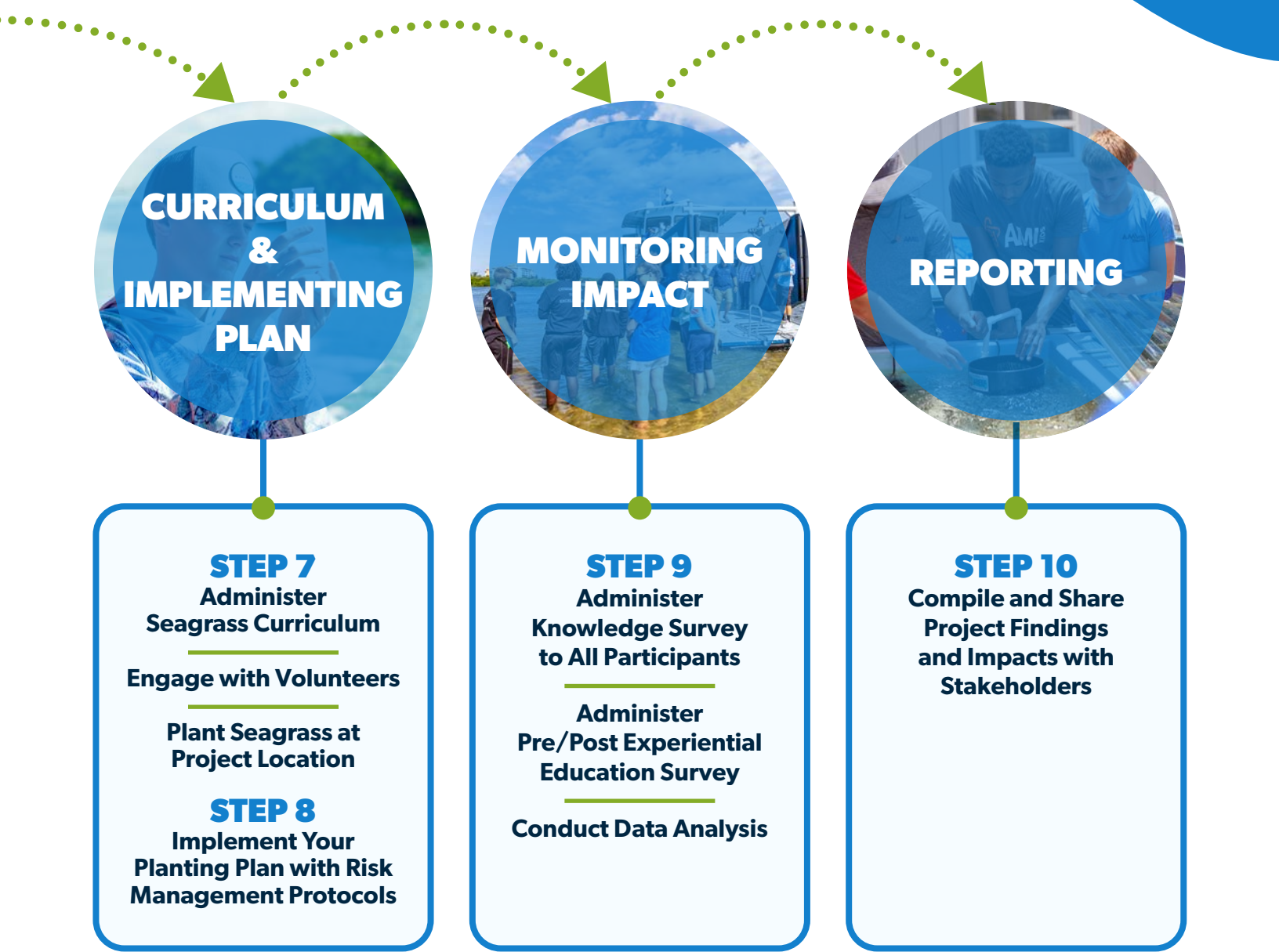
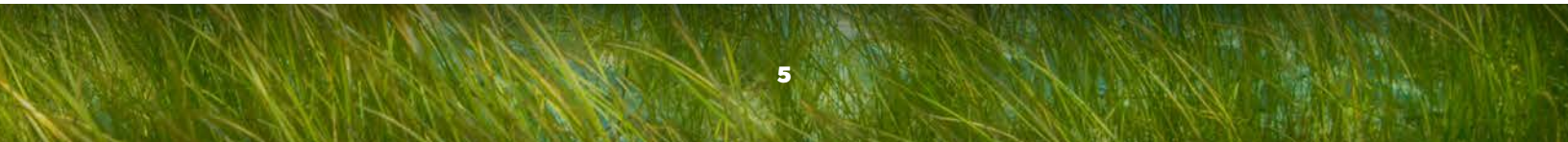
Less than 20% of U.S. high school seniors show proficiency or interest in STEM careers

SEAGRASS RESTORATION: A COMPREHENSIVE PLAN OVERVIEW

The Seagrass Restoration Implementation Plan, outlined on the following pages, is a structured, multi-phase model designed to restore and protect essential seagrass ecosystems while offering valuable STEM learning opportunities.

This visual guide outlines key actions, milestones, and environmental goals, helping to organize and execute the plan effectively.





A STEP-BY-STEP IMPLEMENTATION PLAN

STEP 1: IDENTIFY PROJECT PARTNERS

When identifying project partners for a youth-driven seagrass restoration initiative, prioritize those with mission alignment, environmental sustainability and marine conservation goals. Ideal partners include local environmental organizations, government agencies, academic institutions with marine science expertise, and businesses focused on habitat restoration. Engaging volunteers can also enhance community involvement and expand the project's impact.

Start with a resource inventory. Here are some examples:

UNIVERSITIES

Are there Marine Biology and Environmental Science departments that could partner with you? Universities often have research grants and academic studies focused on seagrass ecosystems, offering volunteer opportunities for students to assist with fieldwork and data collection.

This collaboration could help reduce costs and provide access to specialized resources, such as GIS mapping tools and laboratory facilities.

Additionally, partnering with a university or college can open up opportunities for joint research projects and publications, increase your organization's visibility through workshops and educational outreach, and provide interns or capstone projects focused on seagrass planting.

BUSINESSES

Private or public corporations can provide financial sponsorships or donations for materials and logistics and well as in-kind contributions, such as boats, diving equipment, or office supplies. **Many businesses are looking for employee volunteer programs for planting activities and could support your project.**

In addition, corporations usually are able to provide marketing support through promotional campaigns that highlight their corporate social responsibility (CSR) initiatives tied to environmental sustainability, allowing co-branding. Corporations can provide your youth serving organization with access to events that help promote your seagrass restoration project and build relationships.



Find strategic partners that align with your organization's goals and values.

Partners should bring varied areas of expertise including geographical relevance, educational validity, logistics and operational capacities.

ENVIRONMENTAL ORGANIZATIONS

Environmental organizations can offer technical expertise in marine restoration practices and have established networks for advocacy and public awareness. They are also familiar with grant and funding opportunities specific to conservation and can provide training programs for volunteers and staff.

Partnering with these organizations can expand the reach of your initiative, optimize resources, and create opportunities for joint campaigns. Co-hosting planting events and community clean-ups is another way to enhance your efforts while reducing costs.

VOLUNTEERS

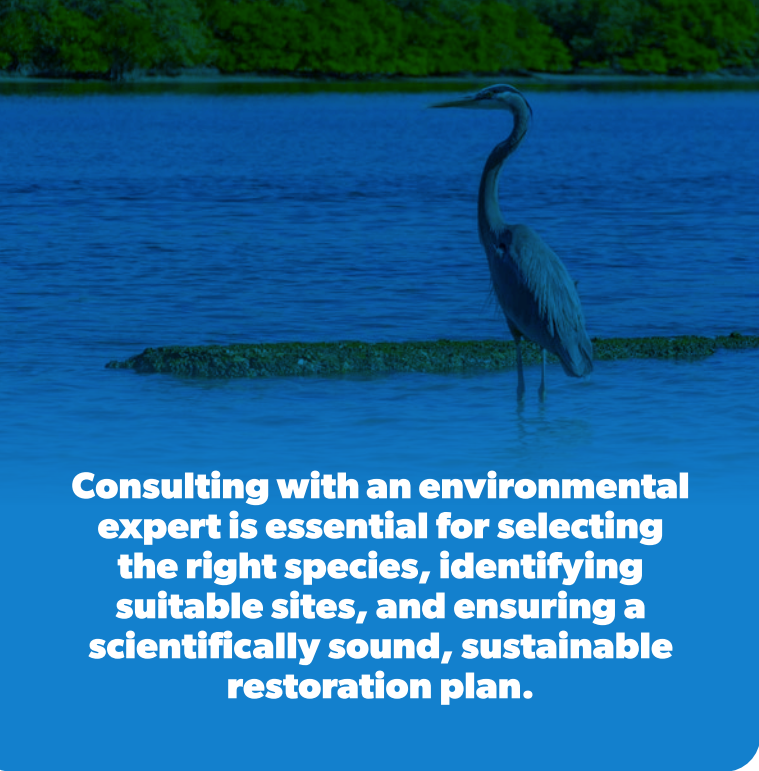
A well-organized volunteer program for your seagrass restoration efforts offers great benefits, including cost savings, community engagement, youth mentorship, and skill development. By engaging both youth and adult volunteers, this model fosters a diverse, energetic team dedicated to the cause. Partnering with local organizations, particularly through corporate social responsibility (CSR) initiatives, can enhance community involvement and support. While managing logistics, safety, and consistency can be challenging, the rewards of building stronger community ties and expanding impact make it worthwhile.



Guidelines for a successful volunteer program are available in Appendix A.

KEY TAKEAWAY FOR IDENTIFYING PROJECT PARTNERS

- Partners should empower youth in roles like conservation, data collection, and outreach.
- Organizations focused on youth, environmental education, and community engagement can lead workshops and drive youth participation.
- Partners are encouraged to support both short-term execution and long-term monitoring by offering resources such as equipment, funding, and expertise.
- Local partners help secure stakeholder support and ensure long-term sustainability.



Consulting with an environmental expert is essential for selecting the right species, identifying suitable sites, and ensuring a scientifically sound, sustainable restoration plan.

STEP 2: ENGAGE WITH AN ENVIRONMENTAL CONSULTANT

Consulting with an environmental expert is critical to ensure that the project is scientifically sound and effective. An environmental consultant can provide valuable guidance on the selection of appropriate seagrass species for restoration, considering local ecological conditions such as water quality, salinity, and current seagrass coverage. A consultant can also help identify suitable restoration sites that have the potential for success, taking into account factors such as water depth, sediment type, and hydrodynamics.

Additionally, the consultant can assist in designing a scientifically robust restoration plan, including the most effective restoration techniques, such as the best practiced transplantation methods, and help establish clear monitoring and evaluation methods to track progress and measure success.

An environmental consultant can help navigate regulatory requirements for marine conservation, permitting, and protected areas while assessing potential impacts of restoration on local ecosystems, including fisheries and marine life. **By engaging a consultant early in the planning process, the project can adopt best practices, ensure compliance with legal frameworks, and align with ecological goals.** This proactive approach builds a strong foundation for sustainability and long-term success.

STEP 3: IDENTIFY PROJECT AREA

Project area selection should consider environmental factors such as clear, shallow waters with good sunlight penetration, proper salinity, and stable sediments, all vital for seagrass growth. Ideal sites are those with a history of seagrass presence, even if degraded by pollution, development, or overfishing. An environmental consultant can help identify suitable areas and use historical data, such as seagrass habitat maps from the Southwest Florida Water Management District, to guide the process.

Restoration should focus on areas with potential for regrowth through natural recolonization or suitable conditions. Consult local municipalities, government agencies, and marine experts to ensure the selected area aligns with other conservation efforts and does not conflict with existing uses. Engaging local stakeholders early builds support, minimizes conflicts, and ensures long-term success. **Including youth in the process enhances education and deepens their connection to the project, especially if the site is near their community.**

IDENTIFYING PERMITTING REQUIREMENTS

It's helpful to engage with an environmental consultant to navigate the complex permitting process, ensuring compliance with all regulatory frameworks and avoiding potential delays or violations during the project. **If the selected project area is not already permitted through another entity, permits will need to be obtained** through agencies including, but not limited to, the Army Corps of Engineers and the appropriate Department of Environmental Protection. Additionally, the project team should consider any potential environmental impact assessments (EIAs) that may be required, particularly if the restoration activities could affect surrounding ecosystems or communities.

STEP 4: UNDERSTAND YOUR BUDGETING NEEDS

Developing a well-structured budget is critical to a successful seagrass restoration project, ensuring all necessary costs are covered and resources are allocated efficiently. Careful financial planning helps prevent delays or interruptions due to unforeseen expenses, allowing the project to proceed smoothly.

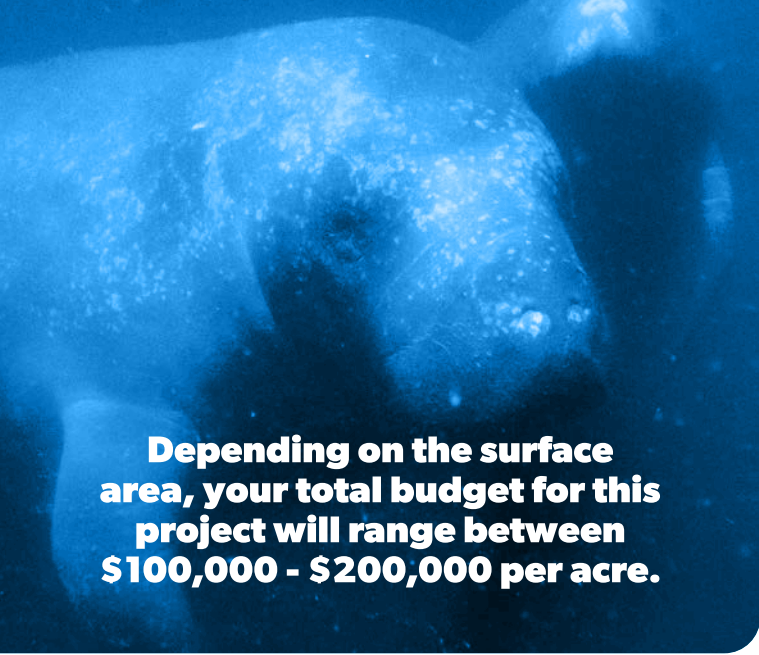
Planting seagrass is a seasonal activity. Depending on when you start your project, you most likely have expenses to forecast spanning over two years. This timeframe could increase depending on your participant length of engagement and monitoring/reporting strategies.

The budget should include administrative and personnel costs, such as salaries for the project manager, field technicians, and marine scientists. For youth-driven projects, incentives for volunteers can help maintain engagement.

A significant portion of the budget will go toward equipment and materials, including planting tools, underwater cameras, GPS units, monitoring instruments, and transplant supplies. Depending on the project's scale, boats or SCUBA gear may also be necessary. Construction and restoration costs should account for site preparation, removal of invasive species, and protective measures. Labor expenses for planting and site maintenance should also be factored in.

Post-restoration monitoring and reporting are essential for measuring outcomes and ensuring long-term success. The budget should cover data collection, analysis, maintenance of protective measures, and potential replanting efforts. Transparent reporting helps maintain stakeholder and funder confidence while informing future projects.





Depending on the surface area, your total budget for this project will range between \$100,000 - \$200,000 per acre.

Additional expenses may include compliance with environmental regulations, permitting fees, and consulting costs to navigate legal requirements.

Lastly, a contingency fund of 5-10% is recommended for unexpected costs, such as equipment repairs or price fluctuations. A well-prepared budget supports effective implementation, demonstrates financial accountability, and ensures the project stays on track. Regular reviews will help manage resources and achieve project goals.

To assist with financial planning, the budget template in Appendix B outlines common costs, including goods sold and operating expenses, for seagrass restoration. Use it as a guide to project revenue, track expenses, and monitor your financial position.



A project budget template is available in Appendix B.

STEP 5: FUNDING YOUR INITIATIVE

Once you understand your budgeting needs, including the costs associated with retaining an environmental consultant and securing a suitable project area, utilize your partner inventory to determine how each one of them can help you secure funding.

The first step at this stage is to define the objectives and needs that you want each partner to meet by clearly outlining the goals of the seagrass planting initiative and identifying the specific areas where partnerships can provide support (e.g., funding, expertise, equipment).

Once you understand who you want to ask for what, **develop a compelling pitch that includes the overview of your seagrass initiative, its significance, and the benefits of partnering on this effort with your agency (e.g., visibility, mission alignment, social responsibility)**. Make sure that you include a clear call to action for your specific requests (e.g., resources, financial support).

Although a written proposal is a great start, **your ultimate goal is to engage your partners and work tirelessly to build relationships with them**. You can achieve this by arranging introductory meetings or presentations, and highlighting the mutual benefits and shared values. As you partner with others, your project will evolve and you must be open to collaboration ideas from them. The more your partner participates, the more shared your project becomes, which ultimately determines the investment they will be willing to make.

Once you come to an understanding about your shared mission, make sure you work to formalize your agreements. You can do this by drafting Memorandums of Understanding (MOUs) or other agreements detailing the roles and responsibilities of each party in terms of the expected contributions and timelines, as well as plans to recognize and acknowledge your partners.

Obtaining a funding agreement for your project is just the beginning; in order to develop a sustainable and mutually beneficial partnership you will need to have a plan to maintain and strengthen those partnerships. Do this by regularly communicating progress and milestones, sharing success stories and highlighting your partner's contributions, and organizing appreciation events or giving awards for their contributions.

STEP 6: DEVELOP A PLANTING PLAN

Permitting takes time – but focusing on pre-construction surveys and the planning process will keep you moving during this period. Working on your Planting Plan will help determine significant elements of the project, such as which species to utilize and which method to employ for obtaining and installing the plants.

Your Planting Plan will also address permit compliance, logistics, operational safety, monitoring and evaluation. For an organization utilizing youth and/or volunteers to perform seagrass restoration work, the Planting Plan should also include curriculum for each component these audiences will be involved with, as well as a general overview of the overarching environmental mission of the project.

The process of developing your Planting Plan is an excellent opportunity to begin involving youth in the project. The more that the youth have a role in the design of the project, the more ownership they are likely to feel, and the more personal investment they may have for the project. This may not be possible in all circumstances; however, consider the opportunity to represent the voice of the youth during this stage of the planning process.



Details about the Planting Plan are available in Appendix C.



STEP 7: ADMINISTER AN ENGAGING CURRICULUM

The curriculum should include at least four key elements: an introduction to seagrass ecology, biology, and physiology; the ecological services seagrass provides; the current threats to seagrass ecosystems; and the foundational knowledge necessary for effective seagrass conservation and restoration. The field component should equip students with practical skills to transplant seagrass into restoration sites, including installation methods.

Youth takeaways from the curriculum should include an understanding of seagrasses' impact on the local environment, a sense of civic duty, and the empowerment to take proactive steps in preserving their community. This essential knowledge will enable youth to actively engage in hands-on learning and apply what they've learned in meaningful ways.



A sample curriculum is available in Appendix D.

STEP 8: IMPLEMENTING YOUR PLANTING PLAN

When planning hands-on seagrass restoration activities, safety should be the top priority.

Your general risk management strategies should consider adult-to-child ratios, supervision policies, regular checks, communication and reporting procedures, particular risk assessment needs, privacy, confidentiality, and documentation.

It is fundamental to have a child protection policy that establishes a zero-tolerance policy for any form of child abuse, neglect, or exploitation. You must create a positive and supportive environment where minors feel safe and respected.

Working in and around water has inherent risks. To address these, you need to have a water safety policy governing all fieldwork activities. This policy needs to include the proper risk assessment components, including participant training, required equipment, first aid, and emergency planning.



Risk management guidelines are available in Appendix E.

STEP 9: MONITOR YOUR IMPACT

The monitoring and evaluation section of your Planting Plan should include clear, measurable success indicators, such as seagrass growth rates, plant survival, biodiversity improvements, and water quality parameters. Your environmental consultant will provide specifics for monitoring and operational guidance for youth and volunteers to carry out these tasks.

However, monitoring your impact in terms of both young people's and volunteers' attitudes and perceptions of conservation efforts is equally important.

EVALUATION OF SEAGRASS INITIATIVE

A critical component of any initiative is to measure its effectiveness and impact. With the Seagrass Initiative, there are two areas of evaluation:

1. **Knowledge gained by youth and volunteers completing the seagrass curriculum, and**
2. **Changes in attitudes and perceptions of youth as a result of their participation.**

Knowledge Gain: Youth and volunteers participating in the Seagrass Initiative work through a formalized curriculum with modules designed to increase awareness and knowledge of seagrass, its importance to our environment, and how to cultivate and plant new seagrass.

As such, the Seagrass Knowledge Assessment allows for the host organization to evaluate its effectiveness in achieving this goal. The assessment found in Appendix E aligns with key concepts that all participants should retain after completing the curriculum.

This survey may be built into a learning management platform to accompany e-delivery of the curriculum or administered to youth and adult participants on paper or electronically through a survey tool such as SurveyMonkey.



Monitoring your impact in terms of both young people's and volunteers' attitudes and perceptions of conservation efforts is equally important.



The Seagrass Knowledge Assessment is available in Appendix F.

Long-term Impact and Social Outcomes: At the core of the Seagrass Initiative is informing youth about their role in environmental stewardship, career exploration, working together with peers towards a common goal, and promoting confidence and self-efficacy skills that will last throughout their lifetime.

The survey sample provided in Appendix F consists of four externally validated scales, which can be administered both before and after participation to measure changes in:

1. **Positive peer relations and social competence** (*adapted SEQ-C subscale; Muris, 2001*),
2. **Career exploration** (*Vocational Identity Status Assessment – In-Depth Career Exploration Scale; Porfeli, Lee, Vonderacek, & Weigold, 2011*),
3. **Self-efficacy and confidence** (*New General Self-Efficacy; Chen, Gully, & Eden, 2001*), and
4. **Environmental preservation** (*2-Major Environmental Values (2-MEV) Scale; Bonger & Wisemen, 1999*).

Additional measurement options are also included for programs that intentionally focus on elements such as civic efficacy (Ballard, Caccavale, Buchanan, 2015); resource mobilization (Youth Empowerment Solutions (YES); Zimmerman et al., 2018); civic engagement (Zaff, Boyd, Li, Lerner, & Lerner, 2010); and/or community belonging (Canadian Community Health Survey).



The Youth Experiential Education Survey Sample is available in Appendix G.



STEP 10: REPORTING

This is the final step of your implementation plan. Reporting on your project's success should include an analysis of the evaluation data collected and a discussion of any reporting requirements from funders or stakeholders. This will help you effectively communicate your efforts and passion for the mission.

Good reporting will give your project future visibility and enhance your partnerships, helping you obtain funding for other environmental restoration projects. Reporting is an opportunity to highlight your stakeholders and recognize your supporters.

Review your resource inventory and current partnerships to identify opportunities for impactful collaboration in communicating the project's success. Consider the following ideas:

- **Print Reports:** A high-quality print report with striking images, statistics, and testimonials will immortalize your project and outcomes. This is a great asset, as you can distribute it to partners and stakeholders as a keepsake, as well as highlight sponsorships and other in-kind or monetary contributions.
- **Highlight Videos:** Compiling social media and other assets produced during the project into a highlight reel will bring long-lasting digital exposure to your project. Videos of this kind generally remain relevant online longer than other content. Depending on the depth of your resources, a highlight video can range from a short, self-produced clip to long-form documentaries featuring your organization.
- **White Papers:** If your partner list includes research organizations, sponsoring a white paper can help your organization establish thought leadership in the field and help position your organization as a trusted authority in the industry. This generally enhances brand awareness in niche markets and can increase visibility and recognition of your organization's brand while reinforcing your organization's messaging and values.



Reporting on your project's success will help you communicate your efforts and passion for the mission, enhance your partnerships and communicate your outcomes.

YOUTH-LED SEAGRASS RESTORATION MODEL

APPENDIX A-G





APPENDIX A: GUIDELINES FOR A SUCCESSFUL VOLUNTEER PROGRAM

RECRUITMENT

- Post on social media, local newspapers, and environmental websites. Benevity and Volunteer Florida are popular platforms you can use to promote your program.
- Review your resources to find volunteers in the your network of schools, universities, and conservation groups.
- Attending community events and promoting your program locally.
- Use eye-catching flyers and brochures to grab attention.

SCREENING PROCEDURES

- **Create an Application Form:** Include questions about volunteers' experience, skills, and availability. Allow for secure submission of resumes and government-issued IDs to protect sensitive information. Ensure that the form also asks about prior experience working with youth. To promote inclusivity, design the form to be accessible to individuals of diverse backgrounds and abilities, and provide clear instructions for securely submitting sensitive data.
- **Conduct Interviews:** You must ensure the interviews discuss expectations, goals, and safety protocols.
- **Conduct Background Checks:** When working with young people, you need to ensure safety and trustworthiness. It is crucial that you check your volunteers against the National Sex Offender Registry and local and state law enforcement records. This process is usually conducted by fingerprinting. Familiarize yourself with state and local background checks, training, and supervision regulations.

ONBOARDING PLAN

- **Welcome Packet:** Volunteers work because they feel their time and effort is valuable to your cause. They need to feel welcome and acknowledged. Good communication is key as different people need different types and depth of information. You can achieve this by providing a general program overview, safety guidelines, and contact information in a written and standardized welcome packet.
- **Orientation Session:** Start by introducing everyone on the team by name, providing general information about the facility and schedule and discussing expectations. Make sure you provide thorough answers to everyone's questions.
- **Training Session:** Teach seagrass restoration techniques and safety procedures in a controlled environment first. This will speed up your fieldwork in a much more dynamic environment.
- **Buddy System:** Pair new volunteers with experienced ones.

RECOGNITION AND ACKNOWLEDGMENT

- Send thank-you notes and emails: Show appreciation for their time and effort.
- Social media shoutouts feature volunteers and their accomplishments.
- Volunteer appreciation events: celebrate milestones and achievements.
- Certificates of completion: recognize their contributions and skills gained.

VOLUNTEER COORDINATOR

To have a successful program, you must assign someone the Volunteer Coordinator role. A team member or even a veteran volunteer could fulfill this role.

The responsibilities of a volunteer coordinator include:

- Recruiting, screening, and onboarding volunteers.
- Coordinating volunteer schedules and activities.
- Providing training, guidance, and support.
- Ensuring safety protocols and environmental integrity.
- Fostering a positive and inclusive volunteer community.
- Setting clear goals, expectations, and safety protocols.
- Role modeling behaviors.
- Providing necessary equipment, tools, and resources.
- Encourage feedback, suggestions, and ideas.
- Celebrate milestones, achievements, and successes.
- Continuously evaluate and improve your program.



APPENDIX B: PROJECT BUDGET TEMPLATE

General Expenses	Year 1			
	Q1	Q2	Q3	Q4
Revenue				
Corporate Sponsorships				
Government Grants				
Other				
COGS				
Pre-planting:				
Site preparation				
Invasive species removal				
Planting:				
Plants & Seedlings				
Field Technicians				
Materials and Supplies				
Ground Transportation				
Boats				
Fuel				
Volunteer training				
Volunteer incentives				
Meals & Refreshments				
Monitoring:				
Laboratory				
Water Sampling				
OpEx				
Permitting				
Advertising and Promotion				
Insurance				
Administration				
Project Management				
Reporting				

- **A contingency fund of 5-10% of the total budget is recommended.**
- **Depending on the surface area, your total budget for this project will range between \$100,000 and \$200,000 per acre.**

General Expenses	Year 2			
	Q1	Q2	Q3	Q4
Revenue				
Corporate Sponsorships				
Government Grants				
Other				
COGS				
Pre-planting:				
Site preparation				
Invasive species removal				
Planting:				
Plants & Seedlings				
Field Technicians				
Materials and Supplies				
Ground Transportation				
Boats				
Fuel				
Volunteer training				
Volunteer incentives				
Meals & Refreshments				
Monitoring:				
Laboratory				
Water Sampling				
OpEx				
Permitting				
Advertising and Promotion				
Insurance				
Administration				
Project Management				
Reporting				

- **A contingency fund of 5-10% of the total budget is recommended.**
- **Depending on the surface area, your total budget for this project will range between \$100,000 and \$200,000 per acre.**



APPENDIX C: ELEMENTS OF A PLANTING PLAN

PRE-CONSTRUCTION SURVEYS

Once a project area has been selected and the permitting process has been set in motion, the team should anticipate approximately 4 to 6 months of time for preparations before receiving a permitted start date.

During this period, pre-construction surveys can be completed so long as it is within the seagrass growing season (March to October) of the year that the restoration work will be taking place. These surveys will establish the baseline conditions of the restoration site, including the current state of seagrass coverage, water quality, and sediment characteristics.

The survey provides valuable data for selecting the most suitable restoration techniques and setting monitoring benchmarks to track the project's success over time. Resources on how to conduct seagrass surveys can be found on the website for the Tampa Bay Water Atlas (n.d.) and the Sarasota Water Atlas (2015).

TIMELINE

Include a detailed timeline outlining the anticipated approximate dates for installation of acreage.

SPECIES AND INSTALLATION METHOD SELECTION

Based off the results of the pre-construction survey, the team can begin to refine what is referred to as a Planting Plan for the restoration project. At this stage details such as seagrass or submerged aquatic vegetation species selection(s) and installation method(s) can be established based upon what is most appropriate for the conditions at the project area, i.e. sediment type and stability, hydrodynamics, water depth, salinity, light attenuation.

Best practiced planting methods for different environments as well as the ideal spacing of planting units within a restoration area based upon available plant material and physical size of the restoration area can be found in literature (U.S. National Oceanic and Atmospheric Administration [NOAA], 2006) or ascertained from environmental consultants or other field experts with specialized knowledge and experience.

PLANTING SPECS

How many planting units (PU) will comprise an acre, and how many PU will be installed during each phase of the project as outlined in the timeline section.

PLANT SPECS

PU type being used for the project and specifics on how many plants make up a single PU, as well as any other materials being used for PU fabrication.

CONTRACTING A CERTIFIED AQUACULTURE FACILITY

Determine which certified aquaculture facility you will contract with to obtain the appropriate plant material for the restoration project. These facilities specialize in cultivating and growing marine plants, including seagrass, under controlled conditions, which can be essential for large-scale restoration projects that require high-quality, healthy seagrass stocks. By working with a certified facility, the project team can ensure that the seagrass is grown using sustainable practices, free from contaminants, and genetically appropriate for the restoration site.

ENSURE PERMIT COMPLIANCE

Once permits have been issued, the team can review the preliminary Planting Plan to ensure that all methods adhere to the stated requirements within the permit and that the plan in its entirety is in accordance with permit compliance.

The types of regulations include restriction of materials used in seagrass transplantation, limitation on seabed modifications, and use or introduction of foreign materials to seabed or water column. Requirements for monitoring and documentation will also need to be adhered to according to the language of the permit. The permit will also outline requirements for plant material acquisition methods and acceptable timeframes from harvest to installation.

ESTABLISH PLANTING PLAN INSTALLATION LOGISTICS

Planning the logistics of seagrass installation involves setting a timeline for executing the Planting Plan, coordinating transport from aquaculture facilities, and ensuring proper handling and storage to maintain plant health while complying with permits.

The project team must organize equipment, such as boats and planting tools, and personnel to ensure efficient installation. The number of planting units installed at a time depends on available resources. The installation phase must be completed before time-zero monitoring and the construction deadline.

Delays, such as weather, may require permit extensions. The timeline will be influenced by factors like project size, available labor, equipment, and plant material. Consulting an environmental expert will help estimate realistic installation timelines.

MONITORING AND EVALUATION

A comprehensive monitoring and evaluation (M&E) plan is essential to assess the success of restoration efforts. The plan should include measurable indicators such as seagrass growth rates, plant survival, biodiversity improvements, and water quality metrics. Data collection methods, like transect surveys, quadrat sampling, and remote sensing, should be defined, along with collection frequency.

Monitoring typically occurs at time zero, every six months for the first two years, and annually thereafter. If resources are limited, consider subcontracting monitoring services. Monitoring must also meet permit requirements, including specific timeframes and reporting responsibilities.



APPENDIX D: SEAGRASS RESTORATION CURRICULUM

The lessons that follow will introduce learners to seagrass, increase awareness around the critical role seagrass plays in marine environments, identify threats and explore how to conserve and restore seagrass ecosystems.

By the end of these lessons, learners have a better understanding of seagrass ecology, their threats, and their conservation strategies. They will be equipped with the knowledge and basic skills required to contribute to the protection and restoration of these vital marine ecosystems.

Lesson Plan: Introduction to Seagrass

Grade Level: Middle School/High School

Duration: 40 minutes

LEARNING OBJECTIVES

By the end of this lesson, learners will be able to:

1. Define what seagrass is and differentiate it from seaweed.
2. Explain the ecological importance of seagrass.

MATERIALS

- Visual aids (images or videos of seagrass meadows and marine life).
- KWL Graphic Organizer.
- Seagrass Species Profile Sheet.

LEARNING ACTIVITIES

Introduction (5 minutes)

1. Using a KWL graphic organizer, ask learners to reflect on everything they know (or think they know) and wonder (or want to know) about seagrass.
2. Instruct them to list what they know or think they know in the K column and what they wonder or want to know in the W column. (The L column will stay empty until the end of the module. There learners will add what they have learned about seagrass).
3. Key Vocabulary: *Ecosystem, Habitat, Biodiversity*.

Exploration (20 minutes)

- Explain that seagrass is a flowering plant that grows underwater in shallow, coastal marine environments and that it differs from seaweed (algae) in the following ways: seagrass has roots, flowers, and seeds, unlike algae.

Locate a brief (less than 5 minutes) video about seagrass and play it for learners. (Ex: [Life Below Water](#) or [Seagrass Beds: Prairies of the Sea](#) or [What is Seagrass?](#) | Ocean Conservation Trust)

Direct learners to read the excerpt from the Florida Fish and Wildlife Conservation Commission.

According to the Florida Fish and Wildlife Conservation Commission:

“Seagrasses are flowering plants that have adapted to live in marine and estuarine environments in coastal waters around the world. Their evolutionary story involves multiple species returning to the sea over many millions of years, most with the same common ancestor which now makes up 70 living species. Although none are directly related to typical terrestrial grasses, many species look and grow very similarly. All seagrasses are fully adapted to submerged aquatic life. Seagrass leaves are often long and flexible, which reduces drag in the water and helps them to avoid being ripped from the substrate by wind, waves, and tidal currents. Below ground structures like roots and rhizomes keep the plants anchored to the sediment and are important in nutrient uptake. Together, the above and below ground tissues help to cycle nutrients and gases like oxygen and carbon dioxide between the sediment and the water column. The plants themselves can form large meadows and are often the dominant physical structure in otherwise sandy shorelines. In this way seagrasses are important ecosystem engineers and critical habitat for a variety of vertebrate and invertebrate life.”

Discussion (10 minutes)

- In small groups, learners will reread the excerpt and paraphrase facts about seagrass.
- Learners will add what they learned about seagrasses in the last column.

Wrap-Up (5 minutes)

- Recap the key points: What is seagrass? Why is it important? What animals live there?
- Ask learners to share one thing they learned about seagrass.

EXTENSION ACTIVITIES

- **Research Project:** Assign learners to research a specific marine animal that relies on seagrass and present their findings.
- **Field Trip:** If possible, organize a visit to a local coastal area with seagrass.

KWL GRAPHIC ORGANIZER

Name: _____ **Date:** _____

Before exploring, list details in the first two columns. Fill in the last column at the end of your learning.

Topic: _____		
What I Know	What I Want to Know	What I Learned

SEAGRASS SPECIES PROFILE SHEET



Turtle Grass (*Thalassia testudinum*)

Turtle grass is the most common of seagrasses off the coast of Florida and throughout the Caribbean. It also occurs in Bermuda, and south from the Gulf of Mexico to Venezuela. The grass blades are flat and ribbon-like, growing to 14 inches (35.5 cm) long and ½ inch (10 mm) wide. These blades have 9-15 parallel veins each, and are densely colonized by epiphytes. These long, broad blades distinguish it from other species of seagrasses. There are two to five blades per rhizome node. These rhizomes may be as deep as 10 inches (25 cm) below the substrate surface. Turtle grass typically occurs from the low tide level to depths of approximately 30 feet

(10 m) on sand and rubble-covered bottoms. Turtle grass grows in extensive meadows throughout its range. The common name “turtle grass” refers to green sea turtles (*Chelonia mydas*) that graze on large fields of this seagrass.



Manatee Grass (*Syringodium filiforme*)

Occurring throughout most of Florida’s estuaries, manatee grass is the second most common seagrass in Florida waters. It is also found in Bermuda, the Bahamas, and throughout the Gulf of Mexico and the Caribbean. Manatee grass, along with turtle grass, is found in tropical coastal waters with salinities of 20-36 parts per thousand (ppt). The blades of this seagrass are cylindrical with two to four blades arising from each rhizome node. These blades can reach lengths of 20 inches (50 cm) in some locations. Roots of this seagrass barely go below the substrate surface. It commonly occurs growing with other species of seagrasses or alone, in small patches.

Commonly referred to as manatee grass, it is a favorite food of the manatee.



Shoal Grass (*Halodule wrightii*)

Shoal grass colonizes disturbed areas where conditions are too harsh for turtle and manatee seagrasses to occur. This seagrass ranges from North Carolina, south along the Atlantic and Gulf of Mexico coasts, to the Caribbean. It is also found off of portions of South America, northwestern Africa, Indian Ocean, and the west coast of Mexico. Although shoal grass commonly occurs in estuarine waters with salinities of 10-25 parts per thousand, it also forms dense patches in high salinity areas exposed to wave energy or in tidal flats. The blades are clustered from a single node on the rhizome, with notched blade tips. The flat, narrow blades grow to

maximum lengths of 4-6 inches (10-15 cm) and widths of only .08-.11 inches (2-3 mm).



Johnson's Seagrass (*Halophila johnsonii*)

Johnson's seagrass was first recognized as a separate species in the Indian River Lagoon in 1980. It was named in honor of J. Seward Johnson Sr., the founder of Harbor Branch Oceanographic Institution in Ft. Pierce, Florida. The National Marine Fisheries Service considers the Johnson's seagrass to be a threatened species under the Endangered Species Act, due to its limited distribution. Its distribution ranges from central Biscayne Bay (north of Virginia Key) to Sebastian Inlet. Johnson's seagrass has been documented within flood-tidal deltas, muddy basins, sandy shoals, and near canals, tolerating fluctuations of salinity and water clarity. Johnson's

seagrass has paired leaves originating from a single rhizome node. Measuring 0.04-0.12 inches (1-3 mm) wide and 4-8 inches (10-20 cm) in length, the blades are light green with a brown midrib and veins. This seagrass was added to the list of threatened species under the Endangered Species Act on September 14, 1998. As protected by the ESA, the recovery plan for the Johnson's seagrass is currently being developed. Management plans are now in place for the Indian River Lagoon, Biscayne Bay, and Loxahatchee River Aquatic Preserves.



Paddle Grass (*Halophila decipiens*)

This seagrass occurs on the continental shelf near the Indian River Lagoon, the Gulf of Mexico, the Caribbean and the Indo-West Pacific. The paddle grass resembles Johnson's seagrass, but is distinguishable by a finely serrated leaf margin and a paddle-shaped green blade terminating with a rounded tip. The two, opposite, blades measure 0.5-1.0 inches (10-25 mm) long and 0.12-0.23 inches (3-6 mm) wide, extending directly from nodes on the rhizome. Rhizomes creep through soft substrates, forming patches of paddle grass in shallow waters.



Star Grass (*Halophila engelmanni*)

Star grass occurs in Florida, the Bahamas, Texas, and the West Indies, growing on sandy or muddy bottoms at depths to 130 feet (40 m). The 0.5-1.2 inch (10-30 mm) long blades are clustered in groups of 4-8, arranged in a star-like whorl. Each cluster has two scale leaves at the base as well as a second pair halfway up the leaf stem. The smooth, flat blades have distinct midribs and veins and fine-toothed edges.



Widgeon Grass (*Ruppia maritima*)

Although widgeon grass is not a true seagrass, it grows in both fresh and brackish aquatic environments. It is widely distributed worldwide in temperate and subtropical regions. In North America, widgeon grass is found along the Atlantic coast from Newfoundland south to Texas. The blades are wider at the base of the stem, arising alternately from the sheath and tapering to long pointed tips. This grass is often confused with shoal grass in low salinity locations. Forming extensive meadows in subtidal areas with exposure to intense sun, widgeon grass is able to tolerate some dessication. Since it does not occur in full-strength seawater,

it is not considered a true seagrass. However, the widgeon grass does provide food and refuge for a variety of organisms, similar to the function of the true seagrasses.

PROFILE SHEET GLOSSARY

Rhizome: the somewhat elongated portion of a plant's stem that is underground, producing shoots above and roots below.

Substrate: the material upon or within an organism lives or grows, including soil, plants, animals and rocks.

Tropical: tropical zone lies between 23.5 degrees north and south of the equator, has small seasonal changes in temperature and large seasonal changes in precipitation.

Salinity: concentration of total salts dissolved in water, usually measured in parts per thousand.

Threatened species: plants or animals likely to become endangered in the near future.

Temperate: temperate zone lies between 30 and 60 degrees latitude, climate undergoes seasonal changes in temperature and moisture.

Brackish: somewhat salty, containing salt, where freshwater mixes with saltwater.

Desiccation: removal of moisture, drying out.

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Lesson Title: Benefits of Seagrass

Grade Level: Middle School/High School

Duration: 55 minutes

LEARNING OBJECTIVES

By the end of this lesson, learners will:

- Identify the benefits of seagrass habitats.
- Recognize the impact of seagrass decline.

MATERIALS

- Images or videos of seagrass ecosystems (optional: virtual reality or 360° videos for immersive experience).
- "7 Reasons to Protect Seagrass" Article.

LEARNING ACTIVITIES

Introduction (15 minutes)

- Pose the following statements to learners and solicit initial feedback:
 - Say "What if I told you that....":
 - Seagrass can absorb carbon up to 35x faster than the Amazonian rainforest.
 - A single acre can support over a million species.
 - Seagrass meadows are disappearing at a rate of two football fields an hour.
- Play two brief (less than 5 minutes) videos summarizing the importance of seagrass. (Ex: [Environmental Justice Foundation](#) or [What's so cool about seagrass?](#)).
- Take turns playing each of the two videos. As learners are viewing each video instruct them to write down at least 3 ways that seagrass benefits the environment.
- Key Vocabulary: *Sediment, Water Quality, Shelter, Biodiversity.*

Exploration (15 minutes)

- Divide learners into groups of 2-3.
- Distribute the article "7 Reasons to Protect Seagrass" and instruct learners to read the article as a group.
- Once done, ask each group to reflect on how *not* having seagrass would impact the environment and the world.

Hands-on Activity (20 minutes)

- Divide learners into small groups and assign them the following tasks: create a poster illustrating the benefits of seagrass ecosystems.
- Each group focuses on one category of benefits: ecological, environmental, or economic.
- Encourage creativity (e.g., include drawings, slogans, or fun facts).

Wrap-Up (5 minutes)

- Ask a representative from each group to share one way the environment and/or world would be impacted if there were less or no seagrass.

EXTENSION ACTIVITY

- **Field Trip:** If feasible, visit a local marine area or aquarium to see seagrass habitats up close.

7 Reasons to Protect Seagrass

Remarkable flora, found in waters around the world, benefits ocean health and people

AUTHOR



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A shallow seagrass meadow surrounds a tropical island off the coast of Belize. Seagrass meadows provide critical habitat for hundreds of marine species, while producing oxygen and stabilizing ocean sediments.

Getty Images

When looking out over coastal waters across much of our planet, one can often see large areas that appear darker than their surroundings—a possible sign of seagrass meadows, which play a critical role in the health of our ocean. Seagrasses evolved millions of years ago when flowering plants on land took up residence in the sea. Now, the estimated 72 species of seagrass fringe every continent except Antarctica.

In honor of Seagrass Awareness Month, observed every March, here are seven reasons this important ecological resource deserves protection:

1. Seagrasses are diverse.

With over 70 species, seagrasses are a diverse group of marine flowering plants that exhibit a range of characteristics. While some have ribbon-like leaves that resemble grass, some look like other plants. For example, the tallest seagrass species—*Zostera caulescens*—is native to the shores of northeastern Asia and can grow leaves as long as 7 meters (roughly 23 feet)!



A hawksbill turtle feeds in a seagrass meadow in Seychelles.

Getty Images

2. Seagrasses are “ecosystem engineers.”

Seagrasses can create or significantly modify their environment and provide microhabitats that would not otherwise exist. For example, they take in carbon dioxide—improving chemical conditions for species affected by ocean acidification—and release oxygen, which marine animals need to breathe. The matted roots of seagrass stabilize ocean sediments, and the plant’s canopy provides shelter and nursery for hundreds of species.



Seagrasses create critical habitat for marine species like the eastern fiddler ray. Credit:

Jordan Robins / Coral Reef Image Bank

3. Twenty percent of the world's largest fisheries depend on seagrass.

Seagrasses provide a leafy underwater canopy that creates shelter for invertebrates and juvenile fish. Experts estimate that one-fifth of the world's most-landed fish species use seagrass as nursery areas, including many commercially important species. Without this crucial habitat, there would be fewer fish to catch and livelihoods could be lost.

4. Seagrasses naturally improve water clarity.

Seagrass leaves slow the flow of water, causing sediment and other suspended particles to settle quickly. Seagrass roots also stabilize ocean sediments. This ecological service improves water clarity and reduces coastal erosion.



Underwater grasses, such as this meadow on the Susquehanna Flats at the head of the Chesapeake Bay, help improve water clarity.

Peter McGowan / USFWS

5. Seagrass captures and stores carbon.

Through photosynthesis, seagrasses remove carbon dioxide from the water and use the carbon to build their leaves and roots. Plant material that collects on the low-oxygen sediment on the ocean floor decomposes much slower than on land. As this carbon slowly decays it becomes trapped and eventually buried in the soils below. In fact, scientists estimate 10% of the total organic carbon sequestered in the ocean is buried in the soils below seagrass meadows.

6. Seagrasses help protect shorelines.

Seagrass meadows buffer coastal communities from the full impact of waves and protect coastlines from erosion, two services that are becoming more valuable with the increasing frequency and severity of storms.



A seagrass meadow lines the coastline of Cadaqués, Spain. Coastal seagrasses buffer shorelines around the world from the full impact of waves—a critical benefit during storm surges.

Getty Images

7. Seagrass is a nature-based solution to climate change.

By sequestering carbon and protecting shorelines, seagrass can help communities mitigate and adapt to climate change.

Healthy seagrass meadows are a nature-based solution to many threats facing coastal waters and communities, including climate change. Governments should protect and restore these key ecosystems as part of their climate change policies.



Lesson Title: Understanding Threats to Seagrass Ecosystems

Grade Level: Middle School/High School

Duration: 45 minutes

LEARNING OBJECTIVES

By the end of this lesson, learners will:

- Identify key threats to seagrass habitats.
- Discuss potential solutions to mitigate these threats.

MATERIALS

- Images or videos of seagrass ecosystems (optional: virtual reality or 360° videos for immersive experience).
- Handouts or digital copies of diagrams showing the seagrass ecosystem.
- A map showing global seagrass distribution.
- Markers and chart paper for group activities.

LEARNING ACTIVITIES

Introduction (10 minutes)

- Show a video or image of a vibrant seagrass meadow.
- Ask probing/discussion questions:
 - “Have you ever heard of seagrass?”
 - “Why might seagrass be important for marine life and humans?”
- Briefly explain what seagrass is and its role in:
 - Providing habitat for marine life.
 - Supporting fisheries.
 - Capturing and storing carbon (blue carbon).
 - Stabilizing sediments and improving water quality.
 - Key Vocabulary: *Threats*.

Exploration (10 minutes)

- Explain that there are **Natural** and **Human-induced** threats to seagrass.
- Present the following threats in random order and ask learners to categorize as a *natural* or *human-induced* threat.

Natural Threats:

- Storms and hurricanes.
- Rising sea temperatures (climate change).
- Diseases (wasting disease in seagrass).

Human-Induced Threats:

- Coastal development (dredging, construction).
 - Pollution (nutrient run-off causing algal blooms).
 - Boat propellers and anchors damaging seagrass beds.
 - Overfishing (disrupting the balance of ecosystems).
- Use visuals to demonstrate the threats (e.g., before-and-after photos).

Hands-on Activity (15 minutes)

- Divide learners into small groups (up to 4).
- Assign each group a specific threat.
- Task:
 - Illustrate the impact of the threat on seagrass (e.g., draw or describe consequences).
 - Brainstorm and present possible solutions (e.g., marine protected areas, eco-friendly tourism).
- Groups present their findings to the class (2–3 minutes per group).

Wrap-Up (10 minutes)

- Ask learners to summarize what they learned.
- Discuss ways they can help protect seagrass (e.g., reducing plastic use, supporting conservation efforts).

EXTENSION ACTIVITIES

- **Interactive Game:** Create a jeopardy-style game with categories like “Seagrass Facts,” “Threats,” “Solutions,” and “Ecosystem Roles.”
- **Field Trip:** If feasible, visit a local marine area or aquarium to see seagrass habitats up close.



Lesson Title: Environmental Stewardship for Seagrass

Grade Level: Middle School/High School

Duration: 50 minutes

LEARNING OBJECTIVES

By the end of this lesson, learners will:

- Identify actions they can take to protect and restore seagrass.
- Demonstrate an understanding of seagrass stewardship through an actionable project.

MATERIALS

- Visual aids (images/videos of seagrass ecosystems) and/or fact sheets about seagrass.
- “10 Rules for Seagrass Restoration” Article.
- Whiteboard or large paper for brainstorming.
- Materials for an activity (e.g., recycled items for crafting, laptops for research).
- Markers, paper, and other art supplies.

LEARNING ACTIVITIES

Introduction (10 minutes)

- Show a short video or image slideshow of seagrass meadows with vibrant marine life (e.g., turtles, seahorses, fish).
- Ask learners:
 - What do you see? Why do you think this ecosystem is important?
 - What would happen if this ecosystem disappeared?
- Briefly remind learners of the role of seagrass in the ecosystem:
 - Seagrass is a flowering plant found in shallow marine waters.
 - It supports biodiversity, stabilizes coastlines, absorbs carbon, and improves water quality.
- Emphasize its connection to global issues, such as climate change and biodiversity loss.

Exploration (15 minutes)

- Distribute the article “10 Rules for Seagrass Restoration” and facilitate a whole-group discussion, exploring each rule with the learners.
- Inform them that there are at least three types of ways they can be a part of the solution:
 - Small actions:
 - Avoiding single-use plastics and reducing waste.
 - Supporting sustainable seafood choices.
 - Community-level actions:
 - Beach cleanups and conservation volunteering.
 - Promoting eco-friendly tourism.
 - Scientific efforts:
 - Seagrass restoration programs.

Hands-On Activity (20 minutes)

Option A: Stewardship Poster Design

- Have learners create posters to raise awareness about seagrass conservation.
- Focus on clear messages: *Why seagrass matters? How can people help?*

Option B: Mini Research Project

- Divide the class into small groups and assign one of the topics to research:
 - Seagrass restoration projects around the world.
 - Local impacts on seagrass ecosystems.
- Groups will present their findings briefly to the class.

Wrap-Up (5 minutes)

- Recap the lesson:
 - *Why is seagrass important? What can individuals and communities do to help?*
- Reflect: Ask learners to share one action they will take to support seagrass conservation.

EXTENSION ACTIVITY

- Research a local seagrass conservation project or organization. Write a short report or share findings with the group.

MATERIALS: "10 RULES FOR SEAGRASS RESTORATION" ARTICLE



ECOSYSTEM RESTORATION

10 Rules For Seagrass Restoration

By admin • August 31, 2024

Restoring The Underwater Meadows: 10 Essential Rules For Seagrass Restoration

Seagrasses, often referred to as the "lungs of the sea," are vital to marine ecosystems. They provide habitat for countless marine species, store significant amounts of carbon, and help stabilize the seabed. However, these underwater meadows are declining globally due to human activities, prompting urgent efforts to restore them. Scientists from Project Seagrass and Swansea University have outlined ten rules for effective seagrass restoration. Each rule plays a crucial role in ensuring the success of these initiatives, offering a strategic framework for restoring these invaluable ecosystems.

1. Protect Existing Seagrass First

Given the increasing interest in seagrass restoration, the authors emphasize that it is significantly more challenging, time-consuming, and costly to re-establish seagrass meadows than to protect those already existing. Protecting these meadows from local stressors, such as improving water quality, reducing boating damage, establishing Marine Protected Areas, and promoting sustainable livelihoods, is essential.

The authors also highlight the importance of prioritizing which seagrass meadows to protect, considering future climate changes, such as temperature shifts, sea-level rise, and changes in land use.

2. Work Together

The restoration of seagrass meadows is a collaborative effort that requires the involvement of diverse stakeholders, expertise, and experiences at every stage of the process. Seagrass ecosystems support various uses and livelihoods, from fishing to recreation, and maintaining equality and rights is crucial. Engaging local communities and stakeholders during site selection is essential, as they often become the long-term stewards of the restoration sites. Without collaboration, large-scale seagrass restoration is unachievable, and co-designing projects with communities enhances the social value of restored habitats.

3. Create Biodiverse Ecosystems with Multiple Functions for People and Planet

The primary goal of seagrass restoration is to maximize the biomass and biodiversity of meadows, ensuring they support diverse and resilient ecosystem functions and services. Natural systems provide multiple interconnected services, and focusing narrowly on a few can lead to unfavorable shifts and stakeholder conflicts. For example, the unregulated conservation of seagrass-associated green turtles may harm seagrass, affecting fisheries and other services. The complexity of seagrass ecosystems means that restoration should consider multiple services rather than focusing on a few in isolation.

4. Select Appropriate Sites for Restoration

A thorough site selection process is critical for successful seagrass restoration. Objectives should include restoration needs, habitat area, intended benefits, and beneficiaries. Habitat suitability modeling can help identify potential sites, but environmental factors like sediment movement, hydrodynamics, and light availability, as well as biological factors such as the presence of bioturbators, algae, and grazers, must also be considered. Social attitudes, opportunities, and costs are equally important when selecting restoration sites, as seagrass restoration is not just a biological process but a socio-ecological one.

5. Determine Appropriate Restoration Methods

While there is guidance on seagrass planting techniques, a universal set of guidelines for restoration success is still lacking. Given the high costs and uncertainties of planting methods, indirect approaches that remove pressures and encourage natural recovery may often be more effective. For instance, replacing traditional boat moorings with environmentally friendly alternatives can reduce seabed damage and support seagrass recovery, as seen in the UK.

6. Use Resilient Plant Materials and Future-Proof Your Project

The long-term cost-effectiveness of planting new habitats for species that may soon disappear is a key consideration. Climate-driven range shifts for seagrass species are already occurring, with significant northward migrations projected in places like the US East Coast. Climate stressors affect seagrass differently at various life stages and times of the year, impacting seed viability and survival. Practitioners must integrate climate projections into restoration plans, adapting methods based on long-term forecasts, such as El Niño intensity and sea-level rise, to ensure future success.

7. Maximize the Potential Opportunity of the Restoration

Maximizing resources is crucial for successful seagrass restoration, focusing on enhancing ecological benefits. Seagrass meadows exist in various landscape patterns, with fragmented meadows being more vulnerable to environmental change than continuous ones. Restoration efforts that reconnect fragmented patches can boost coastal seascape resilience. Techniques like stimulating natural regeneration and modifying sediment conditions have shown success in places like the Florida Keys. Restoration should consider biodiversity at all levels, as it enhances system resilience. The concept of seascape-scale restoration emphasizes connectivity between habitats, which is vital for improving ecosystem function and resilience, particularly in temperate systems. Targeted research is needed to understand and enhance habitat connectivity, contributing to more effective marine ecological restoration efforts.

8. Plan Ahead for Infrastructure, Capacity, and Restoration Material

Planning before starting restoration projects is essential to reduce risks. Decisions about sites and methods should be based on sound science, local data, and existing literature. Besides selecting the right biological conditions, ensuring the appropriate social governance structure is vital for community buy-in. Developing strong community relationships, as illustrated by projects in South West Wales, can determine the success or failure of restoration efforts. Flexible project management, risk assessment, and preparation for potential setbacks are crucial for long-term success.

9. Develop Realistic Informed Goals and Reporting

As global environmental policy increasingly embraces Nature-Based Solutions, clear communication about the effectiveness and uncertainties of seagrass restoration is more important than ever. The authors advocate for a “learn by doing” approach, where the wider restoration community can benefit from shared experiences and lessons learned from both successes and failures.

10. Make It Pay

Seagrass restoration is expensive and has primarily been funded by philanthropic and government sources. New financial mechanisms are needed to support seagrass protection and enhancement, which is crucial for successful restoration. While funding is easier to obtain for planting new areas, innovative financing solutions are necessary to sustain long-term restoration efforts, including monitoring, management, and stewardship to ensure success.

Wider Impact

Restoring seagrass meadows is an intricate process that requires a strategic, well-informed approach. By following these ten golden rules, restoration projects can enhance their chances of success, ensuring that seagrass meadows continue to provide their vital ecological functions for generations to come. As we face growing environmental challenges, the restoration of seagrass meadows is needed to increase the resilience of our oceans.

Seagrass restoration is not just about planting underwater plants; it's about restoring balance to our marine ecosystems and ensuring a healthier planet for future generations. Each of these rules provides a piece of the puzzle, collectively guiding us towards more effective and sustainable restoration efforts. Implementing the 10 Golden Rules for seagrass restoration can help shift the focus from merely planting to facilitating natural recovery and sustaining restoration over the long term.



Lesson Title: Transect Line Sampling

Grade Level: Middle School/High School

Time Required: 50 to 60 minutes

LEARNING OBJECTIVE

By the end of this lesson, learners will:

1. Understand the concept of transect line sampling and its importance in scientific studies.
2. Learn how to design and conduct a transect line sampling survey.
3. Analyze and interpret data collected using transect line sampling.

MATERIALS

- Measuring tape or marked rope (10–50 meters, depending on location).
- Clipboards, pencils, and data sheets.
- Seagrass Species Profile Sheet for species identification (if surveying biodiversity).
- Rulers or meter sticks.
- Flags, stakes, or markers to mark intervals along the transect line.
- A field location with vegetation or habitat of interest.

LEARNING ACTIVITIES

Introduction (10 minutes)

1. Pose a question: “If you wanted to study how plant species change as you move from a grassy field into a forest, how would you collect your data?”
2. Encourage learners to brainstorm methods, leading into the idea of using a transect line for systematic sampling.
3. Explain transect line sampling:
 - a. A method for studying changes across a specific area.
 - b. Data is collected at fixed intervals along a straight line by observing the organisms that are observed below and above the line.
4. Key Vocabulary: *Transect Line, Intervals, Sampling, Population Density, Abundance.*

Demonstration (10 minutes)

- Demonstrate how to set up a transect line:
 - Select a study area (e.g., a patch of grass, a flowerbed, or a simulated environment).
 - Choose a starting point and identify the direction of the line (e.g., across a gradient from a sidewalk to a grassy area).
 - Use a measuring tape or rope to create a straight line of a set length (e.g., 20 meters).
 - Mark intervals along the line (e.g., every 2 meters) using flags, stakes, or markers.
- Show how to record the data in a simple table, noting interval location on transect line, organisms observed, and their count.

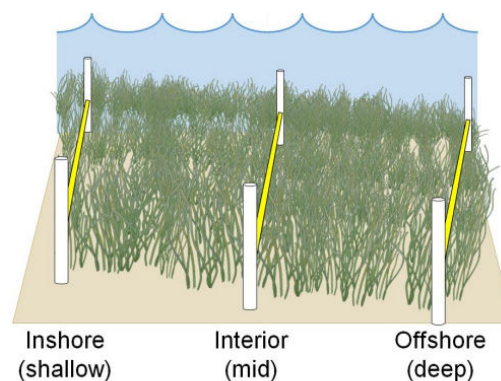


Figure 1. Position of three 50-m transects within a bed.

Hands-on Activity (20 minutes)

- **Step 1:** Explain that learners will observe and record data at each interval along the line.
- **Step 2:** Show examples of what can be measured, such as:
 - Plant organisms above or below the line.
 - Environmental factors (e.g., soil type, sunlight, moisture).
- **Step 3:** Split learners into small groups, with each group responsible for a transect line.
- **Step 4:** Each group collects data systematically at the designated intervals.

Data Analysis and Discussion (20 minutes)

- Return to the classroom and have groups compile their data.
- Guide learners in organizing their data into a table or spreadsheet.
- Discuss ways to analyze the data, such as:
 - Identifying patterns or trends along the gradient (e.g., changes in organisms composition).
 - Calculating organisms richness or abundance.
 - Comparing data among different transect lines.

Wrap-Up (5 minutes)

- Recap the purpose and process of transect line sampling.
- Ask learners reflective questions:
 - What patterns, if any, did you observe?
 - How do environmental factors influence the distribution of organisms?
 - What are the strengths and limitations of transect line sampling?
 - What improvements could they make if they were to repeat the activity?

EXTENSION ACTIVITIES

- **Long-Term Monitoring:** If possible, learners can revisit their transect line later in the semester or next year to document changes over time (e.g., seasonal variations or ecological succession).
- **Comparison Study:** Have learners compare the results from transect line sampling to quadrat sampling and photo quadrat sampling to see if they produce similar conclusions.



Lesson Title: Quadrat Sampling

Grade Level: Middle School/High School

Time Required: 60 minutes

LEARNING OBJECTIVES

By the end of the lesson, learners will:

1. Understand the purpose and principles of quadrat sampling.
2. Learn how to set up and conduct a quadrat sampling study.
3. Analyze and interpret data collected from quadrat sampling.

MATERIALS

1. Quadrats (homemade or premade, e.g., 1m x 1m PVC or wooden frames).
2. Measuring tape, meter stick or ruler.
3. Clipboards and data sheets (or tablets for digital recording).
4. Seagrass Species Profile Sheet for identifying plants/organisms.
5. Quadrat sampling log.
6. Preselected outdoor area or simulated classroom area with diverse objects (e.g., plants, pebbles, or paper cutouts of organisms).

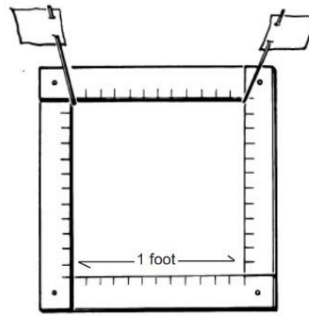
LEARNING ACTIVITIES

Introduction (10 minutes)

1. Begin with a brief discussion:
 - o Why is it important to study the distribution and abundance of organisms?
2. Introduce quadrat sampling as a tool used by ecologists to estimate population size and density in a given area.
3. Show learners a quadrat and explain its purpose.
4. Key Vocabulary: *Quadrat, Population Density, Abundance, Sampling.*

Demonstration (15 minutes)

- Demonstrate how to use a quadrat:
 - Select a study area (e.g., a patch of grass, a flowerbed, or a simulated environment).
 - Randomly place the quadrat on the ground. Use a random number generator or dice for random placement if possible.
 - Count and record the number of specific organisms (e.g., plants, insects, or other visible objects) within the quadrat.
 - Repeat the process in several locations to gather sufficient data.
- Show how to record the data in a simple table, noting quadrat number, organisms observed, and their count.



Hands-On Activity (20 minutes)

- **Step 1:** Divide learners into small groups (2–4 learners per group).
- **Step 2:** Assign each group a quadrat and a section of the study area.
- **Step 3:** Have learners conduct quadrat sampling in their assigned area, recording their findings.
- **Step 4:** Once data is collected, learners calculate:
 - Average number of organisms per quadrat.
 - Estimated total population for the entire area based on the sampling results.

Data Analysis and Discussion (10 minutes)

- Bring the class together to discuss findings.
 - What patterns did learners notice in the distribution of organisms?
 - Were there areas with higher/lower population densities? Why?
- Discuss limitations of quadrat sampling, such as:
 - Sample size and random placement.
 - Organism mobility (e.g., animals moving out of the quadrat).
- If time allows, compare data between groups and discuss variability.

Wrap-Up and Reflection (5 minutes)

- Recap the purpose and process of quadrat sampling.
- Ask learners reflective questions:
 - What patterns, if any, did you observe?
 - How do environmental factors influence the distribution of organisms?
 - What are the strengths and limitations of quadrat sampling?
 - What improvements could they make if they were to repeat the activity?

EXTENSION ACTIVITIES

- **Long-Term Monitoring:** If possible, learners can revisit their quadrats later in the semester or next year to document changes over time (e.g., seasonal variations or ecological succession).
- **Comparison Study:** Have learners compare the results from quadrat sampling with transect line sampling and photo quadrat sampling to see if they produce similar conclusions.

QUADRAT SAMPLING

Name: _____

Date: _____

Assigned Quadrat Number: _____

INTRO

In the study of ecology, it is often important that scientists survey the distribution of species in an area. It is extremely difficult to count every species in an entire area. To solve this problem, we use Quadrat Sampling. A *quadrat* is a small, typically square plot used to isolate a standard unit of area for study. You then use that plot to estimate the coverage for the entire area.

PROCEDURE

You and your group will be assigned a section. As a group you must:

- a) Determine what plant, insect, etc. life exists in your plot. If you do not know what something is called, document as much information about it as possible and look it up online later.
- b) Determine the number of plants by species on your plot. For example, your plot may have 6 dandelions and 9 mayapples. Try to be as accurate as possible. Your total numbers will be used to calculate the diversity index when we return to class.
- c) Only count **living** species. Rocks, dead leaves, etc. don't tell us much about biodiversity!
- d) Count any animal species you see. Are there ants? Spiders? Worms? Anything else? Look under rocks or logs to find insects.
- e) Record all your observations on the back side. You will work together as a class to compare your quadrats and make an estimate for the entire area map (2nd page).

Use this space to record information about any unknown species that you find in your quadrat:

Unknown Species 1: _____

Unknown Species 2: _____

Unknown Species 3: _____

Species/Substrate	Number/Count



Lesson Title: Photo Quadrat Sampling

Grade Level: Middle School/High School

Time Required: 90 minutes to 120 minutes

LEARNING OBJECTIVE

By the end of the lesson, learners will:

- Understand the concept and purpose of photo quadrat sampling in ecological studies.
- Learn how to set up and use photo quadrat sampling to estimate biodiversity and vegetation cover in a specific area.
- Analyze and interpret photo data from a quadrat to make ecological observations.

MATERIALS

- Camera (or smartphone with a high-quality camera).
- Measuring tape or meter stick.
- Quadrat frame (can be made from PVC pipes or any other suitable material).
- Ruler or measuring tape (for reference in photos).
- Printed worksheets for data recording.
- Seagrass Species Profile Sheet for identifying plants/organisms.
- A field location with vegetation or habitat of interest.

LEARNING ACTIVITIES

Introduction (20 minutes)

1. Begin with a discussion:
 - o Introduce the concept of sampling in ecology and why it's necessary to estimate populations, biodiversity, and vegetation cover.
 - o Explain that photo quadrat sampling is a non-destructive method that uses photographs to document and analyze an area within a set quadrat.
 - o Discuss the benefits of using photo quadrats, such as being able to revisit photos for analysis and creating visual records of the site.
2. Define *quadrat sampling* and explain how it works: a fixed-size area is marked, and data on organism composition, vegetation cover, or other environmental factors are collected.

3. Introduce photo quadrat sampling: taking a photo directly above the quadrat to document what's inside the frame. The idea is to use the photo later to analyze biodiversity or vegetation density.
4. Discuss the importance of controlling for variables like light, angle, and distance when taking the photo.
5. Key Vocabulary: *Quadrat, Population Density, Abundance, Sampling.*

Demonstration (20 minutes)

- **Setting Up a Quadrat:**
 - Show the learners how to construct a quadrat frame using PVC pipes or other materials.
 - Demonstrate how to place the quadrat on the ground (ensuring it is level and positioned properly).
- **Taking a Photo:**
 - Show how to position the camera directly above the quadrat (keeping it as perpendicular to the ground as possible).
 - Discuss camera settings like focus, resolution, and lighting to get clear images.
 - Take a sample photo, pointing out important things to note in the shot (e.g., visible plant organisms, ground cover, and any other features).

Hands-On Activity (30 - 40 minutes):

- **Step 1:** Divide the learners into small groups (2-4 learners per group).
- **Step 2:** Assign each group a different spot in the section of the study area to set up their quadrat.
- **Step 3:** Each group will use the quadrat frame and take a set of photos of their area (at least 3 to 5 photos from different quadrats, ensuring varying types of vegetation or terrain).
- **Step 4:** After taking the photos, have learners record their findings. Each group will record relevant details for each photo: date, location, photo number, weather conditions, and any organisms identified.
- **Step 5:** Once data is collected, learners calculate:
 - Average number of organisms per quadrat.
 - Estimated total population for the entire area based on the sampling results.

Data Analysis and Discussion (30 minutes)

- **Photo Analysis**

- Back in the classroom or at the field site, groups will analyze their photos. Using a ruler or measuring tape in the photo, they can estimate the percentage of ground covered by vegetation, identify plant organisms, and record the diversity of organisms.
- Learners can count the number of individual plants or measure the proportion of different plant types (e.g., grasses, shrubs, etc.) within the quadrat.

- **Class Discussion**

- Ask learners to share their findings. What did they notice about the biodiversity in their quadrats? Were there any challenges in taking the photos or interpreting the data?
- Discuss how photo quadrat sampling can be used to track changes in an ecosystem over time (e.g., plant growth, invasive species monitoring, restoration efforts).

Wrap-Up and Reflection (5 minutes)

- Recap the purpose and process of photo quadrat sampling.
- Ask learners reflective questions:
 - What patterns, if any, did you observe?
 - How do environmental factors influence the distribution of organisms?
 - What are the strengths and limitations of photo quadrat sampling?
 - What improvements could they make if they were to repeat the activity?

EXTENSION ACTIVITIES

- **Long-Term Monitoring:** If possible, learners can revisit their photo quadrats later in the semester or next year to document changes over time (e.g., seasonal variations or ecological succession).
- **Comparison Study:** Have learners compare the results from photo quadrat sampling with transect line sampling and quadrat sampling to see if they produce similar conclusions.

PHOTO QUADRAT SAMPLING

Name: _____

Date: _____

Assigned Quadrat Number: _____

INTRO

In the study of ecology, it is often important that scientists survey the distribution of species in an area. It is extremely difficult to count every species in an entire area. To solve this problem, we use Quadrat Sampling. A *quadrat* is a small, typically square plot used to isolate a standard unit of area for study. You then use that plot to estimate the coverage for the entire area.

PROCEDURE

You and your group will be assigned a section. As a group you must:

- a) Determine what plant, insect, etc. life exists in your plot. If you do not know what something is called, document as much information about it as possible and look it up online later.
- b) Determine how many each species of plant shows up on your plot. For example, your plot may have 6 dandelions and 9 mayapples. Try to be as accurate as possible. Your total numbers will be used to calculate the diversity index when we return to class.
- c) Only count **living** species. Rocks, dead leaves, etc. don't tell us much about biodiversity!
- d) Count any animal species you see. Are there ants? Spiders? Worms? Anything else? Look under rocks or logs to find insects.
- e) Record all your observations on the back side. You will work together as a class to compare your quadrats and make an estimate for the entire area map (2nd page).

Use this space to record information about any unknown species that you find in your quadrat:

Unknown Species 1: _____

Unknown Species 2: _____

Unknown Species 3: _____



Species/Substrate	Number/Count





APPENDIX E: SEAGRASS RESTORATION SAFETY COMPONENTS & RISK MANAGEMENT GUIDELINES

When planning hands-on seagrass restoration activities, safety should be the top priority. Here are some key safety components to consider:

GENERAL RISK MANAGEMENT

- 1. Adult-to-Child Ratio:** Maintain an appropriate adult-to-child ratio to ensure adequate supervision.
- 2. Supervision Policies:** Establish clear supervision policies, including guidelines for bathroom breaks, mealtimes, and activity periods.
- 3. Regular Checks:** Regularly check all minors to ensure their safety and well-being.
- 4. Clear Communication:** Encourage open communication among staff and volunteers to promptly address any concerns or issues.
- 5. Child Protection Policy:** Develop a comprehensive child protection policy that outlines procedures for reporting and responding to child abuse, neglect, or exploitation.
- 6. Reporting Procedures:** Establish clear procedures for reporting suspected child abuse or neglect to the appropriate authorities.
- 7. Zero-Tolerance Policy:** Implement a zero-tolerance policy for any form of child abuse, neglect, or exploitation.
- 8. Safe Environment:** Ensure the environment is safe and secure, with appropriate safety measures in place, such as fire safety equipment and emergency exits.
- 9. Risk Assessments:** Conduct regular risk assessments to identify and mitigate potential hazards.
- 10. First Aid and Emergency Procedures:** Have a well-stocked first-aid kit and a plan for handling emergencies.
- 11. Positive Environment:** Create a positive and supportive environment where minors feel safe and respected.
- 12. Conflict Resolution:** Train staff in conflict resolution techniques to address any disagreements or bullying behavior.
- 13. Emotional Support:** Support minors emotionally, especially during stressful or challenging times.
- 14. Privacy Policy:** Develop a privacy policy to protect the confidentiality of minors' personal information.
- 15. Confidentiality:** Ensure that all staff and volunteers understand the importance of confidentiality and adhere to strict guidelines.
- 16. Consent Forms:** Obtain appropriate consent forms from parents or guardians before collecting or sharing personal information about minors, including photo releases for any images that may be taken or shared.

FIELD TRIP SAFETY PLANNING AND RISK MANAGEMENT

- 1. Risk Assessment:** Conduct a thorough risk assessment to identify potential hazards, such as water conditions, water temperature, variations in water depth, marine life, watercraft activity and equipment. Develop a detailed water safety plan outlining emergency procedures and first-aid protocols.
- 2. Water Safety:** Assess the swim competency of each participant by administering a swim test to determine their abilities or ensure that every participant uses a personal flotation device for in-water activities. Have waterfront lifeguards or dive instructors on duty to supervise all fieldwork activities. Making sure that water is adequately marked by dive flags. No work should be done outside of marked area.
- 3. Participant Training:** Provide basic safety training on marine wildlife awareness and respect, including potential marine life hazards and how to avoid them. Discuss environmental ethics and best practices, along with behavior and other expectations.
- 4. Equipment:** Ensure all equipment (boats, snorkels, masks, fins, large dive flags, planting tools) is in good working condition and properly maintained. Have a sufficient supply of spare parts and tools.
- 5. First Aid:** Prepare a well-stocked first-aid kit, including items for marine injuries like jellyfish stings and coral cuts.
- 6. Waivers:** Ensure all participants have waivers signed by the parent/guardian.
- 7. Learning Objectives:** Spend time working on and discussing the learning objectives of each field trip. Remember to include multi-level objectives for the group, each buddy team, and each individual. Encourage secondary objectives unrelated to the curriculum in topics such as self-confidence, overcoming fear, expanding comfort zones, etc.
- 8. Quizzes and Surveys:** Design measuring tools before participation to establish baselines for academic knowledge, perceptions, beliefs, and other essential measurements needed to ascertain the value of experiential education and the impact on individuals regarding personal growth and academic development.

FIELD TRIP SAFETY AND RISK MANAGEMENT

- 1. Safety Briefing:** Provide a safety briefing with succinct but complete information about the objective of the field trip, how it relates to the academic curriculum, the expectations for the day, required personal equipment, the amenities to be provided during the experience, directions and times to facilities, how to stay in supervision, and what to do in case of an emergency. Make sure the group bonds in some form using icebreakers or other techniques that foster group development and team building.
- 2. Quizzes and Surveys:** Utilize your measuring tools before participation to ensure data is being collected.

- 3. Weather Monitoring:** Continuously monitor weather conditions and adjust plans accordingly, especially in case of storms or strong currents. Are you going to dictate maximum weather/wave height and/current speed?
- 4. Buddy System:** Implement a strict buddy system to ensure everyone is accounted for and can assist each other in emergencies.
- 5. Marine Life Awareness:** Continue to educate participants about marine life, especially potentially harmful species like jellyfish and stingrays. Advise them to avoid touching or disturbing marine life but encourage ethical interactions.
- 6. Sun Safety:** Encourage participants to wear sunscreen, hats, and protective clothing to prevent sunburn and heatstroke.
- 7. Hydration and Nutrition:** Provide adequate water and snacks to keep participants hydrated and energized.
- 8. Environmental Considerations:** Minimize impact on the marine environment by following best practices, such as avoiding trampling on seagrass beds and disposing of waste properly.

AFTER THE FIELD TRIP

- 1. Quizzes and Surveys:** Administer your measuring tools after participation to ensure data is being collected. Collect feedback from participants to identify areas for improvement.
- 2. Post-Trip Debrief:** Conduct a post-trip debrief to discuss any incidents, lessons learned, and improvements for future activities.
- 3. Clean Up:** Rinse and store equipment properly to prevent damage and ensure it's ready for future use.



APPENDIX F: SEAGRASS KNOWLEDGE ASSESSMENT (WORKSHEET)

Thank you for completing the Seagrass Initiative course. Please answer the following questions based on what you learned during the course. This knowledge check should only take about 10 minutes to complete.

Date: _____

Program (if multiple programs and/or locations) _____

1. What is seagrass?
 - a. Marine flowering plants
 - b. Coral species
 - c. Seaweed
 - d. Marine algae
2. Where are seagrasses commonly found?
 - a. Polar regions
 - b. Deep ocean floors
 - c. Shallow coastal waters
 - d. Open ocean
3. How many seagrass species exist globally?
 - a. 10-20
 - b. 60-75
 - c. 100-150
 - d. 200+
4. What is the role of seagrass in marine ecosystems?
 - a. Producing oxygen
 - b. Acting as a habitat
 - c. Reducing coastal erosion
 - d. All of the above

5. Which of the following is not a seagrass species?
 - a. Manatee Grass (*Syringodium filiforme*)
 - b. Shoal Grass (*Halodule wrightii*)
 - c. Bermuda Grass (*Sargassum*)
 - d. Turtle Grass (*Thalassia testudinum*)
 6. Seagrass meadows are sometimes referred to as what?
 - a. The lungs of the ocean
 - b. The nurseries of the sea
 - c. Ocean deserts
 - d. Submarine forests
 7. Which organisms rely on seagrass meadows for habitat?
 - a. Manatees
 - b. Young fish
 - c. Sea turtles
 - d. All of the above
 8. Seagrasses help fight climate change by:
 - a. Absorbing carbon dioxide
 - b. Releasing methane
 - c. Reflecting sunlight
 - d. Emitting sulfur compounds
 9. What human activity poses the greatest threat to seagrass meadows?
 - a. Overfishing
 - b. Agricultural runoff
 - c. Dredging and anchoring
 - d. All of the above
 10. Increased nutrition in water (or eutrophication) affects seagrass meadows by:
 - a. Increasing oxygen levels
 - b. Promoting harmful algae blooms
 - c. Strengthening seagrass roots
 - d. Prevention sedimentation
-

11. What is the estimated global rate of seagrass loss?
- a. 1% a year
 - b. 3-7% a year
 - c. 10% a year
 - d. 15-20% a year
12. Which intentional agreement focuses on protecting habitats like seagrass meadows?
- a. Paris Agreement
 - b. Ramsar Convention
 - c. Kyoto Protocol
 - d. Montreal Accord
13. Marine Protected Areas (MPAs) are important for seagrass conservation because they:
- a. Stop human development
 - b. Prevent overfishing
 - c. Minimize destructive activities
 - d. All of the above
14. Seagrasses are unique because they are the only marine plants that:
- a. Produce oxygen
 - b. Flower and pollinate underwater
 - c. Provide food for herbivores
 - d. Anchor in deep-sea environments
15. The process of carbon storage in seagrass meadows is called:
- a. Ocean acidification
 - b. Blue carbon sequestration
 - c. Carbon cycling
 - d. Carbon flux
16. How can seagrasses indicate an ecosystem is healthy?
- a. By their growth rates
 - b. By water clarity in meadows
 - c. By species diversity in meadows
 - d. All of the above

17. Seagrass restoration projects typically involve:

- a. Planting seagrass seeds or shoots
- b. Sediment removal
- c. Artificial reef construction
- d. Deep sea dredging

18. What is the first step in a typical seagrass restoration project?

- a. Collecting seeds or healthy shoots from existing meadows
- b. Installing artificial barriers to protect planting sites
- c. Testing water quality and sediment conditions
- d. Assessing the site for suitability and environmental conditions

SCORING

Total number of correct responses/20 = % Correct, with a goal of 80% or higher.

SEAGRASS KNOWLEDGE ASSESSMENT (ANSWER KEY)

Thank you for completing the Seagrass Initiative course. Please answer the following questions based on what you learned during the course. This knowledge check should only take about 10 minutes to complete.

Date: _____

Program (if multiple programs and/or locations) _____

1. What is seagrass?
 - e. Marine flowering plants
 - f. Coral species
 - g. Seaweed
 - h. **Marine algae**
2. Where are seagrasses commonly found?
 - a. Polar regions
 - b. Deep ocean floors
 - c. **Shallow coastal waters**
 - d. Open ocean
3. How many seagrass species exist globally?
 - a. 10-20
 - b. **60-75**
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 - d. 200+
4. What is the role of seagrass in marine ecosystems?
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 - b. Acting as a habitat
 - c. Reducing coastal erosion
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5. Which of the following is not a seagrass species?
- a. Manatee Grass (*Syringodium filiforme*)
 - b. Shoal Grass (*Halodule wrightii*)
 - c. **Bermuda Grass (*Sargassum*)**
 - d. Turtle Grass (*Thalassia testudinum*)
6. Seagrass meadows are sometimes referred to as what?
- a. The lungs of the ocean
 - b. **The nurseries of the sea**
 - c. Ocean deserts
 - d. Submarine forests
7. Which organisms rely on seagrass meadows for habitat?
- a. Manatees
 - b. Young fish
 - c. Sea turtles
 - d. **All of the above**
8. Seagrasses help fight climate change by:
- a. **Absorbing carbon dioxide**
 - b. Releasing methane
 - c. Reflecting sunlight
 - d. Emitting sulfur compounds
9. What human activity poses the greatest threat to seagrass meadows?
- a. Overfishing
 - b. Agricultural runoff
 - c. Dredging and anchoring
 - d. **All of the above**
10. Increased nutrition in water (or eutrophication) affects seagrass meadows by:
- a. Increasing oxygen levels
 - b. **Promoting harmful algae blooms**
 - c. Strengthening seagrass roots
 - d. Prevention sedimentation
-

11. What is the estimated global rate of seagrass loss?
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 - b. Prevent overfishing
 - c. Minimize destructive activities
 - d. **All of the above**
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- a. Produce oxygen
 - b. **Flower and pollinate underwater**
 - c. Provide food for herbivores
 - d. Anchor in deep-sea environments
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- a. Ocean acidification
 - b. **Blue carbon sequestration**
 - c. Carbon cycling
 - d. Carbon flux
16. How can seagrasses indicate an ecosystem is healthy?
- a. By their growth rates
 - b. By water clarity in meadows
 - c. By species diversity in meadows
 - d. **All of the above**

17. Seagrass restoration projects typically involve:

- a. ***Planting seagrass seeds or shoots***
- b. Sediment removal
- c. Artificial reef construction
- d. Deep sea dredging

18. What is the first step in a typical seagrass restoration project?

- a. Collecting seeds or healthy shoots from existing meadows
- b. Installing artificial barriers to protect planting sites
- c. Testing water quality and sediment conditions
- d. ***Assessing the site for suitability and environmental conditions***

SCORING

Total number of correct responses/20 = % Correct, with a goal of 80% or higher.



APPENDIX G: YOUTH EXPERIENTIAL EDUCATION SURVEY SAMPLE

[Insert Organization Name] provides experiential education opportunities, such as the Seagrass Initiative, throughout the year. We are interested in learning more about participants' experiences. Please complete this survey before and after your participation. It should only take about 10 minutes to complete. Thank you!

Date: _____

Program (if multiple programs and/or locations): _____

1. Are you getting ready to participate or did you already participate in the Seagrass Initiative?

- ☐ I'm getting ready to participate (pre-survey before participation).
- ☐ I have already participated (post-survey after participation).

2. How many other [Insert Organization Name here] events/activities have you participated in before?

- ☐ None – first time participating in an [Insert Organization Name here] event/activity
- ☐ One
- ☐ Two to three
- ☐ Four or more

3. Please indicate how much each statement describes you.

1	I work well with other kids.	Not at all true	A little true	Mostly true	Really true
2	I can make friends with other kids.	Not at all true	A little true	Mostly true	Really true
3	I can talk with people I don't know.	Not at all true	A little true	Mostly true	Really true
4	I can tell other kids that are doing something I don't like.	Not at all true	A little true	Mostly true	Really true
5	I can tell a funny story to a group of kids.	Not at all true	A little true	Mostly true	Really true
6	I can stay friends with other kids.	Not at all true	A little true	Mostly true	Really true
7	I can tell other kids what I think, even if they disagree with me.	Not at all true	A little true	Mostly true	Really true

4. Please indicate how much you agree with each statement.

1	I will be able to achieve most of the goals that I set for myself.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
2	I prefer wildlife reserves to zoos.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
3	I enjoy spending time in nature.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
4	When facing difficult tasks, I am certain that I will accomplish them.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
5	In general, I think I can meet goals that are important to me.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
6	We should protect endangered species.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
7	I believe I can succeed at most anything I try and set my mind.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
8	It's important to conserve natural resources.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
9	I am concerned about environmental pollution	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
10	I will be able to successfully overcome many challenges.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
11	Humans must live in harmony with nature.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
12	I am confident that I can do well on different types of tasks and activities.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
13	I support environmental protection laws.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
14	We should reduce our use of fossil fuels.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
15	I feel a personal responsibility to protect the environment.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
16	Compared to other people, I can do most things very well.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
17	I believe in preserving nature for future generations.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
18	Even when things are tough, I can do quite well.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

5. When you explore careers, to what extent do you agree with the following statements?

Right now, I am...						
1	identifying my strongest talents as I think about careers.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
2	learning what I can do to improve my chances of getting into my chosen career.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
3	learning as much as I can about the particular educational requirements of the career that interests me the most.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
4	trying to find people that share my career interests.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
5	thinking about all the aspects of working that are most important to me.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

SCALES AND SCORING:

Peer Relations/Social Competence (*adapted subscale from the Self-Efficacy Questionnaire for Children (SEQ-C); Muris, 2001*)

1. I work well with other kids.
2. I can make friends with other kids.
3. I can talk with people I don't know.
4. I can tell other kids that are doing something I don't like.
5. I can tell a funny story to a group of kids.
6. I can stay friends with other kids.
7. I can tell other kids what I think, even if they disagree with me.

(Seven items, 5-point scale; 1= strongly disagree, 5=strongly agree)

Career Exploration (*Vocational Identity Status Assessment – In-Depth Career Exploration Scale; Porfeli, Lee, Vonderacek, & Weigold, 2011*)

Right now, I am...

1. identifying my strongest talents as I think about careers.
2. learning what I can do to improve my chances of getting into my chosen career.
3. learning as much as I can about the particular educational requirements of the career that interests me the most.
4. trying to find people that share my career interests.
5. thinking about all the aspects of working that are most important to me.

(Five items, 5-point scale; 1= strongly disagree, 5=strongly agree)

Self-efficacy and Confidence (*New General Self-efficacy; Chen, Gully, & Eden, 2001*)

1. I will be able to achieve most of the goals that I set for myself.
2. When facing difficult tasks, I am certain that I will accomplish them.
3. In general, I think I can meet goals that are important to me.
4. I believe I can succeed at most anything I try and set my mind.
5. I will be able to successfully overcome many challenges.
6. I am confident that I can do well on different types of tasks and activities.
7. Compared to other people, I can do most things very well.
8. Even when things are tough, I can do quite well.

(Eight items, 5-point scale; 1= strongly disagree, 5=strongly agree)

Environmental Preservation (*2-Major Environmental Values (2-MEV) Scale; Bongor & Wisemen, 1999*)

1. I prefer wildlife reserves to zoos.
2. I enjoy spending time in nature.
3. We should protect endangered species.
4. It's important to conserve natural resources.
5. I am concerned about environmental pollution.
6. Humans must live in harmony with nature.

7. I support environmental protection laws.
8. We should reduce our use of fossil fuels.
9. I feel a personal responsibility to protect the environment.
10. I believe in preserving nature for future generations.

(Ten items, 5-point scale; 1= strongly disagree, 5=strongly agree)

ADDITIONAL/OPTIONAL MEASURES

Civic Efficacy (Ballard, Caccavale, & Buchanan, 2015)

1. I can change my world for the better by getting involved in my community.
2. I can make my community a better place by helping others in need.
3. There are things I can do to make the world a better place.

(Three items, 5-point scale; 1 = strongly disagree, 5 = strongly agree)

Resource Mobilization (Youth Empowerment Solutions (YES); Zimmerman et al., 2018)

How much do you agree or disagree with these statements?

1. I know what things are needed to do a community project.
2. Adults can help me do a community project.
3. Working with others on a community project makes the project better.
4. I can find things in my community to help make my community better.

(Four items, 5-point scale; 1=strongly disagree to 5=strongly agree)

Civic Engagement (Zaff, Boyd, Li, Lerner, & Lerner, 2010)

How often do you do the following things?

1. Help make your city or town a better place for people to live.
2. Help out at your church, synagogue or other place of worship.
3. Help a neighbor.
4. Help out at your school.
5. Volunteering Your Time (at a hospital, day care center, food bank, youth program, community service agency).
6. Mentoring/Peer Advising.
7. Tutoring.

(Seven items, 6-point scale; very often, often, sometimes, seldom, never)

Community Belonging (Canadian Community Health Survey)

1. How would you describe your sense of belonging to your local community?

(Single item, four-point scale; “very strong” to “very weak.”)

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Participation in seagrass restoration activities involves inherent risks, including but not limited to environmental hazards, physical injury up to and including death, and potential legal or regulatory considerations. It is the responsibility of each participating organization to conduct its own due diligence, obtain any required permits, follow all applicable laws and safety guidelines, and seek expert advice as necessary.

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