

Design and Grow a Seagrass Nursery to Help Restore Ocean Seagrass Beds around Guam

High School Life Science Guam STEM Design Challenge

Anchor Question: How can we increase seagrass in the ocean around Guam to reduce the impacts of climate change by absorbing and storing carbon dioxide from the ocean water, and to create wildlife habitat?

Overview

Guam Connection

Guam is surrounded by coral reefs and shallow waters that could be home to large sea grass beds. Sea grass beds are disappearing globally, and possibly around Guam because of erosion that moves into the ocean to add sediment and reduce the ability of the sun to reach the sandy bottom where sea grass grows. Seagrasses are important plants that use bicarbonates in the ocean formed from water and atmospheric carbon dioxide. This is important to reduce the acidification caused by the addition of the carbon dioxide creating a weak carbonic acid in the ocean which also bleaches corals and dissolves the shells of some marine species. A 2018 study reports that seagrass beds around Guam have decreased by 22%. (Science Daily)

Engineering Design Challenge

Design a nursery to grow the species of seagrass found in the ocean around Guam. Work with local experts to collect and grow the seagrass in the classroom, and to transplant the new plants into the oceans to help restore declining seagrass beds that are home to many animals and are carbon absorbers that can reduce the impacts of climate change. [Designing a seagrass nursery \(Project Seagrass-UK\)](#)

NGSS Performance Expectation

HS-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon in the atmosphere and hydrosphere [oceans].

HS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the [ocean] environment and biodiversity.

HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

STEM Concepts (NGSS Disciplinary Core Ideas)

LS2.B: Cycles of Matter and Energy in Ecosystems. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the atmosphere, oceans and geosphere through chemical and biological processes.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, and climate change—can disrupt an ecosystem and threaten the survival of some species.

ESS2.D: Weather and Climate: Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gasses added to the atmosphere each year and by the ways in which these gasses are absorbed by the ocean and biosphere.

ESS3.D: Global Climate Change: Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

ETS1.B: Developing Possible Solutions. When evaluating solutions, it is important to consider a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts. (secondary)

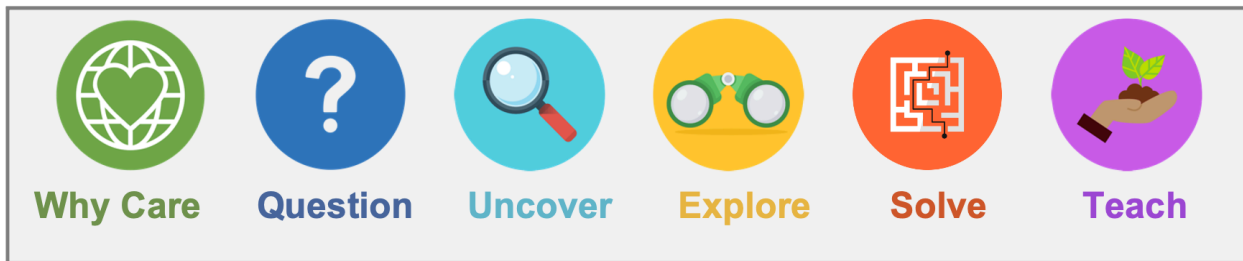
Time: Estimated Number of Classes

4-7 classes (45-minute class)

Materials for the Design Challenge

Talk with an island expert for best design materials. Large plastic or other containers that hold sand and ocean water, seagrass seedlings (get with help of island expert), smaller biodegradable grow pots that can be transplanted in the ocean floor. Buckets, pumps (optional). Sand (beach with permission, or purchased).

The Q-U-E-S-T Experience



Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Question

Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Explore

Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.

Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Teach

Share your project with others to help others understand the problem and how your project helped solve it.



Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Introduce the Quest

1. **Post and read the anchor question:** How can we increase seagrass in the ocean around Guam to reduce the impacts of climate change by absorbing and storing carbon dioxide from the ocean water, and to create wildlife habitat?
2. **Read, describe, and post the design challenge:** Design a nursery to grow the species of seagrass found in the ocean around Guam. Work with local experts to collect and grow the seagrass in the classroom, and to transplant the new plants into the oceans to help restore declining seagrass beds that are home to many animals and are carbon absorbers that can reduce the impacts of climate change.
3. **Share and talk about the Driving Question for why we should care:** Why should I care about seagrass in the ocean around Guam? Share and discuss with students.
4. **Do this:**
 - a. Watch: [Seagrass—an unexpected climate solution](#) (UN)
 - b. Explore this website [Seagrass Watch](#) and examine the global map. What is the mission of this organization? Why is this important? What types of work do they do and where are their projects? What does the global map tell us?
 - c. What seagrass lives around Guam and how is it doing?
 - i. Share this: Guam is surrounded by coral reefs and shallow waters that could be home to abundant sea grass. Seagrass beds are disappearing globally, and possibly around Guam because of erosion that moves into the ocean to add sediment and reduce the ability of the sun to reach the sandy bottom where sea grass grows. A 2018 study reports that seagrass beds around Guam have decreased by 22%. ([Science Daily](#))
 - ii. Figure out [Guam seagrass](#) Guam Reef Life.

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Write or draw your “why I care” and why others on Guam care.



Question

Begin by asking **QUESTIONS** about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Ask Questions

1. **Create a KND Chart (Know, Need to know, Do)** with the three driving questions below. Save the questions and responses to look at during the QUEST; writing them on chart paper, butcher paper, in student design notebooks, or use a digital organization chart, like Jamboard. KND Questions:
 - a. What do we **KNOW** already about seagrass and its role in the health of ocean water and marine life?

- b. What do we **NEED TO KNOW** to understand the role seagrass has in the health of the ocean water and marine life?
 - c. What could we **DO** to learn about the role of seagrass? What are some ideas of what we could DO to help increase the amount of seagrass in ocean waters around Guam?
2. **Gather responses from students.** [Have students think and write responses: First, silently and individually. Then, in small groups. And finally, with the full class. The result is a class KND chart to refer to, add to, and reorganize throughout the QUEST. Students could sort the responses that are similar. This information will help guide the UNCOVER and EXPLORE.]

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Write KND lists. Organize the questions (Need to Know) from class. Record the categories, or themes, of the questions and ones you are most interested in.



Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Uncover Key Ideas

1. **Share the Driving Question:** Why is seagrass important to Guam? What is being done to study and protect seagrass around our island?
 - a. Watch these interactive videos by PBS University- Guam, pausing the videos when cued to do what is asked. Be sure you can answer the two driving questions when done.
 - i. Video 1 on Guam seagrass: [Coastal Outreach - Seagrass: PBSU Higher Learning, S4 Ep2](#)
 - ii. Video 2 on Guam seagrass: [Coastal Outreach - Merry's Seagrass Research: PBSU Higher Learning S4 Ep4](#)
2. **Share the Driving Question:** What is seagrass and why is it important to the larger ocean ecosystem? How does it help reduce global climate change?
 - a. Students can go to these websites to answer the driving question:
 - i. [Sea-Trees: Why seagrass?](#)
 - ii. [Ocean Health: Ocean pH and Acidity](#), NOAA Ocean Explorer
 - iii. [Project Seagrass: Instructions to make a Secchi disk](#) to understand seagrass light requirements could be done here or later in the QUEST. (STEM from home)
3. **Share the Driving Question:** How is seagrass important to marine life?
 - a. Resources for students to gather information to answer this question. What can they find out about animal life cycles, food webs, and interactions that happen in and around seagrass beds?
 - i. [Guam Mangrove and Seagrass Adventure Scavenger Hunt](#) (Interactive slides by Guam Coral Reef Initiative)
 - ii. [Seagrass and Seagrass Beds](#) (Smithsonian)
 - iii. [What is seagrass?](#) (Seagrass Watch)
 - iv. [Seagrasses](#) (National Wildlife Federation)
4. **Share the Driving Question:** Why has seagrass abundance declined?

- a. Video: [Hope or hype? How seaweed may help revive our oceans](#), (NOVA PBS, 2022)
- b. Series of lessons and investigations with action project to grow seagrass: [Declining Seagrass Abundance](#) (Oregon State University)
- c. [Science Presentation](#) Ecology of Submersed Aquatic Vegetation Dr. Laura Murray, University of Maryland: Outlines the ecology, importance, and global decline of seagrass. This PowerPoint is in Additional Resources, and provides information about seagrass life cycle, structures, and living requirements.

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Write the driving question and summarize what you did and learned. (blank page)

Students will understand these NGSS Disciplinary Core Ideas:

LS2B: Cycles of Matter and Energy in Ecosystems. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the atmosphere, oceans and geosphere through chemical and biological processes.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, and climate change—can disrupt an ecosystem and threaten the survival of some species.

ESS2.D: Weather and Climate: Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.

ESS3.D: Global Climate Change: Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities



Explore

Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.

Apply Your Learning

1. **Share the Driving Question with students:** How can we apply what we learned in UNCOVER to design a seagrass nursery and grow plants to transplant in the ocean around Guam?
2. **Revisit the KND lists** you wrote at the beginning of your Quest. Add and edit them to include new understandings and experiences from UNCOVER.
 - a. KNOW - What have you confirmed as accurate? Correct any inaccurate information.
 - b. NEED to know - Mark any questions that you have answered, and ones you still need and want to answer. Add new questions.
 - c. DO - Add any new project ideas you could do to help solve the problem.
3. **Return to the anchor question:** How can we increase seagrass in the ocean around Guam to reduce the impacts of climate change by absorbing and storing carbon dioxide from the ocean water, and to create wildlife habitat?

4. **Read and talk about the design challenge:** Design a nursery to grow the species of seagrass found in the ocean around Guam. Work with local experts to collect and grow the seagrass in the classroom, and to transplant the new plants into the oceans to help restore declining seagrass beds that are home to many animals and are carbon absorbers that can reduce the impacts of climate change. [Designing a seagrass nursery \(Project Seagrass-UK\)](#).
5. Watch [Seagrass Nursery 2023](#) (UK Seawilding) to compare ways of building and identify the difficulties people are trying to overcome. Visit [Guam Coral Reef Initiative website](#) to
 - a. What seagrass would we want to grow? [Guam seagrass](#) Guam Reef Life
 - b. How would we grow seagrass?
 - c. Where would your project happen? If seagrass is grown in a nursery, where, in Guam waters, would it be transplanted?
 - d. Who should we ask to be island expert advisors?

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- Design Challenge Map- Complete as much as you can. Then add to and edit it throughout SOLVE.
- Design Requirements and Limitations (criteria and constraints)



Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Design & Do Your Project

1. At the end of EXPLORE you decided what project you want to do. Continue planning the project: Where, What, How, When, Who. Use pages in the Design Notebook to guide students in this design process.
2. Then do the project with the guidance of island experts who are knowledgeable about the most effective way to increase seagrass bed around Guam.
3. Your steps will follow the steps of the [Engineering design process](#) (Poster).

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- Edit and complete the Design Challenge Map.
- Edit and complete the Design Requirements and Limitations (criteria and constraints)
- Action Plan: List steps to complete the project, and who will do what.
- Team Self-Review: Review your project design to make sure it is focused on the design challenge, anchor question, and Guam.
- Gathering Feedback from Others: Get input from others to help strengthen your project.
- Claim-Evidence-Reasoning (CER): Give evidence for the most effective project design.

Students will understand these NGSS Disciplinary Core Ideas:

ETS1.B: Developing Possible Solutions. When evaluating solutions, it is important to consider a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts. (secondary)



Teach

Share your project with others to help others understand the problem and how your project helped solve it.

Share & Reflect on What You Learned

1. **Return to the anchor question:** How can we increase seagrass in the ocean around Guam to reduce the impacts of climate change by absorbing and storing carbon dioxide from the ocean water, and to create wildlife habitat?
2. **Prepare and creatively share** their project and who it helped solve the problem.
 - a. Who's your audience? Who will benefit from hearing about and seeing your project?
 - b. How will you share this information?
 - c. What do you want them to know and understand about the problem, your project and its impact?
 - d. When and where will you share?
3. **Student reflection:** After teaching others, students can complete a reflection about their Design Challenge. Here is one option: 4-3-2-1: Looking back, planning forward. Respond to:
 - a. FOUR of the most important things I learned doing this design challenge.
 - b. THREE of the most important things I learned about myself doing this design challenge.
 - c. TWO things I will do differently in my next problem-solving experience.
 - d. ONE thing I now want to learn more about.

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- TEACH. Make a plan for sharing your project with others.
- Looking back, planning forward. Reflect on what you did and what you might do next time.



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