

Reduce Harm from an Invasive Species after Tracking Impact in a Citizen Science Project

High School Biology Guam STEM Design Challenge

Anchor Question: How can we gather data about an invasive species living around our school that will help us design a project to reduce the harm they are causing our native species?

Overview

Guam Connection

Population increases in invasive plant and animal species can affect the population size and health of our island's native species and our human residents. Each invasive species on Guam has a unique story of how it got here and the impact they are having on our island's native species. Many hunt or outcompete native plants and animals, and damage natural habitats. This causes environmental, and sometimes economic harm to our island. Citizen science projects like iNaturalist allow any citizen like us to help scientists gather reliable data about both native and invasive species. This data can track a species' population size, location across the island, and impact. The data can help monitor the impact of any student interventions to control an invasive species and help our native species survive and thrive.

Engineering Design Challenge

Create a Guam iNaturalist citizen science project to gather data on one or more of Guam's invasive species around our school and community. Then use this data to design a project that reduces its harm to native species. This could be removing coral vine (chain of love) that is suffocating native species, participating in (or creating a new) a beekeeping project near school, or setting traps or other control equipment and procedures with island experts to reduce and remove the harmful invasive species.

NGSS Performance Expectation

[HS-LS2-2](#). Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.]

STEM Concepts (NGSS Disciplinary Core Ideas)

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

LS4.D: Biodiversity and Humans. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).

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)

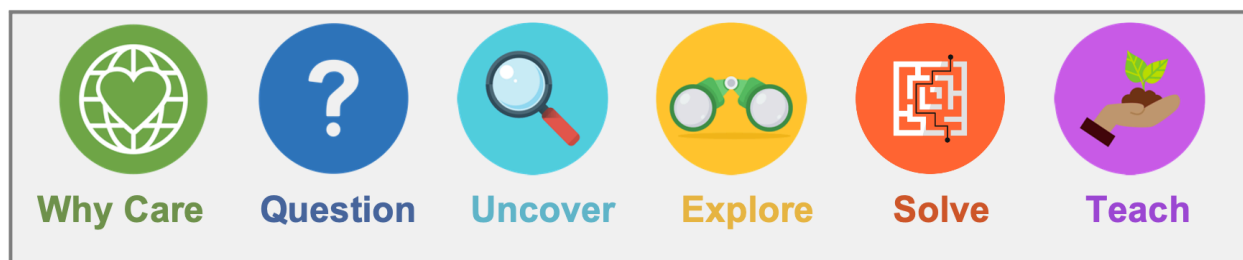
Time: Estimated Number of Classes

3-7 classes (45-minute class)

Materials for the Design Challenge

- iNaturalist app on phone or tablet
- Supplies, equipment to complete your choice of an intervention to reduce impact of an invasive species

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 gather data about an invasive species living around our school that will help us design a project to reduce the harm it is causing our native species?
2. **Read, describe, and post the design challenge:** Create a Guam iNaturalist citizen science project to gather data on one or more of Guam's invasive species around our school and community. Then use this data to design a project that reduces its harm to native species. This could be removing coral vine (chain of love) that is suffocating native species, participating in (or creating a new) a beekeeping project near school, or setting traps or other control equipment and procedures with island experts to reduce and remove the harmful invasive species.
3. **Share and talk about the Driving Question for why we should care:** Why should I, and other Guam residents, care about an invasive species like the coconut rhinoceros beetle, coral vine, or brown tree snake? What does it matter how many there are, where they are, and what they are doing?

4. **Do this:**

- a. Ask students any or all of these questions about invasive species to find out what they know.
 - i. Why does Guam have so many spiders?
 - ii. Why do we rarely hear birds singing?
 - iii. Where did Guam's fruit bats go?
 - iv. Why are so many of our palm trees dying and being cut down?
 - v. Why does the Guam rail [bird] only live on Coco Island?
- b. Introduce the problems with invasive species through a series of videos (#2-4) that you choose. Show one or both videos to give all students basic understanding of any invasive species: [What is an invasive species?](#) NOAA. [The plants and animals destroying ecosystems- Invasive species.](#) Have students define invasive species and list why people are concerned about them. What are their impacts on native species, ecosystems, and people?
- c. Guam invasive species. Show this video about [Invasive species on Guam](#), (2020, National Pesticide Safety Education). Find out which species students are familiar with and which are new species recognized as invasive. Invite students to share any personal experiences they have had with invasive species.
- d. Invasive animal species of Guam. Show this video on a well-known Guam invasive animal species. Together create a list of facts learned. Invite students to share any personal experiences they have had with the species: [See aerial tech that's fighting Guam's brown tree snake problem](#), Kuam News, 2019
- e. Invasive plant species of Guam. Share information about a well-known invasive plant species. Discuss why invasive vines are a concern on Guam. Have students read the Overview and Introduction of [Invasive Vines of Guam](#), UOG brochure. As a class record reasons for concern as described. (They will read the rest of the brochure in a lesson under UNCOVER.) Ask for any personal experiences or observations they have had with this vine.
- f. Let them know that they are going to create an iNaturalist citizen science project to collect data about a particular invasive species to reduce its harm. Have them go to [iNaturalist: Coconut Rhinoceros Beetle](#) and let them explore and evaluate the site: Ask them what information they found on the site, the purpose of the project, what data is collected, and what would make the project more effective (more participation!).

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

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. You will want to 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 these non-native, invasive plants and animals and how they impact our island?
 - b. What do we **NEED TO KNOW** about these non-native animals and plants to be able to design a game to teach others about them and their impact? (driving questions to guide QUEST)
 - c. What could we **DO** to figure out the impact of invasive species around school? What projects could we DO to reduce the invasive species' impact on native species, and our community?
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.

Teacher Prep

1. Decide if you want to set the study site boundaries for the iNaturalist project where you want students to gather data about an invasive species or if you want students to help do this? Watch this video with instructions for how to create the project: [Create an iNaturalist Project for Your School & Participate in the City Nature Challenge!](#) You will need to access [GoogleEarth](#). You can do this with students or before students start.
2. Decide on student requirements: What they are observing (Plants and animals- including small insects), how many observations they need to make and enter, where they will be observing, time frame for gathering data.
3. Consider inviting a UOG scientist to help you get set up, or to get students started and inspired to work with iNaturalist. Both are using iNaturalist projects for their work and have consulting on this design challenge. Aubrey Moore aubreymoore@triton.uog.edu and /or Roland Quitugua quituguarj@triton.uog.edu

Uncover Key Ideas

1. **Share the Driving Question:** How do invasive species affect plants, people, the environment, and other animals of Guam?
 - a. Watch [What are invasive species?](#) (National Park Service). Then read to define the different terms on this page: Native, non-native, invasive, pests, range-expanding.
 - b. Go to [Invasive Species of Guam](#). Divide these 13 species among students. (Do not include the coconut rhino beetle. It is in the next lesson.) Have them read the card, do an internet search to find 1-3 current articles or videos about this species. Then create an infographic with information such as: Name(s), scientific name, where it came from and when it arrived on Guam, how it is affecting life on Guam (example: native species, ecosystems, people, economy), what is being done to reduce harm (if anything), and interesting facts about the species.



2. **Share the Driving Question:** How do invasive (non-native) species end up on an island like Guam and why are they so harmful to island ecosystems?
 - a. [Watch Invasive Species 101 \(National Geographic\)](#) about introducing invasive species into a native ecosystem.
 - b. Go to [NWF Invasive Species](#). Silently read and write down the key phrase or sentence under each of the section headings: What makes a species invasive? How Invasive Species Spread, Threats to Native Species, Examples (describe one), Curbing the Spread.
 - c. Read: [How invasive species are threatening precious island birds and plants](#), (2020) Natural History Museum. In a few sentences, after reading the title, explain “how.”
3. **Share the Driving Question:** What is the impact of a particular invasive species on the environment? local economy? food web? biodiversity? people?
 - a. The coconut rhinoceros beetle is our animal invasive species example. Have students read the card in [Invasive Species of Guam](#) and visit the sites below. Record and discuss the same information as they did with species in the “Why Care” activity. (Name(s), scientific name, where it came from and when it arrived in Guam, how it is affecting life on Guam (example: native species, ecosystems, people, economy), what is being done to reduce harm (if anything), interesting facts about the species.
 - i. Video: [Coconut Rhinoceros Beetle](#), Sea Grant Guahan, 2015
 - ii. [Coconut rhinoceros beetle makes unexpected “host shift” to Guam’s cycad trees](#), September 2020, Science Daily, UOG
 - iii. [Guam moves to contain invasive rhino beetle, protect region](#), September 2022. Guam Daily Post.
 - iv. [Coconut rhinoceros beetle](#), USDA
 - b. The Chain of Love (coral) vine is our invasive plant species example. Learn about and be able to identify the Chain of Love (coral) vine as an example of an invasive plant harming island ecosystems: [Invasive Vines of Guam](#), UOG brochure. [Virtual Proclamation: Invasive Species Awareness](#) with governor (2022)
4. **Share the Driving Question:** How could citizen science projects help scientists and citizens understand a species, a place, and a phenomenon in Guam?
 - a. Watch video: [Get outside with citizen science projects](#), National Geographic
 - b. Survey CitSci projects: Have students visit these sites below to explore the many different citizen science projects people can help with. Have them find 2-3 projects they are curious about. Go to the project site and record: The problem. The purpose of the project. What citizens do to participate. Data collected. Go to one or more of the citizen science project hubs:
 - i. [SciStarter \(Guam search\)](#) Search narrowed to Guam. You can narrow with other filters.
 - ii. [Zooniverse](#). Choose a science topic to search.
 - iii. [Citizen science projects](#), National Geographic
5. **Share the Driving Question:** How can we be citizen scientists to help gather data about an invasive species in Guam?
 - a. Show the introduction to iNaturalist citizen science app at the top of the [iNaturalist YouTube Channel](#).

- b. Have students go to the [iNaturalist website](#). Give them time on [iNaturalist.org](#) to and explore. You can have them record “I noticed, I like, I wonder, Questions I have.”
- c. Watch [How to use iNaturalist. Choose any other video instructions from the iNaturalist YouTube channel](#) that would be helpful.
- d. Show students the class iNaturalist project page you have set up. Show how to join the project and add observation data.
- e. Have students download [iNaturalist app](#) on to phones and tablets.
- f. Go outside, demonstrate, and have students practice using the app on any plant or animal. Each student can take 2-3 photos, have the app identify it, and upload in the iNaturalist database. Make sure everyone feels confident using the iNaturalist app and recording observations in your class project.
- g. The first part of this class design challenge is to gather data about invasive species around the school (and possibly community). You have either set up the iNaturalist invasive species project already, or you are going to have students help now. Have students go to the project site you (teacher) have set up, or have students set up the project on iNaturalist.
 - i. To set up a project, follow the instructions to [Create an iNaturalist Project for Your School & Participate in the City Nature Challenge!](#) You will need to access [GoogleEarth](#). You can do this with students or before students start.
 - ii. Decide on and explain student requirements: What they are observing (Plants and animals- including small insects), how many observations they need to make and enter, where they will be observing, time frame for gathering data.
 - iii. Remember you can invite a UOG scientist to help you get set up, or to get students started and inspired to work with iNaturalist. Both are using iNaturalist projects for their work and have consulting on this design challenge. Aubrey Moore aubreymoore@triton.uog.edu and /or Roland Quitugua quituguarj@triton.uog.edu
- h. Go outside to the study site for the project. Divide the site into sections and assign a small group of students to each section. Have them walk the area and collect data on any invasive species, or signs of an invasive species they find. You could also have them collect data on all species if preferred.
- i. While collecting data on iNaturalist, have students research and gather information about their targeted invasive species. Here are ideas of information that could be researched, organized, and shared. Go to the bottom of this document for a list of invasive species resources that students can begin with.
 - i. Life cycle
 - ii. Physical and behavioral adaptations that help it survive and thrive on Guam
 - iii. What it eats and what eats it (place in the island food chain)
 - iv. Signs of the species being present in an area (e.g., palm tree leaf patterns made by the coconut rhinoceros beetle)
 - v. Harm to native species
 - vi. Current and past solutions (e.g., traps) to reduce the harm. Include citizen science projects.
- j. Take students back out to the study site after doing the research. They will be better able to identify signs of invasive species. If your study site is larger than school grounds, have specific

requirements of how many observations, and of what, each student needs to make in a designated number of days.

6. **Share the Driving Question:** What does the data tell us about the diversity of native plants and animals in our study site?
 - a. **Prep by teacher:** Look at this slide deck with video support in [iNat Data in your Classroom](#) to decide if you want students to practice analyzing iNaturalist data as described here. Roland and Aubrey can help with this.
 - b. **Practice with other data:** Students could also look at existing data (stats) for the [iNaturalist Coconut Rhinoceros Beetle citizen science project](#). How would you summarize it and what does it tell us? What other mathematical representations of data could you create (examples: Make a different graph or a table of the data provided, pull out and organize other data such as the number of a particular species that you found around your school or that interests you).
 - c. **Analyze your project data** gathered in your school-community study site. This is called baseline data and describes the diversity of life before any project you do to help increase biodiversity.



Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

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

Students will understand these NGSS Disciplinary Core Ideas:

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

LS4.D: Biodiversity and Humans. Biodiversity is decreased by the loss of species (extinction).



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 from the iNaturalist data we collected on invasive species around our school to design and do a project that could help reduce the harm of an invasive species to Guam's native species and people?
2. **Revisit the KND lists** you wrote at the beginning of your Quest. Add and edit the lists 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. **Revisit the anchor question:** How can we gather data about an invasive species around our school that will help us design a project to reduce the harm it is causing our native species?
4. **Read and talk about the design challenge:** Create a Guam iNaturalist citizen science project to gather data on one or more of Guam's invasive species around our school and community. Then use this data to design a project that reduces its harm to native species. This could be removing coral vine (chain of love) that is suffocating native species, participating in (or creating a new) a beekeeping project near school, or setting traps or other control equipment and procedures with island experts.
5. **Project Ideas:** Research and decide on the project your class wants to do to reduce the impact of an invasive species around your school that you collected data on. You want to see if your project makes a difference by collecting more data later in the year after your project has been in place for a while.
 - a. Remove invasive plant species. Remove coral vine (chain of love) to see if native species recover.
 - b. Set traps for invasive animal species, with guidance from a local scientist.
 - c. Participate in an ongoing beekeeping project near school or work with beekeepers to set up a bee colony near school grounds to counter the impact of the Varroa destructor, a parasitic mite killing bees.
 - d. Create an educational game, video, or skit to teach others in your school, feeder elementary schools, or the community about the invasive species and how they can help reduce its harm.
 - e. Develop your own project that would reduce harm from an invasive species.

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

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

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)



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. Now design and complete it! Map out the project: Where, What, How, When, Who. Use pages in the Design Notebook to guide students in this design process. Have students 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.



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 gather data about an invasive species living around our school that will help us design a project to reduce the harm it is causing our native species?
2. **Prepare a creative way to share your project and how it helped solve the problem.** Build your presentation around the anchor question.
 - 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, how you collected data on iNaturalists, your project solution and its impact?
 - d. When and where will you share?
3. **Student reflection:** Students can reflect on their experience with this design challenge while preparing their presentation or afterwards. Here's one reflection idea: 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.

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

- 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.

Additional Resources

- **Brown Tree Snake**
 - [Brown tree snake](#), (Invasive Species Information). Several videos here.
 - Brown Treesnake, <https://youtu.be/SfwffcCeeqA> and <https://youtu.be/-NTCzIR6awk>
 - Article: [Invasive Brown Treesnake Present on Cocos Island, Agencies Working to Prevent Further Spread](#) (2020)
- **Coconut rhinoceros beetle**
 - [Coconut rhinoceros beetle](#) (Invasive Species Information). Several videos here.
 - [The rhinoceros beetle](#) (UOG)

- [A Pacific Battle to Eradicate the Rhinoceros Beetle](#) (Oct 2017)
- **Greater banded hornet**
 - [Greater banded hornet](#), New invasive wasp found on Guam, PNC (video embedded).
 - [Video news report on wasp](#).
 - [Great banded hornet fact sheet](#)
- **African land snail**
 - [Land snails of the Mariana Islands](#) (Guampedia)
 - [Invasive species on Guam](#) (UOG)
 - [Giant African land snail](#) (Invasive Species Information)
 - Video: [Why giant snails are a problem in Florida](#) (CNN)
- **Games with environmental themes**
 - Board games examples:
 - [Marae-opoly - \(Article\)](#) Maori [New Zealand] community used surprising tactics to avoid killer floods
 - [Pandemic](#): A cooperative board game in which players work as a team to treat infections around the world while gathering resources for cures.
 - Physically active game examples:
 - [Turtle Hurdles](#) (Project Wild physical activity modeling life of sea turtle)
 - [Oh Deer](#) (Project Wild activity based on Red Rover game)
 - [Quick Frozen Critters](#) (Project Wild)
 - Card game:
 - [Ecologies](#). (Read “Description” on right under cost)
- **Example of an invasive species game**
 - Design a physical activity game focused on one invasive species. The game would simulate the changing impact of when the population grows without any ecological controls, and when natural or human-designed solutions are put in place. The game will simulate the interaction the invasive species has with Guam’s native species and the environment during different stages of its life cycle. The first part of the game would simulate the effects of the species when there are no controls on its population or behaviors. The second part of the game would introduce any natural or human-designed solutions (e.g., traps) being tried on island to mitigate and reduce the impact of the species on native species and the island environment. Debriefing and sense-making of the game could include science and engineering skills such as graphing any population data collected during the game, summarizing, and generating Claim-Evidence-Reasoning summaries.



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