**Subject area/course**: Science/Environmental Science

**Grade level/band**: 9-11

**Task source**: Stanford Center for Assessment, Learning, and Equity (SCALE); author: Susan Schultz

**Silent Invaders: Invasive Species and Their Impacts**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students will play the role of a team hired to work for a non-profit environmental company, *Invasion Free*, to investigate an invasive species introduced locally. Students will learn about different types of invasive species and the distribution of these species in their local region. In teams, students will research the potential impact of these invasive species on the environment, health, and economy. Teams will then investigate one specific invasive species and learn everything they can about the characteristics of the species, its interaction with the native organisms and ecosystems, and the potential impacts.

Students will also research the different options that might be used to remove or reduce the impacts of the invasive species. After researching and evaluating each option, the students will construct an argument. They will write a claim as to which option or combination of options they think will be the most effective at removing/reducing the impacts. Students will need to support their claim with evidence from multiple, credible sources. They will also need to justify their claim and use evidence to explain why the other options (counterclaims) would not be as effective. Then each team will develop a plan to effectively remove and/or minimize the impact of the species. Teams will make an oral presentation to the *Invasion Free* board describing their plan and what they’ve learned.

Each student will prepare a research paper detailing his or her findings and recommendations. They will share what they learned about a specific invasive species, the potential impacts, possible options for controlling the impacts, their argument with evidence for the most effective option or options, the limitations of their argument, and their plan for removing or reducing the invasive species.

1. **Aligned standards:**
2. **Common Core State Standards**

[CCSS.ELA-Literacy.RST.9-10.1](http://www.corestandards.org/ELA-Literacy/RST/9-10/1/) Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

[CCSS ELA-Literacy.RST.9-10.2](http://www.corestandards.org/ELA-Literacy/RST/9-10/2/) Determine the central idea or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

[CCSS ELA-Literacy.RST.9-10.9](http://www.corestandards.org/ELA-Literacy/RST/9-10/9/) Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

[CCSS.ELA-Literacy.WHST.9-10.1a](http://www.corestandards.org/ELA-Literacy/WHST/9-10/1/a/) Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

[CCSS.ELA-Literacy.WHST.9-10.4](http://www.corestandards.org/ELA-Literacy/WHST/9-10/4/) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

[CCSS.ELA-Literacy.WHST.9-10.5](http://www.corestandards.org/ELA-Literacy/WHST/9-10/5/) Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

1. **Critical abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

Analysis of Information: Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Communication in Many Forms: Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience.

Use of Technology: Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information.

Interpersonal Interaction and Collaboration: Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

Modeling, Design, and Problem Solving: Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

1. **Next Generation Science Standards**

*Disciplinary Core Ideas*

[HS-LS2-7](http://www.nextgenscience.org/hsls2-ecosystems-interactions-energy-dynamics) Design, evaluate, and design a solution for reducing the impacts of human activities on the environment and biodiversity. Examples of human activities can include urbanization, building dams and dissemination of invasive species.

Secondary to HS-LS2-7. When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider the social, cultural, ad environmental impacts.

*Science and Engineering Practices*

Engaging in Argument From Evidence

* Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
* Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
* Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
* Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

1. **Time/schedule requirements:**

The following schedule is an estimate of the number of school days required for students to complete this task. Time requirements will vary based on grade level, schedule constraints, class size, class length, and academic readiness.

|  |  |  |
| --- | --- | --- |
| **Due Date** | **What You Need To Do** | **Product** |
| Day 1 | Learn about invasive species within your state | Construct Argument and Plan |
| Days 2-5 | Select and research a specific invasive species and make a “wanted poster” of your invasive species |
| Identify possible options to control or remove your invasive species |
| Generate a list of criteria based on your research and evaluate each option |
| Days 6-7 | Construct an argument using evidence to identify the most effective option or options to reduce/remove the invasive species |
| Evaluate your argument by considering other options (counterclaims) and discuss the limitations of your argument. |
| Days 8-11 | Develop a plan to remove or minimize the invasive species |
| Get peer and teacher feedback on draft plan |
| Finalize your argument and plan |
| Day 12 | Plan your presentation |  |
| Day 13 | Group Presentation: Present your argument and plan to the Invasion Free panel | Oral Presentation |
| Days 2-12 | Research Paper | Individual Paper |

1. **Materials/resources:**

Students will need:

* Access to the Internet for research
* Copies of the *Criteria for Oral Presentations* document
* Presentation software or poster-making materials for the presentation

Helpful links:

* USGS: <http://nas.er.usgs.gov/queries/StateSearch.asp>
* [National Invasive Species Act of 1996 (NISA)](http://thomas.loc.gov/cgi-bin/query/z?c104:H.R.4283.ENR:): NISA is the U.S. federal bill to reauthorize and expand the 1990 federal non-indigenous species legislation. A key element of the legislation is that it provides for ballast water management to prevent the introduction and further spread of non-indigenous species in U.S. waters.
* [Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990](http://www4.law.cornell.edu/uscode/16/ch67.html)
* <http://www4.law.cornell.edu/uscode/16/ch67.html> This act aims to prevent and control infestations of the coastal inland waters of the United States by the zebra mussel and other non-indigenous aquatic nuisance species.
* http://thomas.loc.gov/: Library of Congress   
  Search full-text versions of active or pending U.S. House and Senate bills. Enter "aquatic nuisance" or “invasive species.”

1. **Prior knowledge:**

Students should have an understanding that:

* Human activities have the capacity to alter the biosphere.
* Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
* Small changes in one part of a system might cause large changes in another part.
* Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all of its populations.

Students might have some misconceptions that:

* The natural environment is safe from the non-native plants and fish they stock in their ponds, as long as there is no direct connection between the waters. For example, fish can “escape” if there is no direct aquatic connection to natural waters. Fish eggs can attach to feathers of a duck. There are also times when herons or osprey catch a fish and lose them in flight. There are numerous examples where undesirable fish become established in a river, and then within several years these fish appear in most of the ponds within a couple miles of that river.
* Warmer climate plants will never invade cooler areas because they die in winter.

1. **Connection to curriculum:**

This performance assessment can be a culminating project within a unit on human impacts, changes within different types of ecosystems, and/or natural systems.

1. **Teacher instructions:**

Below is a comprehensive list of *suggested* ways to facilitate, organize, and scaffold student work, based on pilot implementation conducted by SCALE in real classrooms. You will, of course, need to choose what ideas meet the needs of your students, their previous experience with open-ended projects, and practicalities of your classroom/school, and adapt them accordingly.

You’ll notice that throughout we have tried to provide students with opportunities to make choices and take the lead in decision-making to complete the task. In this same vein, we encourage the use of peer-review and revision.

Possible Engagement Activities (The Hook)

An entry event could begin with developing a KWL (Know-Want to Know-Learned) chart on invasive species. Begin by discussing what students already know and what they want to know. These can be completed as a class, in small groups, in pairs, or individually. Possible guiding questions include:

* What are invasive species?
* Do you know of invasive species in your state?
* What types of organisms can be invasive?
* Are invasive and exotic species the same thing?
* When is a species considered invasive?

Introduce the Task

* After the introductory activity, read aloud the task description on page one. Go over the logistics and deadlines.
* Read each bullet aloud and ask if students need any clarification.
* Suggest students design a template to collect information and record references at the time data is being collected.

Review Expectations

* Review the due dates/task timeline.
* Review expectations for working together in a group – the roles students should take on and the norms for behavior (for more details, see “Student Support” section).
* Allow students time to look at the rubric(s), clarify the criteria, and respond to student questions.
* Explain that, as they work in their groups, they will be responsible for gathering information and making their own decisions. As the teacher, you will provide help/resources only when everyone in the group agrees that they need help or if there is information they can’t find themselves.

Depending on your students’ previous research experience, you may need to remind them about the importance of using credible sources, how to cite within a text, and the format you wish them to use for developing a reference/bibliography page. Students will be held accountable for these conventions in their individual research paper.

Part 1: Understanding the invasive species in your state (Team Activity)

Remind students that before they can investigate a specific invasive species, they need to gather some general information on invasive species in the state. Students will use web resources (such as the USGS site listed above) to compare and contrast various aspects of different invasive species. Within their group, students should discuss the following criteria:

* Visual representations of the different types of invasive species (taxonomic groups) in the state
* The most abundant types of invasive species impacting the state
* Where these invasive species came from (origins)
* The methods or pathways of how the invasive species were introduced into the state
* The key points necessary to understand the problem of invasive species in the state

As a large group, students should share the information they found. One group can initially address each criterion, and other groups can add to the discussion any ideas that their group found that have not yet been shared.

After their initial research, ask groups to discuss:

* What kinds of invasive species are in the state? Are there any species considered invasive/native now versus 50 years ago? 100 years ago? 500 years ago?
* How might species designations (invasive, native, non‐native) change in the future?
* What is a working definition of 'abundant'? 'Established'?
* Develop a list of commonalities for many different species.
* Should people care about invasive species? Why or why not?

Students may have questions about the methods used to collect the data listed on the USGS site. You may wish to go through the data they provide on one species to tease it apart.

*Individual Task*: Students summarize what they have learned from the research gathered by their group. They should write a content-specific introduction for their research report.

Part 2: Select and research a specific invasive species (Team Activity)

After students have shared background knowledge on invasive species, have each group choose one organism to investigate more thoroughly. As they complete their research, remind students that this information will be included in their final individual research report. Students can use their own notebooks, blogs, wikis, or shared documents to keep track of their ideas and the resources they use. Students will create a “Wanted Poster” or other type of visual to share the following information:

* A description of the invasive species’ physical appearance and biological characteristics
* An explanation of where the species originated and how it was transported to the state
* An explanation of how this species’ physical and/or biological characteristics enables it to invade, compete, and impact the native ecosystem (habitat and native organisms)
* An illustration of the distribution of this invasive species within the state (distribution map)
* A prediction of what will happen if the growth or expansion of this invasive species continues
* An estimate of the costs (i.e., environmental, health, social and/or economic) of this invasive species

Halfway through the research process, groups can share one thing they learned about their invasive species and one thing they still want to know. At the completion of the activity, groups can share their explanations of why this species has successfully invaded their state and their predictions of how this growth will continue.

*Individual Task*: Students will summarize what they have learned about their specific invasive species in their research report.

Part 3 and 4: Identify and evaluate solutions/options (Team Activity)

Ask students to discuss, as a class, definitions and examples of mechanical, biological and chemical interventions for invasive species. After the class discussion, invite groups to take five minutes to brainstorm several interventions of each type for their specific invasive species. After their brainstorming session, explain that students will be researching actual interventions used, as well as additional information on managing their organism. Students should:

* Describe any state policy and/or legislation to protect the state from future spread
* Identify methods for preventing future infestation or spread of the species
* Research and discuss the potential impacts (positive, neutral, and negative) of each of the possible methods for removing an invasive species, specifically:
  + Mechanical interventions
  + Biological interventions
  + Chemical interventions
* Organize the data into charts, tables, and/or graphs where appropriate, remembering to properly label everything and provide a key/legend when applicable
* Describe and explain any patterns and/or trends that they notice when examining the information

*Individual Task*: Students will summarize and evaluate possible solutions or options for controlling/limiting their invasive species in their research report.

Part 5 and 6: Construct and justify an argument (Team Activity)

Each team needs to construct an argument indicating which option or combination of options they think are most effective for removing or reducing the impacts of their invasive species. Students’ arguments need to include:

* A claim about what they think will be the best option or combination of options to remove or reduce the impacts of their invasive species
* Identify (cite) and explain the evidence to support their claim
* Identify (cite) alternative evidence (counterclaims) and explain whether it supports or refutes their claim
* Provide a justification of why their claim is the “best” and why the counterclaims are not better
* Describe any limitations that exist in their argument

Depending upon how much previous experience your students have writing arguments, you might want to provide them with some sentence starters such as:

1. I think \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the best option or combination of options to remove or reduce the impacts of \_\_\_\_\_\_\_\_\_ invasive species because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. I have many sources of evidence that supports my claim that \_\_\_\_\_\_\_\_\_ is the best option. One pieces of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Another source of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Others might think that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a better option because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but I disagree because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

OR

“Removing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_invasive species using \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is more effective than \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

1. I think my \_\_\_\_\_\_\_\_ option is the strongest because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Although I have strong evidence to support my claim, there are limitations that may affect the accuracy of my claim such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

*Individual Task*: Students will write up their arguments (claims, evidence, counter evidence, justification, and limitations) for controlling/limiting their invasive species in their research report.

Parts 7 - 9: Create a plan and get feedback on argument and plan (Team Activity)

Teams will use their arguments to make a plan to implement the option or combination of options they have selected. After preparing their draft plan teams should get feedback from peers and the teacher. Provide students with opportunities to revise their plan and argument before planning their presentation to *Invasion Free*.

*Individual Task*: Students will write up their final argument for controlling/limiting their invasive species in their research report.

Part 10: Plan oral presentation to *Invasion Free* panel (Team Activity)

Students will plan an oral presentation to share what they learned about the invasive species in their state, to explain their argument on the best option(s), and to present a plan to the *Invasion Free* panel. When preparing their presentation students should refer to the *Criteria for Oral Presentations* document and have opportunities to receive feedback and make revisions before the presentation.

Part 11: Oral Presentation (Team Activity)

Students make oral presents.

Part 12: Final individual research report (Individual Activity)

Each student will complete their own research report. While discussion is encouraged within and among groups, individuals are responsible for writing their own report. Students should write sections of their report as homework as the team works together through each section of the task.

Provide students with a specific due date for rough drafts of the research report. Allow a couple days for students to exchange reports and get peer feedback.

1. **Student support:**

*Planning for Group Interaction*

Introduction of Cooperative Learning

* Review with students the 21st Century Skills related to cooperative learning. Another option would be to discuss traits (including team work) that employers value in their workers.
* Group norms should be created prior to student collaboration. These can be given by the teacher or determined by the students. Or teachers can give norms for the first part(s) of the task and students can determine their own group norms for subsequent sections of the task. (Ex 1: I have the responsibility to ask for help. I have the responsibility to help. Or Ex 2: Criticize ideas not individuals. Disagree respectfully.)
* Students should realize that they will rely on the information gathered by members of their team on different parts of this task. Successful group work is critical to the successful completion of the task.
* Groups can be selected in many different ways. Random groups may be assigned (e.g., use of playing cards as students enter the classroom) or by seating assignments. Groups can be a heterogeneous mix of learning styles, reading levels, achievement, student interest, comfort level with technology, etc. Homogenous groups can also be created, though there is research to indicate that heterogeneous groups are more effective.
* Students can be assigned particular roles in their groups. Examples can include timekeeper, facilitator, equipment manager, spokesperson, technology guru, recorder, etc. Role assignment can be random (e.g., the person facing west is the facilitator) or assigned based on student strength or area of practice for improvement.
* Roles can be discussed/brainstormed with students before group work begins. Student roles can also be explained on role cards that are then given to students. Word stems or example statements for each role (Facilitator – “I appreciate what you have said about…”) can help students maintain their roles as they work together.

*Possible Accommodations*

* Provide students with graphic organizers to help them organize information while gathering information about their invasive species.
* You may decide to have students make individual videos or other types of products using the same criteria but requiring less focus on text.
* If you decide to have students write a final report, it is important to provide scaffolding of what to write in each paragraph as well as sentence stems to help students construct their explanations/arguments.

1. **Extensions or variations:**

If there is an invasive species near your school site, consider a field trip or service trip. There are, for example, non-profit groups that gather together volunteers to remove invasive species of plants from trails.

1. **Scoring:**

Student work can be scored using the SCALE Scientific Literacy Rubric and the SCALE Effective Communication Oral Presentation Rubric.