Promoting Student Understanding of the Ecological Impacts & Management of Invasive Species: A Collaborative Scenario-Driven Activity

TYLER L. POPPENWIMER, HANNAH M. HICKS, PRISCILLA A. NYAMAI, KATHRYN E. BOES

Abstract
Invasive species are an issue of global concern because they can have large impacts on ecosystems and are challenging to manage. We present an activity aimed at improving undergraduate students’ understanding of the ecological impacts and management of invasive species. Students work collaboratively in teams to examine the impacts of a particular invasive species on an ecosystem (a fictional national park). The teams then propose policies that would assist their park in minimizing the introduction and impacts of the invasive species, and discuss potential limitations of these proposed policies. Finally, the teams present their proposals in class, which allows for class discussions and opportunities for collaborative learning. By engaging in this activity, students can develop a more concrete understanding and appreciation of both the impacts of invasive species and the challenges involved in managing them.

Key Words: Invasive species; ecology; ecosystems; management; group projects.

Introduction
Invasive species have become a serious threat to ecosystems, biodiversity, and national economies, both within the United States and at the global scale (Pyšek & Richardson, 2010). An invasive species in a particular ecosystem is a species that is nonnative to the ecosystem and that may be harmful to human health, the economy, or the environment (Invasive Species Advisory Committee, 2006). Biologists are concerned about these species because of their wide range of impacts, including altering ecosystems, displacing native species, and the economic cost of prevention and mitigation. There are significant challenges to the management of invasive species (Simberloff et al., 2013), particularly with regard to public understanding and perception (Young & Larson, 2011).

Enhancing students’ understanding of invasive species is critical in preparing them to be engaged and informed biologists and citizens. To that end, innovative classroom activities can enable students to develop a clear understanding of the impact of invasive species, modes of invasion, and potential management strategies. Further, science educators recognize the need for activities that foster student engagement and cooperation, use relevant examples to make abstract concepts more concrete, and cultivate an awareness of the close connections between science and society (AAAS, 2011). The management of invasive species is inherently an interdisciplinary endeavor, involving an understanding of many fields, including ecology, organismal biology, resource management, anthropology, and environmental policy.

We developed a class activity for undergraduate students in which teams of students are given an ecosystem and then asked to identify the ecological impacts and modes of invasion of a given species, propose management policies, and recognize drawbacks of these policies. Each team is provided with a description and detailed map of a fictional national park, the name of an actual invasive species that could be introduced to the park, and a letter instructing them to propose management policies for their park. Students collaborate with teammates to prepare and deliver a summary presentation to the class. This activity was designed for, and is recommended for use in, undergraduate college courses in biology or environmental science, but it would also be appropriate for students studying ecology at the high school level.

Activity Objectives
By engaging in this activity, students will
(1) understand and describe potential ecological impacts of invasive species on ecosystems;
(2) identify possible modes and pathways by which invasive species can be introduced to an area;

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propose policies that could be enacted to (a) minimize the likelihood of new invasions and (b) reduce impacts in the event of an invasion;

(4) critically evaluate potential drawbacks of proposed policies to manage invasive species; and

(5) collaborate with group members to prepare and communicate ideas.

Key Considerations

Before implementing this activity, the instructor should consider the following:

- The number and size of student groups. This activity can accommodate up to 10 groups. We recommend having two to four students per group.
- Number of class periods to devote to the project. Depending on the course structure, we suggest either three 50-minute in-class sessions or one 3-hour lab session.
- Format of group presentation (oral, written), required length of presentation, and assessment criteria. See our suggested assessment rubric in Table 1.
- Sources that students may use to obtain background information. We provide a list of suggested websites in the next section.
- Location(s) for group research session, presentation, and post-activity discussion.

Recommended Materials

For each Team of Directors (group of students):

- Congratulatory letter that outlines activity requirements (see Supplemental Information) (This letter is a general template; before distributing it, fill in the top lines to specify the national park and invasive species assigned to each group.)

- A detailed description and map of the assigned fictional national park and the assigned invasive species (see Supplemental Information)

- Computers to facilitate literature search for background information and to create a presentation or collaborative document


- Optional: Copy of the rubric with which each group will be graded (Table 1)

For the Instructor:

- Assessment rubric for the group presentations (Table 1)

- Instructor guide (see Supplemental Information)

Implementation of Activity

Activity Part 1: Introduction to Activity (15 minutes)

Begin by separating students into groups. To each group, distribute one congratulatory letter, one National Park packet (which includes a park description, map, and associated pictures; see Figure 1), and the name of a potential invasive species for that park (these resources are available in the Supplemental Information). Note that two different groups may be assigned to the same national park, but they should be given different invasive species. This activity has resources for five fictional national parks (each of which represents a different ecosystem), and because there are two potential invasive species for each park, the activity can accommodate up to 10 student groups. Instructors may instead choose to create their own fictional national park and/or assign different invasive species. Before implementing this activity, we recommend that students have at least a basic level of familiarity with key concepts relevant to this activity, including ecosystem types, species interactions (competition, predation, parasitism, commensalism, and mutualism), logistic and exponential population growth, and carrying capacity.

Table 1. Sample assessment rubric that instructor can use to assess group presentations.

<table>
<thead>
<tr>
<th>National park:</th>
<th>Names of group members:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invasive species:</td>
<td></td>
</tr>
<tr>
<td>Objective(s) Addressed</td>
<td>Components of Presentation</td>
</tr>
<tr>
<td>1</td>
<td>Potential ecological impacts (two total) of the invasive species</td>
</tr>
<tr>
<td>2</td>
<td>Potential mode/pathway of invasion</td>
</tr>
<tr>
<td>3 and 4</td>
<td>Policy to reduce likelihood of invasion, and potential drawbacks of this policy</td>
</tr>
<tr>
<td>3 and 4</td>
<td>In the event of invasion: policy to reduce impacts, and potential drawbacks or limitations of this policy</td>
</tr>
<tr>
<td>5</td>
<td>Group professionalism, communication, and collaborative efforts</td>
</tr>
</tbody>
</table>
Next, describe the instructions and goals of this activity for the class. Inform the class that each group will give an oral presentation or submit a written document that serves as a “briefing” regarding the impacts and control of a nonnative species that may become invasive in their park. In the presentation, each group must discuss the potential ecological impacts and relevant mode of invasion for their assigned invasive species, propose policies that will reduce the risk and impact of invasion, and articulate drawbacks or limitations of such policies. More detailed instructions are provided in the letter given to the students and in the instructor guide (see Supplemental Information).

To assist students in preparing their presentation, give them a list of acceptable information sources for their research. Additionally, instruct students to utilize the park description and map, as well as information they have researched to prepare their presentation. Each national park has “clues” in its description and map that may help students identify potential mode(s) of invasion and policies that may be applicable.

Finally, provide instructions for any logistical aspects of the research session (location, duration, etc.) and the subsequent presentations. Explain to the groups that they will be graded on group-member participation (all members must contribute) and their depth and breadth of knowledge. The students should demonstrate their understanding of the ecological impacts of invasive species by detailing how these impacts could be far reaching and cause alterations to the ecosystem. The instructor may also choose to provide additional objectives tailored to his or her class content, such as asking the students to identify some characteristics of their species that allow it be an effective invader.

**Activity Part 2: Research Session (60–90 minutes)**

After introducing the project, release the students to conduct their research, brainstorm, and prepare their group presentation. This session can take place during a class or laboratory period (time permitting) or outside of class. If it takes place during class time, we recommend that instructors visit each group in turn to see if they have any questions and also to ensure that all group members are contributing to the research and preparation of the presentation. In our classes, we have encouraged the teams to divide the work for the first two aims listed on their Congratulatory Letter (the ecological impacts of the invasion and a possible mode of invasion) and then to share their findings with their group and work collaboratively on addressing the last two aims (proposing policies and identifying the ecological consequences).

**Activity Part 3: Presentations (40–60 minutes)**

Once each group has prepared its presentation, bring all students together to present and watch the presentations. We recommend briefly describing each national park prior to the start of the presentations, so that the students in all groups can better understand the presentations. Additionally, we recommend that groups that have the same national park, but different invasive species, present consecutively. Once the presentations for one national park are concluded, allow a few minutes for questions from the class. We recommend...
allowing a minimum of 5 minutes for each presentation, but this time may vary, depending on class time and the number of groups.

In substitution of the presentations, or in addition to the presentations, the instructor may decide to have students submit a written document. This written document may take the form of an individual assignment, in which each student is tasked with developing their own document, or a collaborative, group out-of-class assignment.

**Activity Part 4 (Optional): Post-Activity Discussion (20 minutes)**

After completion of the presentations, consider facilitating a wrap-up discussion with the entire class. This discussion should allow students to revisit the activity objectives in light of what they have learned from the various group presentations. Here are some possible discussion questions:

1. What impacts might invasive species have on ecosystems?
2. How can knowing the life history of an invasive species allow us to better understand their potential impacts on an ecosystem?
3. What are some similarities in the potential modes of invasion of invasive species?
4. When thinking about the challenges of managing invasive species, were there any general proposed management policies that seemed particularly promising to you? Discuss the benefits and drawbacks/limitations of such policies.
5. What can we, as citizens, do to minimize the spread of invasive species?

**Assessment**

Student presentations should be evaluated in a way that matches the presentation requirements and activity objectives. We have provided a suggested assessment rubric in Table 1. Instructors may assign points to each of the presentation components to determine the final grade, but instructors should feel free to determine their own criteria for assessment based on their instructional approach. For example, instructors may decide to give students the opportunity to rate the effort and participation of peers in their group.

**Conclusion**

This activity engages students in better understanding the ecological impacts and management of invasive species. In our experiences with using this activity, our students took ownership of their scenario and seemed to enjoy working collaboratively to research their invasive species and propose policies for their park. They also applied interdisciplinary perspectives to the activity by identifying a range of biological, sociological, and economic limitations of their policies. Instructors should encourage this interdisciplinary perspective, while requiring that students include and discuss ecological consequences in their presentations.

In addition to engaging students, the activity addresses several national science-education initiatives. First, students develop a stronger understanding of the dynamic interactions in ecosystems, which is a core concept at both the undergraduate and K–12 levels (AAAS, 2011; National Research Council, 2012). Second, students approach problems using an interdisciplinary perspective, communicate and collaborate with peers, and explore the relationship between science and society, which are all core competencies as defined by the AAAS (2011). Third, students link core ideas in ecosystem dynamics with science practices by proposing policies related to human impacts on biodiversity; this meets a standard in the Next Generation Science Standards (NGSS Lead States, 2013; see standard HS-LS2-7). Finally, students cultivate a greater awareness of how anthropogenic factors, including management decisions, affect ecosystems, which is a key challenge for invasion science (Simberloff et al., 2013) and an important component of ecological literacy (Jordan et al., 2009).

**Supplemental Information**

The following supplemental resources to be used in this activity can be downloaded from https://sites.google.com/site/katieeboes/invasivespecies:

- Congratulatory letter, outlining activity requirements for each group
- National Park packets (one for each of the five fictional national parks)
- Instructor Guide

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**References**


The first two authors made equal contributions to this article. TYLER L. POPPENWIMER is a graduate student in the Department of Ecology and Evolutionary Biology at the University of Tennessee, Knoxville, TN 37996; e-mail: tpoppenw@vols.utk.edu. HANNAH M. HICKS is an undergraduate student in the Department of Biochemistry and Molecular Biology at the College of Wooster, 931 College Mall, Wooster, OH 44691; e-mail: hhicks17@wooster.edu. PRISCILLA A. NYAMAI is an Assistant Professor in the Biology Department at Grand Valley State University, 1 Campus Dr., Allendale, MI 49401; e-mail: nyamaip@gvsu.edu. KATHRYN E. BOES is a Laboratory Coordinator in the Department of Biology at the College of Wooster, 931 College Mall, Wooster, OH 44691; e-mail: kboes@wooster.edu.