Lyme disease: a case about ecosystem services

Courtney Richmond[1], Diane Ebert-May[2], and Janet Hodder[3]

One way to help students develop critical thinking skills is to focus on problems or cases where they are challenged to deal with real data and experiences (Bransford *et al.* 2004). Both problem-based learning and case studies allow students to develop the intellectual capacity to deal with complex issues, build confidence and willingness to approach topics from multiple perspectives, and encourage communication with scientists and peers from other disciplines. Students often compartmentalize content and process knowledge by discipline, whereas an interdisciplinary approach allows them to draw from multiple resources in the life sciences, mathematics, social sciences, and other disciplines. The literature is rich with examples and methods for using case studies (see References) and the majority of authors agree that if a case study is to be useful pedagogically, it must serve a specific function for the course and students. Such focus provides students with a more efficient means of achieving specific learning goals as compared to the traditional lecture approach (Herreid 1994, 1998).

Kremen and Ostfeld's paper on ecosystem services (pp 540–48) contains two case studies that provide examples of how ecological data are not often collected or interpreted in isolation. We use the Lyme disease case study to demonstrate how real data can be used to teach complex topics, while enabling students to discover how a number of disciplines can inform ecological issues. This activity is designed for an ecology course but could also be used as part of an introductory biology course.

Student goals

- Identify the issues and interdisciplinary components of a case study.
- Analyze data to develop a management strategy about a case study.
- Find information from scientific sources that increases knowledge about the case.
- Interrelate the ecological concepts of ecosystem services, biodiversity, functional diversity, community disassembly, and landscape ecology.
- Work productively and collaboratively in a team.

Instructor goals

- Design instruction using an interdisciplinary case study.
- Expose students to complex ecological concepts.

[1]*Rowan University*, [2]*Michigan State University*, [3]*University of Oregon*.

Instructional design

Problem posing: analyzing a case

Begin with a mini-lecture that includes background information on Lyme disease: for example, a brief description of the disease, how it is spread by ticks, a general description of tick life cycles, and a primer on the many possible hosts that ticks feed on, including a brief explanation about differential rates of transmission of the Lyme disease spirochete between different hosts and ticks (resources in References). In groups of two to four, students are asked, "How would you manage the problem of Lyme disease to reduce the prevalence of infected ticks?" Students are given four pieces of data to develop their management strategy (Panel 1) and to support it with evidence.

A subset of groups reports out (one minute per group) their proposed management strategy to the class. The instructor lists the different strategies on poster-size post-its; those groups who do not report identify which of the strategies most closely approximates their own. One individual from each group (ie the recorder) adds a check mark (or small post-it) to the appropriate poster. This formative assessment enables the instructor to determine students' initial level of understanding about the case and allows groups to evaluate their ideas in relation to their peers.

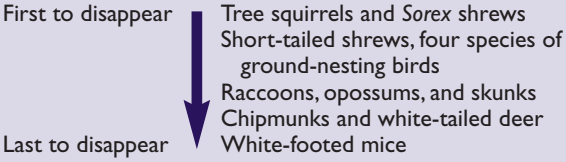
Next, students read the Lyme disease case study in Kremen and Ostfeld, and are told that they may include other information in the paper to revise the details of their management plan. As a tool to guide their thinking, each group generates a "Know/Need to Know" table (http://serc.carleton.edu/introgeo/icbl/strategy4.html), finds the additional information they "need to know" from scientific resources, cites the resources under the appropriate "need", and submits both the table and citations with their revised management plan. In addition, if the instructor has access to a classroom management system such as Blackboard, Angel, or WebCT, each group could post one unique (not already posted) citation on the course website as part of the homework.

Assessing student learning

Each group's revised management strategy should reflect students' comprehension of the case study and ability to use information to support recommendations to address the problem. The rubric in Panel 2 shows the criteria of an exemplary response that is provided to students before they begin the case study. "Adequate" and "Needs

Panel 1. Information provided to students for Lyme disease case study

- Graph of the number of tick larvae fed per hectare and the percentage of larvae fed per host species (Kremen and Ostfeld, p 546, Figure 6a)
- Graph of the relationship between forest fragment size and tick infection rates (Allan *et al.* 2003, Figure 1)
- Graph of the relationship between species richness and tick infection rates (Schmidt and Ostfeld 2001, Figure 2)
- The order in which species disappear in a system as it "disassembles" (LoGiudice *et al.* 2003, Figure 1)



Improvement" categories are scaled down in terms of content, accuracy, and possible points from the "Exemplary" level response. Additional questions on exams should provide further insight to student thinking. For example:

- Why are intact, unfragmented ecosystems associated with a lower prevalence of Lyme disease?
- Use the first case study in Kremen and Ostfeld ("Pollination services for crops in Northern California", p 544) to answer the question of how and why the proportion of natural (wild) habitat surrounding a farm affects pollination services.

Final note

The literature on case studies is extensive, and this article represents only the tip of the iceberg in their use by students as a means to practice the analysis of information to comprehend and address interdisciplinary problems. The instructor could include many other goals and resources, thereby expanding the case over a series of classes. For example, this Lyme disease case study interconnects the ecological literature on biodiversity and ecosystem services with conservation issues, private property rights, economic concerns for developers or others likely to be negatively impacted by certain management options, and the environmental ethics that arise when human and environmental interests are at odds. Assessment data are collected at multiple points during the case study, to provide both students and the instructor with ongoing feedback about learning.

Panel 2. Rubric for assessment of the management plan

Criteria for an "Exemplary" level response are provided. "Adequate" and "Needs Improvement" levels of responses are scaled down based on inclusion of content, accuracy, and possible points. Actual scoring depends on the relative weight of the assignment in the context of the course evaluation. A reference to rubrics for cooperative groups is provided.

Comprehension and analysis

- Identifies all of the issues and interdisciplinary components of the case (from the "Know" list)
- Accurately interprets data provided and uses it to support the management strategy
- Demonstrates ability to identify additional information they would "Need to Know" to build a better management strategy
- Selects appropriate citations that answer all of the "Need to Know" questions in the table
- Uses proper grammar and appropriate style in the management plan
- Group functioned as a productive team; each individual contributed (Nagel *et al.* 2005)

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Schmidt KA and Ostfeld RS. 2001. Biodiversity and the dilution effect in disease ecology. *Ecology* **82**: 609–19.

Online case study resources

The Starting Point project. http://serc.carleton.edu/introgeo/icbl/what.html.

National Center for Case Study Teaching in Science. http://ublib.buffalo.edu/libraries/projects/cases/case.html

Additional sources about Lyme disease

Centers for Disease Control and Prevention on Lyme Disease. http://www.cdc.gov/ncidod/dvbid/lyme/.

ESA Electronic Data Archive. http://www.esapubs.org/archive/. Washington, DC: Ecological Society of America. Archive No E084-035-A1.

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