

Teaching Notes for “Are Eastern Fox Squirrels (*Sciurus niger*) ‘good’ or ‘bad’ for the Greater Los Angeles Region?”^{1 2}

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Abstract

In this case, students draw on various disciplinary perspectives to characterize the eastern fox squirrel (EFS) as “good” or “bad” for the greater Los Angeles, California region. To do this they weigh evidence to decide if the EFS is truly an invasive species (as popular news articles charge) and suggest possible interventions. Students begin by reading popular news articles, blogs, and petitions to identify the components of this socio-ecological system and the typologies of attitudes toward animals expressed in these popular sources. They then read the Disciplinary Perspectives Handout and associated web links to identify the kinds of insights various disciplines bring to the case. Through combining and analyzing this work, they next build a concept map of the system, including the human, nonhuman living, material, and socioculturally constructed components of the system. In the concept map, they also describe the relationships between the components, highlighting how different disciplinary perspectives make sense of those relationships. To conclude, students create a class presentation where they answer the case’s questions, “Are eastern fox squirrels “good” or “bad” for the greater Los Angeles, CA region.”

Topical areas: Urban ecology, transspecies urban relationships, invasive species, animal ethics, new ecology

Education level: Undergraduate upper division; graduate (with modifications)

Type/method: Small group, student presentation, student position paper

Background

Eastern fox squirrels (*Sciurus niger*) were introduced the greater Los Angeles, CA region at various points beginning in the early twentieth century. It is believed that the first introduction occurred at the National Home for Volunteer Disabled Veterans in Sawtelle, CA sometime prior to 1904 (Becker & Kimball, 1947), which recent DNA evidence supports (Claytor, Muchilinski, & Torres, 2015). As Civil War and Spanish American War veterans headed out west from the Mississippi Valley, they toted the EFS along with them, possibly as pets or companions, and possibly as food (Becker & Kimball, 1947). According to scant historical evidence, an administrator at the Sawtelle facility believed that caring for and feeding the squirrels was a poor use of state resources, so they were released. It is also rumored that Henry E. Huntington, founder of the Huntington Library in Pasadena, CA and nephew of the railroad tycoon, Collis P. Huntington, ordered a pair of eastern fox squirrels from New York in 1912. And finally, factory workers from Iowa apparently brought eastern fox squirrels to Long Beach, CA during World War II (Page, 2007).

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The dispersal of the EFS from its initial entry points has occurred for a variety of reasons, including relocation by residents and wildlife rehabilitation facilities and movement along utility lines and riparian corridors (King, Chung Sue, & Muchilinski, 2010). The EFS's success in the greater Los Angeles area has been attributed to its ability to take advantage of southern California's urban and suburban spaces, which offer a year-round food supply from exotic plants and other sources, including refuse (King et al., 2010). Although biologists and local residents have reported that the EFS has replaced the native western gray squirrel (*Sciurus griseus*) (also a tree squirrel, WGS) in many locales during the last 30 years, it is not entirely clear whether this is due to competitive exclusion or a combination of other factors, including food availability and habitat fragmentation.³ WGS, for example, tend to consume hypogeous fungi, pine nuts, acorns, California bay fruit, green leafage, and bark (Stienecker & Browning, 1970) and are less tolerant of urbanized/suburbanized spaces, whereas EFS willingly scavenge from a vast array of food sources (both plant and animal) and find suitable nest areas in these urban/suburban locales (Fong, 2013).

A flurry of popular newspaper articles, blogs, and other websites have written about the increase in EFS populations in the greater Los Angeles area, often characterizing the squirrel as “invasive,” even though current research does not appear to support this designation. In this case, students draw on perspectives from the humanities (animal/urban environmental ethics), the social sciences (environmental studies, geography, anthropology, and the natural sciences (ecology, conservation biology) to identify the stakeholders and their positions in this urban/suburban system. They then use these stakeholder positions to characterize the EFS as simply a nonnative species or truly an invasive species and answer the question, “Are eastern fox squirrels good or bad for the greater Los Angeles area?”

This case has been developed for upper division Liberal Studies majors. This student population has a broad interdisciplinary background, but most students will not be experts in fields typically associated with socio-environmental synthesis, such as environmental studies and sciences, biology, ecology, geography, or anthropology. For students with more significant disciplinary training related to socio-environmental synthesis (and for graduate students), the case could be modified, as suggested in the “Classroom Tips—Teaching the Case section.”

Disciplinary Perspectives

Since there is a wealth of disciplinary perspectives that inform this case, the Disciplinary Perspectives Handout provides a summary/overview of some of these guiding concepts. The instructor may choose to have the students read some or all of the literature cited in the handout.

Learning Goals

This case study addresses the following Socio-Environmental Synthesis learning goals:

1. Understand the structure and behavior of socio-environmental systems

³ The total replacement of WGS by EFS recently occurred on the Cal Poly, Pomona campus (case study author's university campus). By 2009, it is reported that WGS were completely gone (Muchilinski, Stewart, King, & Lewis, 2009). See Cooper and Muchilinski (2015) for a detailed analysis of the shifting tree squirrel demographics in the greater Los Angeles area.

- a. Identify the environmental and social components of the systems and their interactions
2. Consider the importance of scale and context in addressing socio-environmental problems
 - a. Understand that ecological and social processes often vary across differing contexts, including space, time, and conditions (e.g. economic or political).
 - b. Understand that ecological and social processes interact across different scales.
3. Find, analyze, and synthesize existing data, ideas (e.g. frameworks or models), or methods.
 - a. Integrate different types of data (interdisciplinary integration)

Objectives

In this case study, students will:

1. Identify and assess the values/ethical positions/attitudes towards eastern fox squirrels in the popular media.
Related activities: List system components; typologies of attitudes chart
2. Identify which disciplinary perspectives are relevant to this case and describe how each perspective illuminates the case.
Related activity: Charting disciplinary perspectives
3. Identify the various components/stakeholders of this socio-ecological system drawing on perspectives from the humanities, social sciences, and natural sciences.
Related activities: List system components, typologies of attitudes chart, charting disciplinary perspectives
4. Analyze the scaled nature of the interactions of the components/stakeholders of this socio-ecological system, drawing on perspectives from the humanities, social sciences, and natural sciences.
Related activities: Typologies of attitudes chart, charting disciplinary perspectives; concept map, group synthesis presentation
5. Synthesize the various types of disciplinary data collected to explain how these perspectives complexly interact to characterize the squirrel either as a “nonnative species” or “invasive species.”
Related activities: Charting disciplinary perspectives; concept map, group synthesis presentation; individual position paper (Modification #1)
6. Reflect on their work to examine how their decision would have been impacted if they had only considered one component/stakeholder perspective.
Related activities: Group synthesis presentation

This case intentionally begins with lower level Bloom’s taxonomy tasks (identify and describe) and builds to higher cognitive load tasks (analyze, synthesize, and reflect) in order to scaffold students’ thinking as they consider a complex system from various (and often divergent) disciplinary perspectives.

Classroom tips

Background Information

This case assumes that students have an interdisciplinary understanding of: (1) how species are designated as “invasive”; (2) the broad impacts of humans on nonhuman animals in urban environments; and (3) the role of ethics in assessing human obligations to nonhuman animals. Below are suggested pre-readings for the case.

- Botkin, D. B., & Beveridge, C. E. (1997). Cities as environments. *Urban Ecosystems*, 1, 3-19.
- Clark, J. L. (2015). Uncharismatic natives. *Environmental Humanities*, 6, 29-52.
- Cronon, W. (1996). The trouble with wilderness: Or, getting back to the wrong nature. *Environmental History*, 1(1), 7-28.
- Donihue, C. M., Lambert, M. R. (2015). Adaptive evolution in urban ecosystems. *Ambio*, 44, 194-203.
- Fortwangler, C. (2013). Untangling introduced and invasive animals. *Environment and Society: Advances in Research*, 4, 41-59.
- Hinchcliffe, S., Kearnes, M. B., Degen, M., & Whatmore, S. (2005). Urban wild things: A cosmopolitical experiment. *Environment and Planning D: Society and Space*, 23, 643-658.
- Lockwood, J. L., Hoopes, M. F., & Marchetti, M. P. (2007). *Invasion ecology*. Malden, MA: Blackwell. Chapter 1, (pp. 1-15).
- McKinney, M. L. (2002). Urbanization, biodiversity, and conservation. *BioScience*, 52(10), 883-890.
- National Geographic. (2015). Encyclopedic Entry: “Endangered Species.” Retrieved from <http://education.nationalgeographic.com/encyclopedia/endangered-species/>
- Olive, A., & Minichiello, A. (2013). Wild things in urban places: America’s largest cities and multi-scales of governance for endangered species conservation. *Applied Geography*, 43, 56-66.
- Palmer, C. (2003). Placing animals in environmental ethics. *Journal of Social Philosophy*, 34(1), 64-78.
- Pearce, F (2015). *The new wild: Why invasive species will be nature’s salvation*. Boston, MA: Beacon Press. Chapter 7, “Myths of the Aliens”
- Vucetich, J. A., Nelson, M. P., & Phillips, M. K. (2006). The normative dimension and legal meaning of *endangered* and *recovery* in the U.S. Endangered Species Act. *Conservation Biology*, 20(5), 1383-1390.
- Wolch, J., West, K., & Gaines, T. (1995). Transspecies urban theory. *Environment and Planning D*, 13, 735-760.
- Zimmerer, K. S. (1994). Human geography and the “new ecology”: The prospect and promise of integration. *Annals of the Association of American Geographers*, 84(1), 108-125.

For homework during the case, the students will be assigned the readings below. Depending on the level of the course, the instructor could assign additional readings from the scholarly literature (See Modification #2).

- “100 of the World’s Worst Invasive Alien Species” (Just skim the list and see what it says about the EFS, *Sciurus niger*): <http://www.issg.org/database/species/search.asp?st=100ss&fr=1&str=&lang=EN>
- California Invasive Species Council Project Overview: <http://ice.ucdavis.edu/invasives/>
- Coates, P. (2015). A tale of two squirrels: A British case study of the sociocultural dimensions of debates over invasive species. In R. P. Keller, M. W. Cadotte, & G. Sandiford

(Eds.), *Invasive species in a globalized world: Ecological, social, and legal perspectives on policy* (pp. 44-71). Chicago: The University of Chicago Press.

- Cooper, D. S., & Muchilinski, A. E. (2015). Recent decline of lowland populations of the western gray squirrel in the Los Angeles area of southern California. *Bulletin of the Southern California Academy of Sciences*, 114(1), 42-53.
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- Nature of Cities Global Roundtable Discussion on Exotic and Invasive Species: <http://www.thenatureofcities.com/2014/07/07/how-much-should-we-worry-about-exotic-species-in-urban-zones-how-do-we-reduce-damage-from-exotic-invasives-when-management-resources-are-limited-are-there-conflicts-between-management-or-eradication/>

Estimated time: 8 hours

Teaching the case

Step 1: Identify values/positions/stakeholders in the popular media (2 hours total)

Prior to the first class, students are asked to write a 3-400 word formative pre-assessment that addresses the questions listed below. Since students have already completed readings and activities related to understanding invasive species, this writing assignment serves as a concept review and formative assessment for the instructor.

- What is the legal definition of “invasive species?”
- How do invasion ecologists define the term?
- Why are invasive species considered bad?
- What are some general critiques of the term?

At the start of class, the instructor discusses student responses to the questions above, checking for understanding and clarifying any misconceptions. The instructor might highlight, for example, how legal definitions, natural/social scientists’ working definitions, and word uses in the popular media sometimes diverge. The instructor might also assist students in identifying critiques of the word “invasive.”

Next, the instructor introduces the scenario and has students read the introduction to the case on their own. The instructor then explains that the students are going to form research teams that will participate in a series of activities allowing them to assess whether or not the EFS is “good” or “bad” for the greater Los Angeles, CA area. They will tackle this question using a variety of disciplinary perspectives and their analysis will include an assessment of whether or not there is enough evidence to warrant: (1) legal designation of the EFS as an invasive species and (2) interventions to stop the spread of the EFS.

The instructor then introduces Step 1 of the case, which should take approximately 1.5 hours. The instructor begins by having the students form groups of 3-4 people, explaining that each group is going to read 8 short popular articles, blogs, and petitions related to the case. These articles were selected because they are short, accessible, and represent a wide variety of positions expressed in the popular media throughout the last decade. As they read these articles, the students are to complete two major tasks: (1) identify the components of the system (human, nonhuman, nonliving materials, social/cultural constructs, places) and (2) identify the typologies of attitudes toward animals that shape the case, citing evidence from the texts.

For the first task, the instructor explains that students should simply make a list of all of the components of the system, categorizing them as they go. Students identify these components as they read through the articles. The instructor could start with the first article and provide a few examples for the students. Students may wish to construct a table to do this in an organized manner. Depending on the level of students, the instructor might assist the students with setting up a table.

Below are some possible system components (identified in popular news articles):

Places

- Rancho Santa Ana Botanical Garden
- University of La Verne
- Oak woodlands
- Low altitudes
- Skid Row
- California Wildlife Center—Baby Care Unit
- Natural History Museum of Los Angeles
- Cal Poly Pomona
- San Dimas Canyon Park

Humans

- Local residents (squirrel haters/lovers and everything in between)
- Wildlife biologists (Randy Good, Jay Jones, & Jeffrey Burkhart of University of La Verne; Tom Scott of UC Riverside; Alan Muchilinski and Julie L. King of Cal State LA; Kevin Brennan, State Department of Fish and Game)
- Collections Manager for LA County Natural History Museum—Jim Dines
- Developers
- Parks and Recreation Staff

Nonhumans

- Eastern fox squirrels (*Sciurus niger*) (described as nonnative, invasive, pests, nest-robbers)
- Western gray squirrels (*Sciurus griseus*)
- Gardens
- Fruit and nut trees
- Dogs
- Biodiversity damage (also in the cultural construct category because what counts as biodiversity damage is in many ways a cultural and material construct)
- Acorns, fungi, various beds of growth, nuts, fruits
- Bird nests
- Baby rabbit

- Exotic fruit trees
- Garden vegetables
- Infectious disease
- Closed canopy
- Evergreens
- Eggs and nestlings
- Crows
- Ravens
- Peanuts
- West Nile Virus
- Bubonic Plague
- Orphaned offspring

Nonliving materials

- Overhead utility lines/Southern California Edison
- Frightening devices (designed to scare squirrels away from gardens)
- Traps
- Bows, arrows, firearms, hunting licenses
- Avocado pickers
- Cages
- Organic chili-based powder
- Bird feeders
- Attics, electrical wires
- Poison
- Property damage (also in the cultural construct category because what counts as property damage is in many ways a cultural and material construct)

Cultural constructs (laws/regulations/issues)

- State recommended humane euthanasia for caught squirrels
- Humane euthanasia guidelines
- State of CA law: can trap a wild animal within a 150-yard radius with permission from all neighbors
- Riverside City Council: Residents can kill squirrels on their property through traps
- Relocating wildlife in CA is illegal
- Shooting within the city is illegal
- Pest Management Programs
- Petition to stop Riverside City Council resolution
- Biodiversity damage
- Property damage

For the second task, the instructor explains to students how to organize their typologies of attitudes table (the far left column for each article and the top row for each typology so they have a grid to fill in). This way students can easily access which articles express which typologies, citing textual evidence. They may wish to use an Excel spreadsheet for this. As the students fill in the chart and identify which articles represent which typologies, they should also identify the human components that express each typology (For example, the conservation biologists in “Much Ado about Nuttin” express ecologicistic values toward the EFS, while the residents in Riverside express moralistic values toward the EFS in “Don’t Allow People to Kill Squirrels for Pest Control!”). The typologies are

replicated here, which derive from Kellert (1979; 1980) and Kellert and Berry (1980) and are discussed extensively in Wolch, West, and Gaines (1995).

Naturalistic: the primary interest is in wildlife and the outdoors; animals provide the context and meaning for activities in natural settings.

Ecologistic: the primary concern is for the environment as a system; emphasis is placed on wildlife interactions with other species and on the ecosystem.

Humanistic: interest and affection for individual animals, especially pets, is primary; the wildlife focus is on large, attractive animals.

Moralistic: the primary concern is for the ethically correct treatment of animals, with strong opposition to exploitation of and cruelty toward attractive animals.

Scientistic: the primary interest is to study and/or observe the physical attributes and biological functioning of animals.

Aesthetic: the primary interest is in the artistic and symbolic features of animals.

Utilitarian: the primary concern is over the practical and material values of animals.

Dominionistic: primary satisfaction is derived from mastery and control over animals, typically in a sporting context (hunting).

Negativistic: the primary orientation is an active avoidance of animals because of fear or dislike.

Neutralistic: the primary orientation is a passive avoidance of animals because of indifference.

Step 2: Charting disciplinary perspectives (~1.5 to 2 hours total)

The purpose of Step 2 is to have students think systematically about how various disciplines contribute to understanding the complex nature of the case.

Have the students read the Disciplinary Perspectives Handout and peruse the provided links (15 minutes). Then, the instructor leads a short class discussion related to the Disciplinary Perspectives Handout (15 minutes). Points to consider include:

- Which disciplines are not represented in the handout?
- Are they represented in the online materials or in other course readings?
- What kinds of information about the case would you like to know that seem to be missing?

Then, the instructor explains to the students that they should refer to the online articles, blogs, and petitions from Step 1, the Disciplinary Perspectives Handout and associated links, and other course readings to fill in the chart provided in the Student Handout. Their goal is to identify disciplines relevant to the case and then explain how each perspective illuminates the case, identifying possible weaknesses. The instructor demonstrates how to do this with an example from a relevant discipline. For example, the instructor could use invasion ecology as a relevant discipline and then explain how invasion ecology perspectives are important because they consider, among other things, the complex mechanisms (e.g. stages of invasion) by which a species goes from being introduced to invasive (30 minutes-45 minutes).

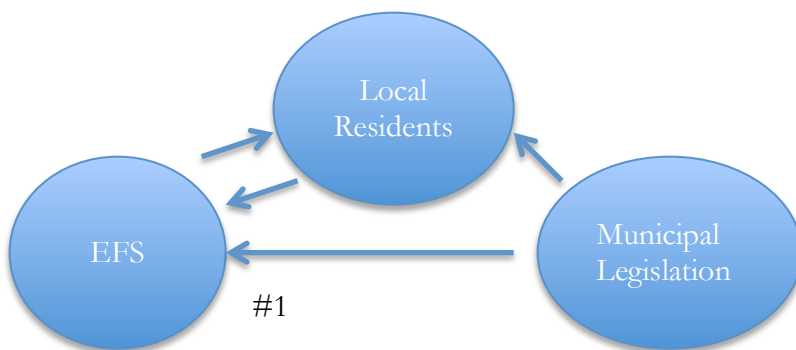
To conclude, the instructor leads a whole class discussion. Each group shares its findings with the class and the instructor creates one large chart so that the entire class can consider all of the group's ideas, making adjustments as needed (30 minutes).

** In field-testing the case, I found it helpful to brainstorm a list of disciplines (categorized according to “natural sciences,” “social sciences,” and “humanities”) with the students and to provide a few, rather than just one example.

Step 3: Concept mapping and disciplinary integration: A systems perspective of the EFS case (~2 hours)

The instructor introduces the concept mapping activity to students by explaining that they will piece together the system components and typologies of attitudes (Step 1) by bringing the concepts and theories from various disciplines (Step 2) to bear on the case. In this activity, the students will therefore use the data they have collected and organized from the previous two activities. This task will likely be the most challenging for students, particularly those unfamiliar with concept mapping. At this point, the instructor may wish to demonstrate how to do this with “Mental Modeler” by selecting two linked system components. For example, in the city of Riverside, EFS are linked to local residents both because the EFS damage residential property and because the city council has implemented regulations that allow the killing of EFS. An animal ethics perspective problematizes the linkage between the EFS and the new regulations because it violates moral duties to individual animals as the city and its residents embrace both dominionistic and negativistic values. Students could also explain that some residents express moralistic values as they sign the petition to repeal the legislation. Before students begin work on the activity, explain that they should have a ~2-3 sentence narrative description of each linkage, and that each description should include how: (1) the system components are linked; (2) which typologies of attitudes influence the relationship; and (3) how at least one disciplinary perspective illuminates the relationship (Feel free to include more than one disciplinary perspective).⁴

This section of the map would look something like this, with students numbering each arrow in order to write brief explanations of each numbered relationship at the bottom of the diagram.



#1: Municipal legislation enacted from a legal perspective embracing dominionistic and negativistic values allows residents in the city of Riverside to kill EFS. An animal ethics perspective problematizes the linkage between the EFS and the new regulations because it violates moral duties to individual animals.

⁴ Note that the relationships represented here are not statistical or mathematical. These diagrams are intended to assist students in making conceptual sense of relationships, so students are asked to be descriptive only.

As students begin to build their maps, the instructor circulates the room, assisting students with any challenges. As the instructor does this, she reminds students that they should consider the following questions:

- How are these relationships influenced by scientific evidence?
- How are these relationships scalar?
- How are these relationships influenced by policy decisions and legal requirements at the state level? See the websites below.
 - UC Statewide Integrated Pest Management Program: <http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74122.html>
 - California Department of Fish & Wildlife: <https://www.wildlife.ca.gov/Conservation/Invasives/About>
 - Executive Order 13112: <http://www.invasivespeciesinfo.gov/laws/execorder.shtml>

Step 4: Group synthesis presentation (~ 1 hour to prepare and ~1 hour to present)

In the final step of the case students create a group synthesis presentation.

The instructor explains to the class that the culminating activity for the case is a 10-minute group presentation. In the presentations, students include the following:

- List of stakeholders and the table of typologies of attitudes created in Step #1
- Disciplinary perspectives chart from Step #2
- Concept map of system from Step #3

Students then take all of the data they have pieced together, synthesize it, and answer the following questions in their presentations:

- Is the EFS an invasive species according to the legal definition? Is there evidence to warrant interventions to stop the spread of the EFS? If so, what kinds of interventions would you suggest? Do you agree with the interventions currently being implemented?
- Is the EFS good or bad for the greater Los Angeles area?

In answering these questions, they should share with the group how they defined the term “invasive species.” They should also provide multiple sources of evidence and perspectives in their presentations.

Expected outcomes

It is expected that the concept maps will not be identical, as students identify some system components but not others, and as they highlight divergent disciplinary perspectives. The key linkages, however, should be quite similar. Depending on which sources of evidence (and which disciplinary perspectives) the students find most compelling, they might classify the EFS as “good”

or “bad.” However, most students should recognize that, according to the legal definition of “invasive species,” (Executive Order 13112) there is currently not sufficient evidence (particularly given the results of nascent scientific studies) to truly classify the EFS as invasive in southern California.

Modifications

Modification #1: Individual position paper prompt

Depending on the time the instructor has allotted for the case, the level of students, and the strength of the course’s writing component, the instructor can require students to write an individual position paper. Environmental and scientific organizations frequently write position papers in order to inform policy makers and ultimately shape public opinion and action regarding specific issues. Simon Fraser University provides some great information about writing position papers here: <http://www.sfu.ca/cmns/130d1/WritingaPositionPaper.htm> and the Ecological Society of America has published a position paper on invasive species management available here: <http://esa.org/pao/policyStatements/pdfDocuments/bioIvasions2006.pdf>.

In this particular instance, students could focus on one of two major questions:

Is the EFS truly an invasive species?

Is the EFS good or bad for the greater Los Angeles, CA region?

In taking a stand that addresses one of the above questions, they would draw on all of the activities from Steps #1-4 to assemble an argument to defend their position. They would suggest possible courses of action and solutions.

Sample Prompt

Now that you have collected diverse sources of evidence and presented to the class your position regarding: (1) whether or not the EFS is truly an invasive species and (2) whether or not the EFS is good or bad for the greater Los Angeles, CA region, you are going to write an individual position paper. In this paper, you will take a stand in reference to either of the above (but not both). To do this, you will follow the general outline for writing position papers provided here: <http://www.sfu.ca/cmns/130d1/WritingaPositionPaper.htm>, which will require you to: (1) introduce your topic, (2) summarize and refute counter claims with evidence, (3) generate your own argument, and (4) provide possible courses of action. In writing your paper, be sure that you draw on multiple disciplinary sources of evidence and avoid relying too heavily on a single perspective (e.g. invasion ecology or animal ethics). Your position will be stronger if you can demonstrate that multiple sources and perspectives support your claims. This paper should be 5 pages in length and cite a minimum of 8 sources.

Modification #2: Inclusion of additional scholarly literature

For more advanced students, the instructor might require students to read more of the scholarly literature related to the case. A list of possible readings is included in the “Background” section of this handout and in the Disciplinary Perspectives Handout. The instructor could ask students to include some of these articles in their identification, description, analysis, and synthesis in Steps 1-3 of the case.

Sample assessments

Formative Assessment Questions

Pre-Assessment Questions Prior to Case

To both assess students' prior knowledge of the case and assess where students might have misconceptions or gaps in knowledge, the instructor asks the students to write about the following (~300-400 words):

- What is the legal definition of “invasive species?”
- How do invasion ecologists define the term?
- Why are invasive species considered bad?
- What are some general critiques of the term?

Charting Disciplinary Perspectives

After students read the Disciplinary Perspective Handout, the instructor leads a discussion, asking the students to free write the answers to the following questions. The students first share their answers with a partner or in a group and then with the whole class. The instructor uses this feedback from students to lead a whole class discussion. Depending on student input/feedback, the instructor might assist the students in developing a list of various disciplines to use in their charts.

- Which disciplines are not represented in the handout?
- Are they represented in the online materials or in other course readings?
- What kinds of information about the case would you like to know that seem to be missing?

During Concept Mapping Activity

The questions provided below provide the instructor a means to informally assess students as she circulates the room. Depending on how students verbally answer these questions, the instructor should provide feedback and guidance to ensure that students are completing the concept mapping activity correctly.

- How are these relationships influenced by scientific evidence?
- How are these relationships scalar?
- How are these relationships influenced by the typologies of attitudes?
- How are these relationships influenced by policy decisions and legal requirements at the state level? See the websites below.

Summative Assessment Activities

List of system components

Typologies of attitudes chart

Disciplinary perspectives chart

Concept map, including ~2-3 sentence descriptions of each linkage in system

Group synthesis presentation

*Position paper (Modification #1)

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