Here today, not gone tomorrow?

Evelyn Gaiser[1], Kristen Rosenfeld[2], Diane Ebert-May[3], Everett P Weber[3], and Amanda McConney[4]

Extinction has been a fact of life since long before humans arrived on Earth. Now that humans have contributed to the issues of scale and novel causes of endangered species, questions addressing how many species there are in the US, and which ones are at risk, are increasingly relevant. Wilcove and Master (pp 414–420) provide an estimate of the number of described species in the US that may be at risk of extinction, including neglected groups of species. The article highlights the opportunity that the NatureServe databases provide to search for rare plant and animal species by US county or watershed – in effect, in students' own backyards.

At first, it may appear that concepts about species extinction are not difficult for students to understand. However, students' misconceptions about this topic include the belief that the only important endangered species are the "charismatic megafauna", and that some populations in a community are not important, therefore their elimination has no effect (Munson 1994). Furthermore, students often assume that we know definitively how many species exist and how many are endangered.

Student goals

- Demonstrate skills in using web-based data.
- Calculate the proportion of major groups of endangered organisms and explain any variance among groups.
- Analyze, based on life-history strategies, why some species are endangered in a habitat and others are not.

Instructor goals

- Design active homework.
- Practice cooperative learning strategies in large classes.
- Use formative assessment data in class to identify student conceptions.
- Analyze summative assessment data to make decisions about instruction.

Instructional design

Pre-assessment at the end of previous class

Students write a minute paper about the following questions:

- What major groups of organisms are endangered in the US? What proportion of endangered species belong to each major group you identified?
- How do we know which species (or groups) are endangered?
- What are the major causes of species endangerment?

The instructor subsamples (if class is large) the responses and, at the beginning of the next class, reports trends to students.

[1]*Florida International University,* [2]*North Carolina State University,* [3]*Michigan State University,* [4]*Archbold Biological Station*

Active homework

Students read Wilcove and Master and use the NatureServe database to find out the status of all species in their home county. Record the name, group (eg mammals, birds, reptiles, amphibians, fish, invertebrates, plants, and fungi), and status of species in the GH, G1, and G2 categories. They then select a species from their county that is on the endangered list, read the comprehensive report, and print it out to bring to class. Based on the paper and website, they should write the best answers to the following questions:

1. What is the current population size of the species?
2. What is its range of distribution?
3. How does it reproduce? (How many offspring, how often, under what conditions?)
4. How does it disperse? (Is it territorial or does it have a large range? How are offspring/seeds/pollen distributed?)
5. Does it have any specific resource requirements (eg specific prey items, physicochemical needs).

In class

Process homework

When students arrive, there are large post-its with graphs of numbers of species versus conservation status (GH, G1, G2) for each of the eight major groups of organisms positioned around the room. In a large class use duplicate sets. Individuals write their species names on small post-its and plot them as a function of conservation status on the appropriate graphs. To avoid counting species more than once, students who have the same species should place their post-it notes on top of each other. When all the data are plotted, each student team is responsible for collecting and tabulating data from the large post-its. Ask individual students to quickly count the number of species per group of organisms. Each team then calculates the percentage of species (sum of GH, G1, G2) represented by each major group of organisms.

Ask groups of students to discuss, interpret the data on the graphs, and write one response per group (this reduces grading substantially) to the following questions:

1. Are the groups of organisms endangered in roughly the same proportion? If not, predict possible reasons why the proportions of groups vary.
2. Describe and explain any differences between the class proportions and those presented by Wilcove and Master.

Analysis

A mini-lecture addressing potential reasons for species vulnerability to extinction is intended to guide students through further analysis. The instructor calls on a sample of students to report the name of an endangered species they investigated, and fills in a table, as shown in Panel 1.

Panel 1. Example: characteristics of endangered species in the Florida Everglades

Species	*Pop size*	*Range*	*Reproduction*	*Mobility*	*Extinction cause*	*Requirements*
Puma concolor coryi (Florida panther)	<50	South Florida swampland	90–96 d gestation, 2–3 offspring every 2 years, mature at 3 years	200–400 mi^2 range	Habitat and prey loss	Carnivore
Papilio aristodemus ponceanus - (Schaus' swallowtail)	<1000 (1989)	Dade and Monroe Counties, FL	Annual eggs; Lengthy pupal diapause	Does not migrate; very isolated	Habitat loss, pollutants	Larvae feed mainly on *Amyris elemifera* (highly seasonal plant)
Ammodramus maritimus mirabilis (Cape Sable sparrow)	6000 (1981)	South Florida wet grassland	3–4 eggs, 20 day parental care, nests flood-prone	Does not migrate; territorial	Habitat loss (wet grassland), poor habitat management	Invertebrates and grain
Galactia smallii (Small's milk pea)	11	Everglades pine rocklands	1–5 flowers that produce leguminous fruit	Localized populations	Fire repression, habitat loss	Rockland habitat

All data are from NatureServe.org

After some answers are recorded, the instructor provides additional data on endangered species and similar but not endangered relatives. In Panel 1 above, the instructors might compare *Galactia smallii* to *G floridana*, a widespread species that is not endangered (also found in the pine rocklands). A discussion of factors that might cause these two species to differ in their response to management can follow (eg genetic diversity, pollinator diversity, mode of reproduction and response to fire). See if students note that minimal information is available for many taxa, but is copious for the "charismatic megafauna".

Summative assessment

At the end of class, students write an extended response to the following questions: (1) What three general life-history attributes make a species more or less vulnerable to extinction? (2) State how each of these attributes affects extinction vulnerability and our ability to predict it.

Analysis of assessment

Student responses can provide the instructor with more information than merely "percent correct". By formally coding student responses, the instructor can determine misconceptions and gaps in student knowledge. An example for the assessment above is shown in Panel 2. The accuracy of the reasoning for each life-history trait described in each essay is tallied. By examining the finished data, the instructor can determine: (1) traits for which students provided correct reasoning; (2) traits students felt were important but were not sure why (trait listed without a reason); and (3) traits that students reasoned incorrectly, thereby illuminating possible misconceptions. Subsequent instruction can address vital concepts still missing from student understanding.

Panel 2. Sample concept tally sheet

Life-history attribute	*Correct*	*Missing*	*Incorrect*	*Total*
Range		/////		5
Reproduction	/			1
Mobility	///////	//	/	10
Population size	/	///	////	8
Extinction cause	///////	/		8
Resource specialization	////////	//	/	11

Final note

Student misconceptions uncovered in the assessment analysis probably also pertain to topics beyond threatened species, such as population dynamics, biodiversity, and functional groups. Many other ecological misconceptions are cited by Stamp and Armstrong (2005). The information gained from this analysis should be used to guide future instruction and assessment, to ensure that difficult concepts important to the discipline are achieved through active learning.

Acknowledgements

We thank the National Science Foundation for their long-term support of the FIRST project, Faculty Institutes for Reforming Science Teaching (DUE 0088847). All Pathways papers are peer reviewed.

References

Munson BH. 1994. Ecological misconceptions. *J Environ Educ* **25**: 30–34

Stamp N and Armstrong M. 2005. Overcoming ecological misconceptions. Binghamton University, State University of New York. http://ecomisconceptions.binghamton.edu/. Viewed 13 September 2005.