Eco-Tutelage

Teachers experiment with eclectic efforts at ecological erudition

By RICK WEISS

Last year, only 15 of 22 college students taking Christopher C. Smith's ecology class survived the winter. But the Kansas State University professor lost no sleep over their demise. He reckons there's no better way to learn the hard facts about winter food-gathering in the animal world.

Smith's course in basic ecological principles reaches beyond the usual lecture-and-lab format, sending students into the Kansas prairie for a living lesson in foraging for nonrenewable resources. The course isn't really all that risky. Even the students who "die" of starvation dust themselves off at the end of the popular exercise and head to the campus cafeteria for dinner.

But Smith's clever simulation of life and death in the wilderness attunes students to the merciless rules of ecology. The exercise, which has students groveling in the grass for elbow macaroni and pinto beans, was one of several novel approaches to biological pedagogy described in July at a meeting of the Ecological Society of America.

With dwindling resources and endangered species gaining increasing attention in the United States, ecology teaching appears poised for a renaissance. But teachers warn that without appropriate creativity, the study of plant and animal interactions can border on the boring.

Indeed, to many a student's chagrin, the study of biological and environmental dynamics inevitably requires an immersion into mathematical principles and statistical methods — classically unpopular topics among life-sciences students. And too heavy an emphasis on theoretical models can leave students wondering what it all means in the real, green world. So high school teachers and college professors are increasingly turning to imaginative exercises that bring textbook studies to life.

George M. Briggs, for example, incorporates a truly rotten idea into his ecology course at the State University of New York at Geneseo. Students create indoor mini-compost heaps to study processes of respiration, decomposition and nutrient mobilization.

Briggs' students fill flasks with combinations of shredded spinach, potatoes and sawdust, then perform biological and chemical experiments on the decomposing mess over time. In doing so, they gain an introduction to some basic biological principles while getting practical experience with a technique that can help solve the world's growing solid-waste problem, Briggs says.

Students adjust such variables as temperature, moisture and organic content, then measure things like oxygen consumption, ion exchange capacities and amounts of leachable nutrients. "They get some experience designing experiments, they get some experience finding that things don't always work out and they get to play with some numbers," he says.

"The biggest drawback to this lab is that it stinks," Briggs concedes. But he figures most students are well accustomed to the odor from routine, if inadvertent, "composting" experiments performed in the dorms. "In my experience, most students' refrigerators smell pretty bad," he quips.

Nancy M. Eyster-Smith, who teaches ecology to business students at Bentley College in Waltham, Mass., has expanded on a somewhat bizarre theme broached several years ago by ecologists Patrick C. Kangas of Eastern Michigan University in Ypsilanti, Paul Risser of the University of New Mexico in Albuquerque and David A. Zegers of Millersville (Pa.) University. Recognizing that business often imitates biology, she uses local fast-food restaurants to demonstrate concepts of niche, competition, evolution and extinction.

"The restaurants are the species," Eyster-Smith explains. "We have McDonald's species, Arby's species, Kentucky Fried Chicken species and so on." Her students note ways in which menus vary from one species to the next and how the offerings have varied over time. In addition, they survey the species' preferred habitats. (Many restaurants congregate along a highway habitat called "the strip," they observe.)

In the Darwinian world of fast-food competition, Eyster-Smith says, each restaurant species competes for a limited resource: customers' money. Categories of food — such as burgers, sodas and French fries — represent ecological niches, or areas of competitive expertise. Within this food-service framework, students discover a smorgasbord of ecological rules.

For example, their surveys reveal that in the fast-food jungle, niche dimensions (food categories) may overlap but no two species can have exactly the same food requirements and still coexist in close proximity. Ecologists recognize this as the competitive exclusion principle. Moreover, students observe that species — whether plant, animal or restaurant — engage in both interspecific and intraspecific competition, competing with other brand-name chains as well as with nearby franchises of their own chain.

Like biological species, some fast-food restaurants are "generalists" — trying to maximize survival by offering a wide variety of food items, or resource strategies — while others are "specialists," offering a narrower but unique menu to customers. Moreover, students find that restaurants can best share limited resources (business) by partitioning their activities in different ways, a strategy common among biological competitors. For example, rival restaurants might space themselves in distant neighborhoods, stay open late into the night, adopt marketing strategies such as kids' meals, or add special offerings such as ice cream or salad.

Eyster-Smith takes the gastronomic analogy even further by having students consider the social and environmental factors — such as neighborhood affluence and customers' increasingly busy schedules — that may have influenced the evolution of various restaurant species. She has them draw phylogenetic diagrams, or family trees, describing this evolutionary process, starting with a presumed common ancestor: the "drive-

in generalist."

Finally, the class performs post-mortems on restaurants that have failed to survive the evolutionary battle. "If you know the towns and you look at the data, you might get an idea about local extinctions," she says, noting that most fast-food extinctions occur in neighborhoods that have become either very affluent or severely crime-ridden.

Being business majors rather than biologists, Eyster-Smith's students struggle for a while with ecological terminology. But before long, "you can tell they're enjoying it," she says. And because the students frequent fast-food restaurants and probably know them more intimately than they know biological species, "they feel more knowledgeable and comfortable writing about them."

The prospect of earning college credit while sampling fries and shakes may sound like a student's dream come true. But simulated starvation evokes comparable enthusiasm among students in Smith's ecology class at Kansas State. The three-hour teach-in takes place far away from the fast-food strip, on a windswept, roughly mowed prairie. Markers divide the field into 100-square-foot foraging zones.

Juniors and seniors majoring in general biology or wildlife and fisheries management work in pairs within each square of sun-parched grass. One tosses 100 pieces of elbow macaroni into the square and then activates a stopwatch. The other plays the role of a foraging animal. It's winter, Smith announces, and no new food can be expected before spring.

The rules are simple. One minute of foraging time equals one make-believe day. Each forager has an energy requirement of five macaroni pieces per day (one minute), and winter lasts 12 days (12 minutes). On your mark, get set, scrounge.

At first, food comes easily. Some minute-long days bring more than the required five macaronis, allowing a little hoarding for the next day.

Soon, however, supplies begin to thin and the little yellow elbows become more difficult to spot. A few minutes into the exercise, foragers begin to get an almost panicky, lean-and-hungry look, Smith says. Their teacher remains dispassionate. "We have the students forage until they die," he says.

Later, Smith has the students plot graphs depicting the amount of food retrieved per day. Their findings – which generally indicate that fulfilling daily energy needs becomes more difficult as the season progresses – serve as a basic model showing "what happens to organisms that feed on nonrenewable resources through the winter," he says.

Smith extends this format to study related ecological principles. For example, to investigate the effect of protective coloration among food sources, students forage for a mix of pinto beans and brightly colored macaroni. "The pinto beans are pretty hard to find," he says. (Field mice, apparently more talented at the task, clean up the leftovers after class.)

In another exercise, Smith demonstrates the risks of becoming a food "specialist" by offering only one food source (such as green macaroni) until students become accustomed to spotting it, and then tossing them a food mix in which that food is scarce.

What happens when food density drops, or when the habitat itself changes? Spreading the same amount of food over four times the area causes student survival to plummet, Smith says. And when the class moves to an unmowed pasture, life really gets rough. "In tall grass, all of them died by the fourth day," he reports.

Principles of competition come into focus as students measure survival rates of classmates given their own 100-square-foot areas and compare these with survival rates observed when four students share a 400-square-foot area bearing four times the amount of food. In this case, food density and availability per student remain constant, but students begin to interfere with each other. "Survival time shortens with competition," Smith notes, because students must spend time fighting for the same piece of food and because increased trampling of the grass makes food more difficult to find.

In one version of the exercise, Smith has students investigate the advantages of cooperative behavior by assigning some nonforaging students the role of hawks sneaking over a hillside. Foragers who are permitted to warn each other with shouts of "Hawk!" live longer than those forbidden to communicate with each other.

By the end of the day, students come to recognize one of nature's most basic truths: Certain individuals are simply better equipped to survive than others. "Some students are very good foragers," Smith says. In the most striking example of survival of the fittest, he says, one girl lived 14 days, well into make-believe spring, meeting her energy needs even when food was spread at one-quarter its usual density.

Smith says the foraging experience gets students to think about issues of ecology in very real terms – even more so because he conducts the exercise just before dinner, when students are ravenous. But perhaps equally important, he adds, "it's a lot of fun."

"Students really get involved in this," he says. "They even go belly up when they die." □