In This Ecological Undercard, the Forest Understory Is the Underdog

By Hannah Fairfield

Dave Ellum reached into the dense grass, ripping at the tangled mats as the sun beat down on a field of grasses and asters in Yale-Myers Forest that had been shaded by a canopy of sugar maples and oaks two years earlier. When his hand felt earth, he parted the matted green stalks, exposing a tiny wild sarsaparilla plant.

"The forest undergrowth is still here in some places," said Ellum, a doctoral student and the forest's coordinator of research and demonstration. "But the cards are stacked against it."

Ellum's research focuses on the ecology of forests, *below* the trees. The species that live in the understory are ecologically sensitive and exhibit the highest plant biodiversity in the forest, but they are also the most vulnerable to change. Common uses of a forest, such as timber production, watershed management and recreation, often result in major changes in the forest canopy. Because of the abrupt ecological shifts that occur when the trees are removed, Ellum believes that the conservation ethic should extend to the nonwoody species—plants that have been previously overlooked in forest management practices.

When a forest stand is logged, the groundcover plants immediately switch from living in deep shade to constant bright sunlight, and most are not able to survive. Sun-loving plants, such as grasses, asters and fireweed, sweep in and crowd out the shade-lovers—ecological underdogs like wild sarsaparilla, Jack in the Pulpit, wild orchids and starflowers.

Keeping the understory plants alive, Ellum said, is an important part of managing a multiuse and sustainable forest. The shade lovers have been shown to be important links in nutrient cycling, helping to keep the trees healthy; this in turn allows a forest to prevent erosion, purify drinking water and sequester greenhouse gases, among other functions. Understory plants also tell the story of the land itself, because their growth patterns can indicate land-use history. And some plants, like American ginseng, wild sarsaparilla's cousin, can be cultivated in the forest understory and harvested to sell.

But in the shadow of the trees, the understory plants have been largely ignored. "We do not yet understand the full role of these plants in maintaining the viable function of forested ecosystems, or the many more tangible benefits they will provide to society in the future," Ellum said.

Efforts toward sustainability have, for the most part, been focused on timber. Regulatory standards for sustainable forestry, as set by the Forest Stewardship Council and the Sustainable Forestry Initiative, recommend that biodiversity be protected, but specific techniques for doing so are not widely available. Ellum's research seeks to change that, to find ways that timber managers can increase the survival rate of many ecologically valuable species, rendering the whole forest more valuable. There is a growing interest in "multitasking" forestland by finding medicinal and horticultural uses for understory plants, like ginseng. Because the Yale-Myers Forest, which covers 7,840 acres in northeastern Connecticut, has earned certification as sustainably managed and is logged periodically, it is the perfect laboratory.

"Timber is an important resource," Ellum said. "But in many instances it is possible to take the timber, as well as conserve plants of interest. We don't have to choose between them."

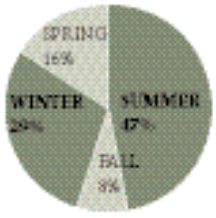
A forest's biodiversity riches are found in the understory; the Yale-Myers Forest has more than 200 species of nonwoody ground plants, but just 28 species of trees. In Connecticut, 40 percent of all plants listed by the state as endangered or of special concern, including all listed wild orchids, live in the forest understory.

Understory plants are vulnerable to ecological stress because they are unable to adapt quickly to changes in exposure to sunlight. They are long-lived—a Jack in the Pulpit may live 25 years—but they grow

Conserving the Forest *Below* the Trees

Most timber harvests occur during the summer and winter when the soil is dry or frozen. David Ellum, a forest ecology doctoral student, demonstrated that in areas where certain understory plants need to be conserved, shifting more harvests to winter can better protect the plants.

Yale-Myers Forest timber harvests, 1978 to 1993



The experiment: Jack in the Pulpit (Arisaema triphyllum), a common understory plant, was grown in pots for a year. Some were moved into direct sun, which simulated canopy removal.

MOVED INTO THE SUN:	RESULTS
Never. The control group remained in the shade.	The control plants were healthy, with large, flat leaves.
In June, after the plants grew leaves.	The leaves became bleached and dried out.
In February, before the plants grew leaves.	**Leaves grown in the sun were smaller and thicker, less likely to dry out.**

Source: David Ellum

David Ellum tends to a downy rattlesnake orchid (*Goodyera pubescens*), one of several understory plants that he is studying at Yale-Myers Forest. In the foreground, at left, is partridge berry (*Mitchella repens*).

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slowly and reproduce even more slowly. A downy rattlesnake orchid creates one clone a few inches away from itself every three years. A patch of orchids that covers 1 square foot represents many decades of growth.

So when an area of the Yale-Myers Forest is logged, the understory plants are metabolically sucker punched because their exposure to sunlight soars to 100 percent, with no canopy, from about the 1 to 5 percent they have adapted to. Their leaves begin to look burned and desiccated. Their respiration races ahead of their photosynthesis, and they struggle to stay alive. While they are foundering, sun-loving plants parade in, reproducing quickly and choking off the already stressed shade plants. Grasses, asters and fireweed can cover wide swaths of logged land in a few weeks.

Because of the increasing pressure for timber resources, Ellum knows that forest managers need better techniques for preserving biodiversity and conserving rare plant species in areas that are logged.

"I'm not looking for really complex answers," he said. "I want to develop forest management techniques that can be readily applied in the field."

To that end, one of Ellum's experiments focused on the seasonal timing of timber harvests and its effect on nonwoody plants. Nearly half of all the timber harvests at the Yale-Myers Forest between 1978 and 1993 occurred in the summer. But many of the understory plants are dormant in the winter and leaf out in the spring, so their low-sunlight metabolic processes are set by the summer.

Ellum wondered whether, if canopy removal took place in the winter, the plants' metabolism might have time to adapt during leaf development, leading to higher survival rates.

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He devised an experiment for four nonwoody forest plants—wild sarsaparilla, Jack in the Pulpit, starflower and Canada mayflower—grown in pots. After a year of being grown in the shade, the plants were divided into three groups: one group was moved to full sunlight in February before the plants had grown leaves; a second group was moved to full sun in June after the plants had grown leaves; and a third group, the control, remained in the shade.

He expected that the plants grown under the full canopy would prosper and that the ones exposed to full sun in June would wither, but the big question was how the plants exposed to full sunlight in February would react. Ellum predicted that they would show a greater ability to adapt to the sun—and he was right. The plants exposed to full sunlight in February—three months before the plant produced leaves—grew extraordinarily well. Their leaves were thicker and smaller and, therefore, less likely to dry out in the bright sun than the shaded control group. And they were healthy and fully able to photosynthesize, unlike the plants that were moved to sunlight in June, which died.

Ellum's conclusion: if forest owners shifted more harvest operations to the winter, the exposed understory might be able to compete with the asters and grasses.

"Can most small, private landowners wait six months to log? Probably, said Ellum."

Changing the timing of logging is one technique that forest landowners can use to wisely manage the timber while preserving biodiversity. Another proposal to promote the survival of native species is modifying the shape of the harvested area. Forest understory plants have a higher survival rate near the edges of a timber cut, where they are still shaded by trees. So oval- or rectangle-shaped timber cuts, which have longer perimeters than a circular one of the same area, could provide increased refuge at the edges, where forest understory plants can set the stage for recolonization of a future forest stand.

Ellum's holistic view of forest management grew out of his deep involvement with the forest. In addition to his doctoral research, he coordinates faculty and student research projects in the forest, and lives there for several months of the year. He also hosts about 100 incoming master's students every summer, demonstrating for them the principles of field ecology and his love for the forest.

"I think it's important to become part of the place you study and to see it through many seasons," he said. "I've been lucky to have this opportunity, and I hope to do this for the rest of my life." EY