PNW
Pacific Northwest
Research Station

# Science
FINDINGS

INSIDE



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*"Science affects the way we think together."*
Lewis Thomas

# SYMBIOSIS AND SYNERGY: CAN MUSHROOMS AND TIMBER BE MANAGED TOGETHER?

Photo credit: USDA Forest Service

*Jeanne McConnell and Ed Strawn have harvested matsutake mushrooms for more than 20 years in Oregon. The profit made from the mushrooms supplements their retirement income.*

**IN SUMMARY**

*Recreational and tribal use of mushrooms has been historically important, and during the last two decades, commercial demand for mushrooms has burgeoned. A large nontimber forest product market in the Pacific Northwest is for various species of wild edible mushrooms. Many of these species grow symbiotically with forest trees by forming nutrient exchange structures called "mycorrhizae" on their root tips.*

*Managers are beginning to better understand the biology and ecology of some commercial mushroom species. Estimates of site productivity, silvicultural implications for mushroom yields, and regional price trends are being used to develop estimates of both timber and mushroom values given varying silvicultural regimes. Information from these studies can help land managers explore forestry methods to produce multiple products from the forest simultaneously.*

*"The soundest reasoning leads to the wrongest conclusions when the premises are false."*
Dr. Vihljamur Stefansson

Suppose you're a forest manager, contemplating your various forest products, both timber and nontimber. To manage for multiple products, value comparisons are essential. So how might you compare mushrooms with trees?

One is harvested every 5 to 10 decades, the other annually. One has well-documented price trends that are relatively stable from year to year. The other has poorly documented, wildly vacillating market prices that can change from day to day. On Federal land, one has a long-established bid system for purchase of the resource, the other has a dozen oft-criticized permit and bid systems to control access to the resource. One contributes to an industry largely composed of corporations and capitalized businesses, the other to an industry known best for its diversity and the individuality of its subsistence-level practitioners.

Compare them?

"Confusion frequently arises in comparisons of different forest goods, such as mushrooms and timber," says Susan Alexander. A natural resource economist with the PNW Research Station in Corvallis, she has been a lead investigator on a recent effort to provide valid value estimates of commercial mushrooms and

timber in the Pacific Northwest. "One common pitfall is to compare goods by using different methods of analysis for incomparable areas of economic concern. An economic analysis of revenues and values must be clear about the purpose of comparisons and it must use relevant indicators."

Demand for nontimber forest products has existed for a long time—millennia, when you count traditional use of wild edibles and medicinals—but commercial harvesting of mushrooms, particularly from National Forest lands, has burgeoned through the last decade, and has only recently received closer research attention. Rising demand, along with reduced timber harvests, has spurred the need to attend to nontimber resources.

Ecosystem management, focusing on multiple products, has untested potential for enhancing the commercial value of forests, says Alexander.

## KEY FINDINGS

- The relative value of timber and mushrooms, discounted over perpetual timber rotations, can differ widely, from trees being far more valuable than mushroom crops, to the opposite. Relative value depends on the species of trees, site productivity, associated mushroom species, markets for each, and land management goals.
- Silvicultural treatments can increase or decrease mushroom productivity over time. Prediction of the impacts of various treatments depends on understanding the interactions among fungi, trees, and the forest environment.
- Mushroom harvesters have various motives for mushroom picking and have varied backgrounds. Many harvest to supplement their income, some combine recreational and commercial picking, and still to others being outdoors and independent is important.
- There is little profit margin for harvesters, and prices differ considerably depending on species as well as market volatility within and among seasons. Factors affecting price include competition among purchasers, biological availability, and worldwide competition.

## WILD EDIBLES AND WILD ESTIMATES

Many nontimber forest products are collected in the region, wild mushrooms being among the most economically significant. According to Alexander and colleague David Pilz, a mycologist from the PNW Research Station in Corvallis, available information allows us to create a preliminary estimate of the value per acre of the three major commercial wild mushrooms: American matsutake, chanterelles, and morels.

"We know a great deal about the symbiosis, or mutual benefits, of many fungi and trees," says Pilz. "We have lots of biological information on how mycorrhizal relations benefit both tree and mushroom in a complex nutrient exchange: an extended root system for nutrient and water uptake for the tree, and carbohydrates for the fungus produced by the tree during photosynthesis. But little of the information is helpful in assessing mushrooms as products or resources of the forest."

Of the three groups of mushrooms, matsutake generally commands the highest price, being particularly valued in the Japanese market, followed by morels, then chanterelles. The latter two species each often are harvested in greater annual volumes than the matsutake. In 1992, for

*Chanterelle.*

*Morel.*

*Matsutake.*

*Photo credits: USDA Forest Service*


### *Purpose of PNW Science Findings*

To provide scientific information to people who make and influence decisions about managing land.

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example, 1.3 million pounds of morels, 1.1 million pounds of chanterelles, and 825,000 pounds of American matsutake were harvested in Idaho, Oregon, and Washington combined.

"It is important to remember that average or typical mushroom yields are more difficult to estimate than timber yields, even with years of data," says Pilz, "because mushroom crops are in part weather-dependent and vary widely from year to year." The matsutake yield in the Oregon Dunes National Recreation Area is more predictable than others, he says, because the area has a mild climate and regular rainfall.

Mushroom yields in a particular stand can be affected by moisture, sunlight, disturbance, wildlife use, insect infestation, the previous year's harvesters, and timber management. Mushroom values are even more highly variable, potentially fluxuating from day to day in response to world markets, competition among buyers, and local and regional competition among harvesters.

### LAND MANAGEMENT IMPLICATIONS

- Mushroom productivity (counts and weights per unit area) differ considerably for commercial mushroom species, among species, across sites, and annually. If a range of variability is estimated for a species in an area or region, land managers can make more realistic regulatory decisions, such as season length, permit prices, and permit numbers.
- Tree harvest and mushroom production can be complementary or even synergistic management activities. Further exploration of species biology, innovative silvicultural regimes, and harvester motivations will clarify production opportunities.
- Synergistic production of multiple forest products is expedited when information about site productivity, silvicultural implications for yield, and regional price trends is combined to track value under various silvicultural regimes.

Although all these factors also affect timber, they do not so aggressively affect daily or even seasonal timber prices. Managers would be helped by having a range of price variability for mushrooms that allowed them to make more realistic regulatory decisions, such as season length, permit prices, and permit numbers, Alexander suggests.

Loose estimates of mushroom yields and values can be misleading. They are frequently based on figures from a limited area, or they compare factors that are not equivalent.

## BEWARE COMPARING APPLES AND ORANGES

Alexander and Pilz's recent analysis and comparison of mushroom and timber values outlines three broad areas of economic concern by which different goods or actions can be assessed. The first is efficiency analysis, which can be used to contrast the market price of two goods at the same level of production. The second, economic impact, looks at the flow of money (such as by employment) through an economy or region, and the effects of that flow. Finally, distributional comparisons raise questions about the rights to and distribution of goods, services, and property, which can be looked at across geographic areas, generations, income levels, or between racial and ethnic groups.

Their approach used a growth model to predict management and yields through time, and to calculate a factor called soil expectation value (SEV) for mushrooms and for timber. Soil expectation values represent the present net worth of a continuing set of rotations, taking all costs into account, and can be used to compare values for different products in different places.

"We also outlined our assumptions explicitly—the assumptions necessary to calculate value for a nontimber forest product such as mushrooms—and we suggest that resource managers or landowners can incorporate their own assumptions to complete their own calculations," Pilz explains. Key assumptions include how the resource will grow, how it will be managed, and what the dollar value for the resource will be after costs are accounted for.

The researchers calculated per-acre value for mushrooms and per-acre value of a representative timber type (where commercial timber was present) for each of four areas: the Winema National Forest, the Dunes National Recreation Area, the Olympic Peninsula, and the Wallowa-Whitman National Forest. Relative values of timber and mushrooms differed widely, depending on species of trees, their associated mushroom species, markets for each, and land management goals, he notes.

The way timber is measured, marketed, and sold makes SEV calculations for timber fairly easy: delivered log price minus harvest cost, wages and transportation costs, and other costs associated with harvest and transport, equals stumpage price, or the bid price in government timber sales. The amount sold and the price are clearly defined, and harvest costs are known. Generally there are one buyer and one seller (the landowner).

Mushrooms, on the other hand, aren't so easy to pin down.

### WRITER'S PROFILE

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## QUEST FOR HIDDEN TREASURES

At harvest time, it's hard to miss a tree, but surprisingly easy to miss a mushroom, no matter how experienced the picker. The same problem faces researchers and resource valuers. Also, animals and insects get to some species before they can be harvested. Any blemish or imperfection renders a mushroom less valuable and likely to be left behind. Similarly, there's an ideal size for some species in some markets, again making harvest a more selective process.

"Furthermore, the permit to pick does not generally give the individual exclusive rights to harvest in a particular area, and the landowner doesn't know how much product is harvested, or from where," Alexander explains. "Harvest costs and gross revenue for individual harvesters is unknown, and people sometimes harvest either without a permit or with a permit from a different landowner."

To date there has been no systematic collection of price data to ease the challenge of analysis. As Alexander notes, if the industry collected these data, they would have it available for insurance companies to insure products before they reach market or banks considering loans to small business owners.

There is notable lack of data about mushroom harvester costs, particularly the individual's minimum wage. "Each harvester has an idea of what he or she must earn to continue working, but that personal minimum wage is not reported, and has not been estimated for mushroom harvesters," she says. "A personal minimum wage is not official, it is simply the amount that harvester feels is the minimum he must make to participate in the activity."

The recent analysis developed ranges of on-the-ground estimates of harvester costs. Significant variation in mushroom and timber values among their four selected sites emphasizes how important it is for managers to develop ranges of values on a site-specific basis.

## SEEN ONE MUSHROOM SITE, SEEN ONLY ONE

American matsutake values were assessed alongside timber values first in a representative stand typical of high-elevation forests in south-central Oregon's Winema National Forest. The researchers drew on daily information about weights, grades, and prices of this mushroom, which has been collected there for several years. Assumptions about commercial productivity (percentage of biological productivity actually harvested), and costs to harvesters (which might consume anywhere from 50 to 90 percent of harvest income) were specified.

Two silvicultural scenarios were examined: (1) current management for visual quality and development of large-diameter trees, and (2) management for visual quality as well as American matsutake habitat. The latter was designed to encourage matsutake fruiting up to double its initial productivity, and in both scenarios, thinning was used to enhance timber yield over the whole landscape.

To the surprise of the researchers, the mushroom-emphasis prescription produced higher SEVs for timber. "But the differences in the timber harvest values of the two alternatives occur only after more than 70 years," Alexander explains. "There is honestly not much difference in net present timber value between the two management alternatives." Mushroom values ranged from lower to about the same as that for timber.

In a vastly different scenario for matsutake, the Oregon Dunes National Recreation Area harbors prolific matsutake fields in an area not used for timber production, and nearby privately owned land has a high conversion value for housing and development. With the milder climate and longer season, matsutake SEVs here were higher than in Chemult, but were not compared to speculative land values.

Another high-contrast example is provided on the Olympic Peninsula, where chanterelles do not fruit in commercial quantities until a stand is at least 20 years old, although they persist longer, are less attractive to animals and insects, and are easier to find than matsutake. Notably, though, Douglas-fir in this area commands consistently high stumpage values. Consequently, chanterelle SEVs are considerably lower for every scenario modeled, including high- and low-yield values for mushrooms, and two timber production styles—a 50-year clearcut rotation and a 100-year rotation with commercial thinning. For timber, values ranged from $1,329 to $1,654 per acre. For chanterelles, the range was $7 to $125 per acre. Timber values are more than 10 times higher than mushroom values.

The final example, morels in the Wallowa-Whitman National Forest, highlighted the variations within the morel group. According to Pilz, some species appear to prefer disturbances such as fire, harvest, windfall, and insect or disease stress. Other species appear regularly in certain habitats year after year.

"The periodic large flushes of some morel species, fruiting in response to episodic or planned disturbances, require land managers to define sustainable resource production on landscape scales and rotation timeframes," he says.

On the Wallowa-Whitman National Forest, the projections were based on management to develop an uneven-aged stand, including harvest thinnings, underburnings, and no cumulative soil compaction from harvest.

"Projections of productivity and value for trees and morels in this area are highly sensitive to the assumptions used regarding silvicultural prescriptions, types of fires modeled, and timing," says Alexander. "Readers adapting our calculations to their own situations should examine their assumptions carefully."

## THE PRODUCT, THE PEOPLE, AND THE POLICY

The question of sustainable harvest also drives decisions about access and the permit process. Concern for impacts on the mushrooms and timber resource, has generated diverse efforts to reduce negative impacts. These have included limiting the width of the tool used to pry mushrooms from the ground, thereby preventing disturbance to the fungal organism in the soil. Harvesters usually are instructed to cover holes and leave mature specimens to disperse spores. Minimum cap diameters have been specified to minimize removal of matsutake mushrooms before they reach optimal size and value, and collaboration with buyers to refuse purchase of undersized mushrooms has helped. Other measures designed to reduce harvest impact include restricted seasons, no-harvest areas, and limiting permit numbers.

On a larger scale, various silvicultural treatments by Japanese, and more recently, American researchers, are being tested to determine impacts on the mushroom resource.

"We do know that mushrooms take 10 to 20 years to bounce back after a clearcut. We know that clumps of leave trees preserved around productive mushroom patches seem to maintain fruiting," Pilz says. "We also know that any kind of harvest that avoids soil compaction, such as harvest on snow, or use of dedicated skid trails, reduces the impact on mushroom productivity. Beyond that, there are many hypotheses, especially about how to increase productivity of mushrooms, but nothing has been solidly established yet."

One benefit of the greater attention focussed on commercial mushroom harvest in the last decade, Pilz comments, is that the industry is now better understood to be the highly diverse creature that it is. "The elements of confrontation, rumor, and misinformation have abated as the frantic 'gold rush' mentality of mushroom harvesting has been replaced by better communications among harvesters and managers."

## SO WHAT OF THE FUTURE OF MANAGING FORESTS FOR MULTIPLE PRODUCTS?

"This line of research clearly implies that tree harvest and mushroom production can be complementary or even synergistic management activities. Further exploration in the fields of mycology, silviculture, economics, and social science will clarify the opportunities that exist for multiple-product management," Pilz says.

Frequently, harvesters are divided into commercial and noncommercial groups for research purposes, but Alexander warns against this apparent distinction. Studies as far apart as France, Finland, and northern Michigan reveal similar results: for many harvesters, the cultural meanings and values of the resources are as important to them as their economic or subsistence values.

"In dividing harvesters into mutually exclusive categories of commercial and noncommercial use, we increase the likelihood that our scientific information will have unintended, and possibly negative, social and ecological consequences," Alexander says.

Clearly, everything about mushrooms and their harvest is site-specific, the products as well as the people. But the researchers note that most studies, including their own, suggest the commercial value of forests can be enhanced through the harvest of nontimber forest products.

Says Pilz, "Studies of nontimber forest product harvesting and production provide a cogent example of the usefulness of ecosystem management, with its requirement of integrating social, economic, and ecological factors."

*"While a turkey head*
*has no market value,*
*a turkey has a hard time*
*getting along without it."*

Gobblers, The Oregonian, November 26, 1992

### FOR FURTHER READING


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