



# Sustainable harvests of edible forest mushrooms: perspectives and paradigms in the Anthropocene

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## Abstract

The process of ensuring the sustainable harvest of edible forest mushrooms is described as a subset or example of the type of perspectives and paradigms that are needed for humanity to restore our home planet and live harmoniously with its biomes.

**Additional key words:** ectomycorrhizal fungi; existential crises

**Citation:** Pilz, D (2022). Sustainable harvests of edible forest mushrooms: perspectives and paradigms in the Anthropocene. *Forest Systems*, Volume 31, Issue 2, eM01. <https://doi.org/10.5424/fs/2022312-19352>

**Received:** 27 Feb 2022. **Accepted:** 18 May 2022.

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**Competing interests:** The author has declared that no competing interests exist.

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This article belongs to the Special Issue "Forests: Reservoirs of Global Mycocultural Heritage and Mycological Resources". <https://revistas.inia.es/index.php/fs/si1>

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In my seven plus decades on the planet the human population has mushroomed from 2.5 billion to 7.8 billion people, and it is on track to reach 9.7 billion by 2050. One of the most overwhelming revelations that most visitors to space experience is how incredibly thin our atmosphere is relative to the planet. If the earth was a ball 2 meters in diameter, the atmospheric layers that are thick enough to support human life would only be the width of the skin of an apple. Yet, in a geological instant, our billions continue to drive changes to our atmosphere not seen in millions of years. And most of the people on the planet today have lived their whole lives in the shadow of a nuclear annihilation in the form of mushroom clouds. Nevertheless, in our hubris, we ignore the implications of the fact that we live in a universe of trillions of galaxies, some with trillions of stars.

Everyone has their own ways of grappling with these existential threats and immense perspectives; running the gamut from denial through religious convictions. The most common thread is awe; recognizing the wonders of the reality that we share with each other and with all of life on our little blue planet. But awe, per se, is not a sufficient strategy for addressing the problems that we face. What is?

I contend that managing edible mycorrhizal fungi for sustainable human consumption and health is an exemplar, or microcosm, of the larger paradigm shift that is needed to address global catastrophes of our own making.

Scientific and technological innovations have undeniably and dramatically altered how humanity is able to interact with our planet and its biosphere; sometimes beneficially, but too often not. Still, we remain merely mortal humans. Most people are motivated by the basics of life: sustenance, security, livelihoods, family, community and cultural identities. Many are also motivated by justice, peace, creativity and caring for each other. Our sense of caring often extends to the other inhabitants of our planet as well. This includes the complex and diverse ecosystems that we inhabit and upon which we ultimately depend for our existence. Indeed, it includes the awareness that we are not separate from, or superior to, the world from which we emerge.

I believe that if we want to solve (or at least dramatically ameliorate) our global crises, it needs to happen from the ground up (figuratively and literally). It takes more than a village to raise a child. It takes an ecosystem. It will take more than scientific, technical, economic, or political solutions to heal the planet; it will take broad consensus

on preserving our entire biosphere. The paradigm that will see us through these trying times is a global groundswell of respectful interconnectedness with the natural world. Sustainable (respectful) harvesting of edible forest mushrooms (which often involve ectomycorrhizal mutualisms among forest organisms) serves as an example of applying this global paradigm locally and illustrates many of its essential components.

Key elements of this groundswell paradigm include:

- Sustainability that functions optimally when designed and implemented locally
- Mutualisms and interconnectedness that are acknowledged and encouraged
- Healthy ecosystems that are nurtured or restored
- Native ecosystems that are critical refugia for original biodiversity
- Traditional ecological knowledge that offers critical insights and solutions
- Science that informs effective choices
- Historic injustices and inequalities that are rectified
- Benefits that accrue to everyone

When my colleagues and I write about the topic of sustainable ectomycorrhizal mushroom harvesting, we invariably point out that this topic interfaces with numerous sub-topics, thus illustrating the principle of interconnectedness. Examples include:

Symbioses or mutualisms, synecology, taxonomy, biodiversity conservation, genetics, ecosystem processes, forest management goals, reforestation, afforestation, myco-silviculture, mycorrhizal inoculation methods, forest fire regimens, forest carbon capture, sustenance, non-meat protein sources, hunger mitigation, ethnomycology, linguistics, conservation of biocultural heritages, empowerment of women, land tenure, harvesting access and regulations, local/national/international commerce, sustainable economic development, myco-tourism, conserving refugia, climate change mitigation, and shifting biomes.

Although broad swaths of the earth do not have forests or many wild edible mushrooms, forest that do support wild edible mushrooms are common on all continents and in most countries. Clearly not all of the subtopics listed above apply in every local context, but they do provide salient examples of how to work with the complexity of conserving natural processes.

In my neck of the woods (western North America), most forest lands are owned and managed by various federal and state agencies, as well as corporations. The greatest threats to these forests from global warming are mega-droughts, resultant insect infestations, and catastrophic wildfires on landscape scales. The impacts of these stressors on the forests where edible forest mushrooms grow have been worsened by decades of a forest management paradigm that emphasized economic profit, industrialized logging, mono-cropped tree plantations and a century of suppressing almost all forest fires.

Fortunately, some ectomycorrhizal fungi persist and fruit again in young stands where reforestation is successful.

But what happens when the climate warms so much that tree species associated with a particular edible mushroom will no longer grow in the hotter drought-stricken areas where they previously flourished? Can we facilitate the mutual migration of tree species and ectomycorrhizal fungi with nursery inoculations? With which tree and fungal species and how? What are the limitations of this approach? For instance, what about the migration of all the other species in a particular forest community?

Or take the case of fire-adapted morel species that fruit only for a year or two after wildfires. If large portions of the forested landscape are consumed by stand-replacement conflagrations in the near future, there might be extensive morel harvests for a few years, but how can the “sustainability” of such morel crops be ascertained when early seral forest conditions become the norm?

More to the point, how can forest management shift its paradigm from one of emphasis on economic value of timber to one of figuring out how to optimally capture and sequester carbon through restoring fire-resilient forests stands. Doing so will entail a lot of on-the-ground work by both loggers (to thin understory trees) and fire managers (to re-introduce frequent low-intensity fires). Employing so many workers while timber revenues decline will require a realistic price on captured carbon and proven methods for sequestering it in fire dependent ecosystems. Native American Tribes are increasingly being consulted and engaged with this process. On their own tribal timberlands, they manage not just for sustainable harvests of timber, but for sustaining an abundant natural world in perpetuity.

Another movement is concurrently afoot to conserve large forest reserves that are optimal for biodiversity refugia, have large current carbon stocks and exhibit good potential for future forest carbon capture. These reserves dovetail well with the increasingly common goal called “30x30”; that is, conserving a minimum of 30 % of a country’s natural landscapes by 2030. A laudable goal, it will best be achieved and maintained through active participation of local citizenry.

In the context of these shifting forest management paradigms in western North America, the collection wild edible forest mushrooms remain a significant commercial enterprise and employment opportunity. Concurrently, large and growing proportions of the public enjoy hunting and eating these delicacies. Some traditions are ancient, such as the gathering of prized matsutake mushrooms by the Karuk and Hoopa Tribes in California, as well as Asian-Americans. In rural communities, many forest workers have family traditions of supplementing their diets with mushrooms found in surrounding forests and near their work sites. More recently, many urban dwellers have found solace from city life (and from constraints

like the Covid pandemic) by taking to the woods for the connection to nature that mushroom hunting always entails.

All of these stakeholders of our natural resources, here and around the world, will be critical participants in developing new local, regional and global paradigms for living in mutually beneficial relations with the natu-

ral world. The image of a beautiful, edible, mycorrhizal mushroom erupting from the forest floor can be viewed as a symbol of our interconnectedness with the forests, ecosystems, biomes, and geologic processes that support us all. Solutions to our crises will emerge and flourish as the citizenry of this planet embrace the needed change, from the ground up.