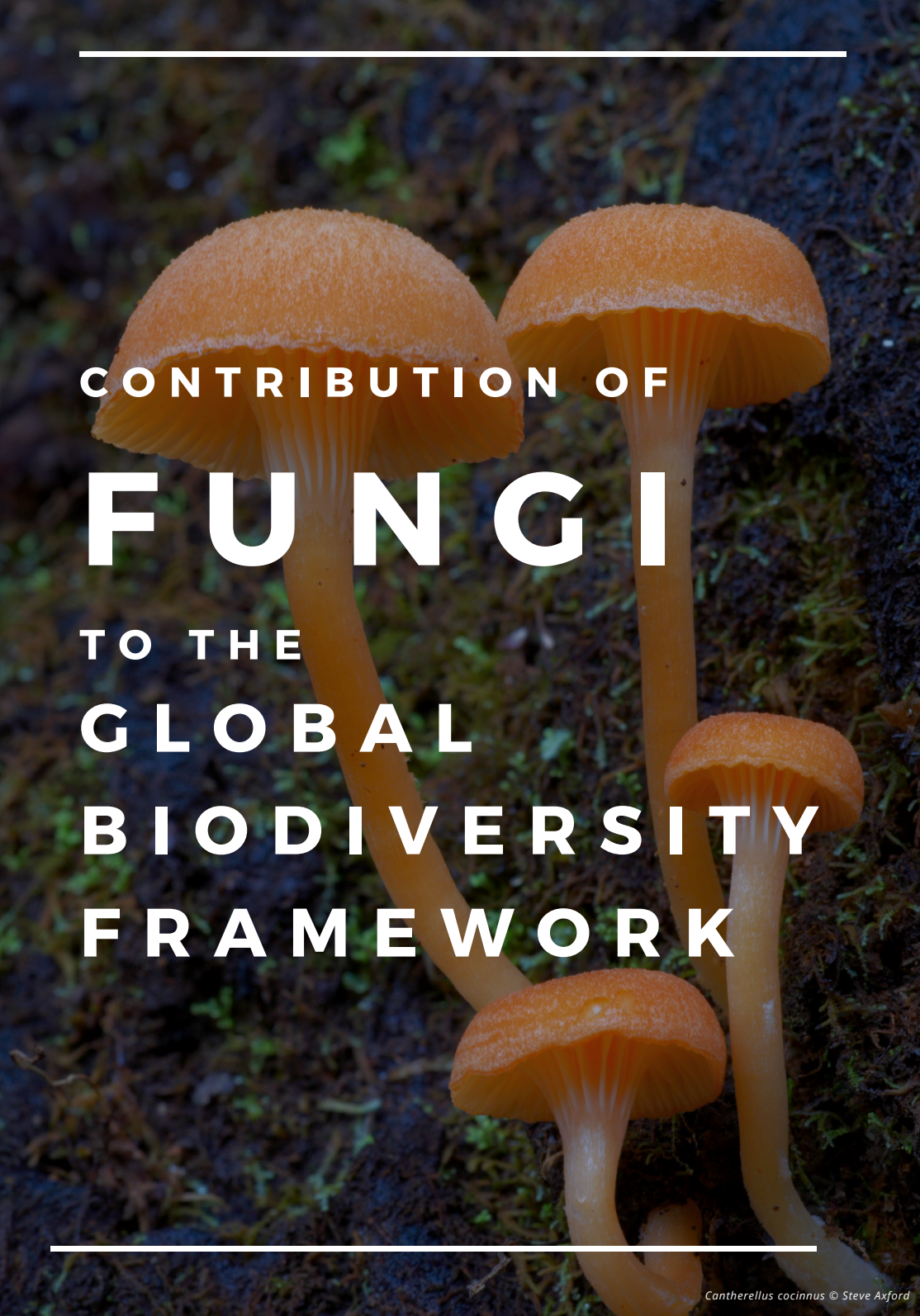
CONTRIBUTION OF FUNGI TO THE GLOBAL BIODIVERSITY FRAMEWORK



Cantherellus cocinnus © Steve Axford

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FUNGI ARE CRITICAL FOR IMPLEMENTING THE KUNMING-MONTREAL GLOBAL BIODIVERSITY FRAMEWORK (GBF)

The Kunming-Montreal Global Biodiversity Framework (GBF) [1] was adopted during the fifteenth meeting of the Conference of the Parties (COP 15), following a four-year consultation and negotiation process. A historic Framework, the GBF sets out an ambitious pathway toward achieving the global vision of a world living in harmony with nature by 2050. It includes four key goals for 2050 and 23 targets for 2030.

Integrating fungi into global conservation efforts is crucial for countries to achieve GBF goals and targets.

Incorporating fungi in conservation policies and actions is important not only for conserving fungi, a large component of biodiversity, but because of their intimate connections with other organisms and the myriad of ecosystem services they provide. Fungi play a fundamental role in sustaining life on Earth. Fungi are key decomposers and nutrient recyclers not only in terrestrial but also in aquatic habitats [2–5]. Most plants depend on fungi for survival [4], and many animals rely on them for food [6,7].

Fungi are also extremely important economically, for food security and livelihoods, production of antibiotics, vaccines and other pharmaceuticals, biofuels, and the production and decomposition of plastics [4,8,9]. Like plants and animals, fungi face significant threats, with over 40% of the assessed fungal species listed in the IUCN Red List categorized as threatened [10], yet they continue to be understudied and largely omitted from conservation initiatives.

The purpose of this brief is to demonstrate the importance of fungal species for achieving the GBF goals and targets. Fungi are important to consider/include in most of the 23 targets – they are essential for the successful implementation of targets 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 20.

Marasmius haematocephalus, © Steve Axford

GOAL A - PROTECT AND RESTORE

The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050. Human induced extinction of known threatened species is halted, and, by 2050, the extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels. The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential.

Leratiomyces sp. © Steve Axford

IMPORTANCE OF FUNGI

Fungi represent one of the most diverse kingdoms of life, on par with animals and plants, with an estimated 2.5 million species [11]. Fungi provide critical ecosystem services, especially as decomposers and mutualists driving the planet's biogeochemical cycles [4,5]. The survival of most plant species depends on fungi [4], and many animals rely on them for food and water [6,7]. Fungi are critical to the integrity and resilience of all ecosystems, and their extinction risk must be assessed, mitigated, and monitored to ensure no species is lost due to human-induced threats [12].

Panus sp. © Steve Axford

Cyptotrama asprata © Steve Axford

GOAL B - PROSPER WITH NATURE

Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050.


Volvariella volvacea Ivory Coast © Nourou Yorou

IMPORTANCE OF FUNGI

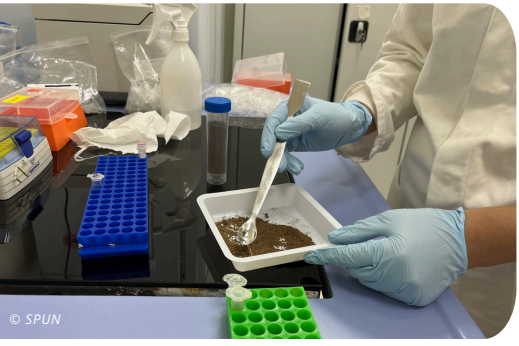
The volume of international trade in wild edible fungi was estimated at 1.23 million tons in 2017, is worth billions of dollars annually, and is important for livelihoods of diverse communities worldwide [13,14]. Additionally, fungi are important targets of bioprospecting for medicinal and industrial products [4,15]. Many soil fungi are essential to the maintenance of healthy agricultural systems and food production worldwide. Therefore, it is important to ensure the sustainable and equitable use and management of fungal species.


Pleurotus sp. © Steve Axford


Hericium erinaceus (LC) © Steve Axford

GOAL C - SHARE BENEFITS FAIRLY

The monetary and non-monetary benefits from the utilization of genetic resources and digital sequence information on genetic resources, and of traditional knowledge associated with genetic resources, as applicable, are shared fairly and equitably, including, as appropriate with indigenous peoples and local communities, and substantially increased by 2050, while ensuring traditional knowledge associated with genetic resources is appropriately protected, thereby contributing to the conservation and sustainable use of biodiversity, in accordance with internationally agreed access and benefit-sharing instruments.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IMPORTANCE OF FUNGI

Global trade in fungi as food, traditional medicine plus fungal-derived industrial and medicinal use is estimated in the trillions of dollars annually [8,16]; the value of statins alone is estimated at over 14 billion USD [17]. With a large number of indigenous peoples and local communities dependent on fungi for their livelihoods [13], it is crucial to ensure their use and benefit-sharing are fair and equitable.


Sphaerobolus sp. © *Steve Axford*


Scutellinia sp. © *Steve Axford*

GOAL D - INVEST AND COLLABORATE

Adequate means of implementation, including financial resources, capacity-building, technical and scientific cooperation, and access to and transfer of technology to fully implement the Kunming-Montreal Global Biodiversity Framework are secured and equitably accessible to all Parties, especially developing country Parties, in particular the least developed countries and small island developing States, as well as countries with economies in transition, progressively closing the biodiversity finance gap of $700 billion per year, and aligning financial flows with the Kunming-Montreal Global Biodiversity Framework and the 2050 Vision for biodiversity.

Ophiocordyceps sp. © Steve Axford

IMPORTANCE OF FUNGI

Less than 5% of an estimated 2.5 million fungal species are scientifically described, and only 0.5% of these are assessed in the IUCN Red List of Threatened Species™ [12]. Considering this huge knowledge gap and the importance of fungi to biodiversity, ecological services, and humans, a greater allocation of funding, capacity-building, technical and scientific cooperation, and access to and transfer of technology to this kingdom is essential for the successful implementation of the Kunming-Montreal Global Biodiversity Framework [18,19].

Cortinarius magellanicus (LC) © *Mateo Barrenengoa/SPUN*

Anthracophyllum archeri © Steve Axfordz

TARGET 1

Ensure that all areas are under participatory, integrated and biodiversity inclusive spatial planning and/or effective management processes addressing land- and sea-use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of indigenous peoples and local communities.

Bridgeoporus nobilissimus (CR) © *Noah Siegel*

IMPORTANCE OF FUNGI

Historically, fungi have been mostly absent from land spatial planning and management, yet they are critically important components of all habitats. The identification and protection of fungal diversity hotspots and areas with high endemism are essential to ensuring the ecological integrity of ecosystems, and need to be part of integrated and biodiversity inclusive spatial planning and management efforts.

TARGET 2

Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.

IMPORTANCE OF FUNGI

Fungi play a crucial role in terrestrial, marine, and freshwater ecosystems as decomposers and symbionts, with most plants dependent on fungal species for their survival [4,5]. Their integration into restoration efforts is important for the successful establishment and persistence of plants, and to improve biodiversity, ecosystem functions and services, ecological integrity and connectivity.

Aniptodera inflatiascigera © *Huzefa Raja*

TARGET 3

Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.

Nephroma arcticum © Jessica Allen

IMPORTANCE OF FUNGI

Considering the role of fungi in ecosystem functioning and services, their inclusion is crucial for the identification of areas of particular importance for biodiversity and ecosystems. It is important to consider that areas which may be considered relatively insignificant in regards to animal or plant species, such as the temperate boreal zones, may in fact be fungal biodiversity or ecosystem service hotspots [20]. This is relevant not only in terrestrial but also in marine and freshwater environments.

Chlorociboria sp. © *Steve Axford*

Mycoparasite on mushroom © *Steve Axford*

TARGET 4

Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimize human-wildlife conflict for coexistence.

Hypocreopsis amplectens (CR) © *Tom May*

IMPORTANCE OF FUNGI

Despite only a small percentage of total fungal species having had their extinction risk assessed in the IUCN Red List of Threatened Species™, more than 300 are considered threatened, and almost 80% of these are suffering population declines [10]. Urgent recovery actions are needed for those species at higher risk to prevent their extinction as well as the extinction of other species that depend on them and the associated loss of ecosystem functioning and services.

TARGET 5

Ensure that the use, harvesting and trade of wild species is sustainable, safe and legal, preventing overexploitation, minimizing impacts on non-target species and ecosystems, and reducing the risk of pathogen spillover, applying the ecosystem approach, while respecting and protecting customary sustainable use by indigenous peoples and local communities.

IMPORTANCE OF FUNGI

Almost every culture treasures fungi for food, traditional medicine, trade or biotechnological development [13]. Examples include matsutake, morels, truffles, caterpillar fungus, and termite-mushrooms. These and other species are harvested from the wild, and it is critical to ensure their sustainable, legal, and equitable use. Thus, sustainable harvesting and ethical trade are needed to protect both the local communities that depend on fungi and the ecological services the species provide.

Ophiocordyceps sinensis (VU); Nepal © *Shiva Devkota*

TARGET 6

Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent by 2030, and eradicating or controlling invasive alien species, especially in priority sites, such as islands.

Amanita phalloides © Machacekcz

Amanita muscaria © Taibath Chaichanoga/SPUN

Pleurotus citrinopileatus © Kirsanov

IMPORTANCE OF FUNGI

Numerous pathogenic fungal species become invasive outside their native range causing "billions" of dollars of damage annually [21,22]. Additionally, a growing number of non-pathogenic fungal species have escaped such as the deadly Death Cap fungus (*Amanita phalloides*) in North America and Australia, Fly agaric (*Amanita muscaria*) in various localities in the Southern Hemisphere, including Argentina, Australia and New Zealand, and Golden oysters (*Pleurotus citrinopileatus*) in North America [23]. These species not only displace native fungal species, but also impact the native plants and other organisms they associate with [23,24]. Thus it is crucial to identify and prevent additional fungi from becoming invasive, and eliminate, minimize, reduce and mitigate the impacts of existing invasions in both agricultural and natural systems.

Microbotryum piperi © Teodor Denchev

TARGET 7

Reduce pollution risks and the negative impact of pollution from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services, considering cumulative effects, including: (a) by reducing excess nutrients lost to the environment by at least half, including through more efficient nutrient cycling and use; (b) by reducing the overall risk from pesticides and highly hazardous chemicals by at least half, including through integrated pest management, based on science, taking into account food security and livelihoods; and (c) by preventing, reducing, and working towards eliminating plastic pollution.

Crustose lichen community © *Jessica Allen*

IMPORTANCE OF FUNGI

Fungi provide practical solutions for measuring, reducing inputs, and remediating pollution. Lichens are effective and easily deployed bioindicators to monitor pollution levels [25,26]. Mycorrhizal fungi are key to maintaining soil carbon-nitrogen ratios via their relationships with most land plants, promoting efficient acquisition of nitrogen, phosphorous and other key nutrients [4]. Consequently, fungi can be applied as a nature-based solution to reduce the use of fertilizers. Mycorrhizal relationships also increase crop resilience against pests and diseases, reducing the need for chemical pest control. Finally, many species of fungi can degrade plastic and other pollutants and are key components of organic and regenerative agriculture [4,9].

Schizophyllum commune © Steve Axford

Blyttiomyces helicus © Rabern Simmons

TARGET 8

Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solutions and/or ecosystem-based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity.

Mycorrhizal root tips: Costa Rica © *Gregory Mueller*

IMPORTANCE OF FUNGI

Mycorrhizal fungi make a significant contribution to carbon dynamics, comprising up to 50% of soil biomass. The annual amount of carbon allocated by terrestrial plants to mycorrhizal fungi is currently estimated to be the equivalent of c. 36% of current annual CO2 emission from fossil fuels [27]. Mycorrhizal fungi are also essential for the success of new reforestation and restoration projects, often related to carbon sequestration efforts, by facilitating nutrient uptake, enhancing climate change resilience, and increasing drought and salinity tolerance.

TARGET 9

Ensure that the management and use of wild species are sustainable, thereby providing social, economic and environmental benefits for people, especially those in vulnerable situations and those most dependent on biodiversity, including through sustainable biodiversity-based activities, products and services that enhance biodiversity, and protecting and encouraging customary sustainable use by indigenous peoples and local communities.

IMPORTANCE OF FUNGI

Many indigenous peoples and local communities (IPLC) rely on fungi as a source of food, medicine and income [13,28,29]. With the continuing increase in international trade of edible and medicinal species plus ongoing bioprospecting efforts, it is crucial to guarantee that IPLC continue to benefit from wild fungi. This can be achieved by working closely with local harvesters (especially women), protecting their existing sustainable harvesting practices, and recognizing and including traditional knowledge in management and decision-making through shared governance.

Termitomyces le-testui; Ivory Coast © *Koné NA*

TARGET 10

Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices, such as sustainable intensification, agroecological and other innovative approaches, contributing to the resilience and long-term efficiency and productivity of these production systems, and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.

Arbuscular mycorrhizal fungi © *His Majesty the King in Right of Canada, as represented by the Minister of Agriculture and Agri-Food, 2020-2024*

IMPORTANCE OF FUNGI

While many crop and tree diseases are caused by fungi, other fungal species are critical components of nature-based solutions that reduce agriculture, aquaculture, fisheries and forestry practices that threaten biodiversity. Mycorrhizal and other fungi enhance nutrient uptake and increase plants' resilience to pests, diseases and climate change enhancing plant growth while reducing the need for fertilizers and chemical pest control.

TARGET 11

Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, such as the regulation of air, water and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.

IMPORTANCE OF FUNGI

Fungi are key decomposers/recyclers and symbionts in nearly all terrestrial and aquatic ecosystems. Numerous fungi engage in relationships with other living organisms, influencing the survival and fitness of both fungus and host. They are key components of the soil biota. It is vital to manage existing natural areas appropriately to maintain, or in some cases enhance, their fungal community and to include fungi in restoration projects to facilitate plant establishment and persistence, and maintain ecosystem services and functions [30].

Laccaria bicolor © Gregory Mueller

TARGET 20

Strengthen capacity-building and development, access to and transfer of technology, and promote development of and access to innovation and technical and scientific cooperation, including through South-South, North-South and triangular cooperation, to meet the needs for effective implementation, particularly in developing countries, fostering joint technology development and joint scientific research programmes for the conservation and sustainable use of biodiversity and strengthening scientific research and monitoring capacities, commensurate with the ambition of the goals and targets of the Framework.

Chile © *Fungi Foundation*

Freshwater fungi sampling © *Elias Stofel*

IMPORTANCE OF FUNGI

Indigenous peoples and local communities are key sources of knowledge with respect to status and management approaches of fungi in many countries in the Global South, and are key stakeholders in the uses of wild edible fungi. Concurrently, the paucity of formal knowledge regarding fungal diversity, distribution, uses and conservation status is especially challenging in many of these same countries, since it is this knowledge which is most commonly used to address the GBF Goals and Targets. Consequently, both the erosion and loss of indigenous and local knowledge (ILK) and the lack of access to necessary technologies and research support present major threats to the conservation and sustainable use of wild fungi in the Global South. Therefore, capacity-building for joint scientific research programs, access to and transfer of various technologies, and the protection and use of indigenous and local knowledge must all be central to efforts towards knowledge documentation, creation, and transfer to meet the goals and targets of the GBF.

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