FUNGI IN AUSTRALIAN ENVIRONMENTAL LAW

A thesis submitted to fulfil the requirements of the degree of
Master of Laws (Research)

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STATEMENTS

I certify that the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes.

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No content generated by generative AI tools has been used in the preparation of this thesis.

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In my opinion, this thesis is sufficiently well presented to be examined and does not exceed the extended word limit (for which prior approval has been granted).

Associate Professor Ed Couzens

Lead Supervisor

5 May 2025

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Third, my employers — formerly Lindsay Taylor Lawyers and the NSW Department of Planning and Environment, and currently the NSW Department of Climate Change, Energy, the Environment and Water — for supporting me with study leave.

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DECLARATIONS

The author is employed as a solicitor by the NSW Department of Climate Change, Energy, the Environment and Water, and prior to that was employed by the NSW Department of Planning and Environment. The author provides legal services to the NSW Government in relation to environmental matters, including certain legislation that is analysed in this thesis.

The author is a member of Fungimap Inc and a member of its Committee of Management. Fungimap Inc is a charity that, among other things, advocates for fungus conservation. Fungimap Inc is referred to in this thesis. The author is also a member of the Sydney Fungal Studies Group Inc, which is also referred to in this thesis.

Two persons were interviewed for this thesis, and both are associated with Fungimap Inc. Dr Tom May is a past President. He is still involved in the organisation but no longer holds a formal position. Dr Sapphire McMullan-Fisher is a former Committee Member and employee. She is engaged to work for the organisation.

The opinions expressed in this thesis are the author's alone and do not reflect the opinions of any organisation with which he is or has been affiliated.

CURRENCY

The laws and other matters referred to in this thesis are current as of 26 April 2025.

ABSTRACT

Life on Earth as we know it would not exist without fungi. They mediate the nutrient cycle, control populations, and form essential life partnerships with plants and animals. Yet, we know extremely little about fungi. Aside from their scientific complexities, we have virtually no idea whether our existing environmental laws — those that govern terrestrial biodiversity conservation and protected area management — include fungi, and if so whether the manner of their inclusion has any significant consequences for their conservation or restoration.

This thesis assesses critically and comprehensively, for the first time in legal scholarship, the extent to which fungi are effectively included in Australian environmental law, and finds fungi generally neglected. While most environmental laws include fungi at least impliedly, misdescription and nondescription are universal features. Few fungi are listed for protection; they have never been the subject of environmental litigation; and they are virtually absent from protected area management planning. This neglect is despite fungi warranting specific attention because of their diverse values and unique conservation and restoration requirements. Reforms are required if there is to be any reasonable confidence in environmental law protecting Australia's fungal diversity.

The thesis explains why fungi warrant specific attention by describing what fungi are, the state of and threats to the Australian funga, and the instrumental, intrinsic, and relational values of fungi. It then carries out a doctrinal analysis of the environmental laws of the Commonwealth, Australian Capital Territory, New South Wales, Tasmania, and Victoria to ascertain whether fungi are included or excluded in those jurisdictions and the legal consequences of those inclusions and exclusions. The thesis then turns to environmental litigation and conservation practice to consider whether the inclusion of fungi under law has had any significant consequences for their conservation or restoration from a practical perspective. Finally, the thesis offers a reform agenda to include fungi more effectively by recognising and integrating them into existing laws and creating new laws for the benefit of biodiversity generally and fungi in particular. The thesis concludes by setting out directions for future research, illustrating how fungi could open a new, rich field of inquiry for scholars of environmental law.

CONTENTS

Bonnets (*Mycena* sp) at Royal Botanic Gardens Sydney, Sydney

CHAPTER ONE

INTRODUCTION

I A STATE OF NEGLECT

This thesis seeks to answer two rather simple questions. First, are fungi included in Australian environmental law? Second, to the extent they are included, does their inclusion have any significant consequences for their conservation or restoration?

In seeking to answer these questions, this thesis traverses terrain that is virtually unexplored by legal scholars. Fungi, 'a kingdom of life that has not had a kingdom's-worth of attention',[1] have not been the subject of any legal analysis in the literature relating to Australian environmental law.[2] Analyses done sit outside the legal literature and have been done by persons with expertise in disciplines other than the law.[3] While

[1] Evidence to Science, Innovation and Technology Committee, UK House of Commons, Palace of Westminster, 7 February 2024 (Merlin Sheldrake) 2 <https://committees.parliament.uk/oralevidence/14248/pdf/>.

[2] Indeed, there are few legal analyses anywhere with respect to fungi, whether in the context of environmental law or otherwise. The only work in the Australian legal literature of which this author is aware is Charles Lawson, 'Taxonomic Conceptions of Algae, Animals, Fungi and Plants in Granting Intellectual Property Privileges' (2010) 19(3) *Griffith Law Review* 472. But this work is about plant breeders' rights, not environmental law.

[3] The most significant of these analyses include conservation overviews of fungi and lichens (Tom W May, 'Fungi' in George A M Scott (ed), *A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi* (Environment Australia, 1997) 49; G Nell Stevens, 'Lichens' in George A M Scott (ed), *A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi* (Environment Australia, 1997) 15); an analysis of how fungi may be listed under Victorian biodiversity legislation (Tom May et al, 'The Victorian *Flora and Fauna Guarantee Act* and the Conservation of Lesser Known Groups of Biota' (2003) 120(6) *The Victorian Naturalist* 248); a directory of threatened species legislation as it relates to plants, but with several mentions of fungi (R O (Bob) Makinson, 'A Directory of Conservation-status Listing Processes for Threatened Australian Plant Species and Ecological Communities' (2008) 17(2) *Australasian Plant Conservation* 2); a review of fungus conservation in Australia, including under law (Alison M Pouliot and Tom W May, 'The Third "F" — Fungi in Australian Biodiversity Conservation: Actions, Issues and Initiatives' (2010) 7 *Mycologia Balcanica* 41 ('The Third "F"')); a PhD thesis and related book about Australians' relationships with fungi, including through law (Alison Pouliot, 'A Thousand Days in the Forest: An Ethnography of the Culture of Fungi' (PhD Thesis, Australian National University, 2016) <http://hdl.handle.net/1885/110356> ('A Thousand Days in the Forest'); Alison Pouliot, *The Allure of Fungi* (CSIRO Publishing, 2018)); a fungal conservation tracker that considers environmental laws with respect to fungi (Fungi Foundation, 'Australia', *Fungal Conservation Tracker* (Web Page, 2025) <https://fungalconservationtracker.ffungi.org/country?recordId=reco3czWC7g1o7Rf2>); and identifications of current listings of fungi under law ('Australasian Fungi Conservation Group', *The Australasian Mycological Society* (Web Page, 2025) <https://www.australasianmycologicalsociety.com/conservation-group>; 'How Well Are They

these analyses have often considerable merit, they vary in their usefulness and reliability. Some are questionable because they make statements that are inconsistent with other published works in the literature,[4] or because they refer to laws that were long outdated at the time of their publication.[5] Others have become less useful over time because the laws they analyse have been amended, repealed, or replaced.[6] Still others make assertions that are unsupported by evidence or that are so generalised that it is difficult to know whether they apply in any particular legal context.[7] The result is a knowledge gap: it is not satisfactorily known at any useful level of detail whether Australian environmental law includes fungi effectively. This makes it difficult to say with any reasonable confidence whether the current laws are adequate for fungi or whether there is a need for reform.

This thesis aims to close this knowledge gap. It provides, for the first time in legal scholarship, a comprehensive and critical assessment of the effective inclusion of fungi in Australian environmental law.

II THE ARGUMENT

This thesis argues that fungi are generally neglected by Australian environmental law. Fungi are typically not recognised by law, and when they are recognised, they are misdescribed as plants. Yet, most laws can be construed as including fungi impliedly. This means fungi are usually permitted to be conserved or restored under the operative provisions of environmental laws. But this manner of inclusion, while technically effective in most cases, in practical terms has resulted in few significant consequences for fungus conservation or restoration. Fungi seldom feature in the legislative lists of species and ecological communities that are threatened with extinction or otherwise in

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Conserved?', *Fungimap Inc* (Web Page, 2025) <https://fungimap.org.au/about-fungi/how-well-are-they-conserved/>).

[4] For example, 'How Well Are They Conserved?' (n 3), which gives a number of listed fungi that is different to the number given in other literature (eg, 'Australasian Fungi Conservation Group' (n 3); Tom W May et al, 'The Impacts of the 2019–20 Wildfires on Australian Fungi' in Libby Rumpff et al (eds), *Australia's Megafires: Biodiversity Impacts and Lessons from 2019–2020* (CSIRO Publishing, 2023) 127, 129).

[5] For example, the fungal conservation tracker (Fungi Foundation, 'Australia' (n 3)), despite being launched in 2024, still refers to outdated legislation such as the *Threatened Species Conservation Act 1995* (NSW) (which has been repealed for nearly a decade).

[6] For example (to some extent), Makinson (n 3).

[7] For example (to some extent), Pouliot, 'A Thousand Days in the Forest' (n 3); Pouliot and May, 'The Third "F"' (n 3).

need of protection. Fungi have never been the subject of environmental litigation. And they are virtually absent from protected area management planning under law. It is argued that this general neglect should be addressed because fungi have diverse and critically important values, as well as unique conservation and restoration requirements. Reforms to recognise and integrate fungi in existing laws, together with innovations to improve those laws, are required for the more effective inclusion of fungi. It is argued that such reforms are not just desirable, but necessary, if there is to be any reasonable confidence that environmental law might be effective in protecting Australia's fungal diversity.

III Overview of the Thesis

This thesis has six chapters.

Chapter One is this introduction. So far, it has presented the context and aims for this thesis and its argument. In the sections that follow it discusses the methodology and parameters of, and terminology used in, the thesis.

Chapter Two provides an overview of fungi. It sets the premise for why fungi are worth conserving. It describes the biology, ecology, and evolution of fungi, some of their complexities, as well as their unique conservation and restoration requirements; the uniqueness of and threats to the Australian funga; and the diverse instrumental, intrinsic, and relational values of fungi.

Chapter Three analyses the inclusion of fungi in Australian environmental legislation. The chapter argues that the inclusion of fungi can be understood as being on a spectrum of neglect: on one end, there are statutes that expressly recognise fungi and include them in their operative provisions; on the other end, there are statutes that generally exclude fungi. Misdescription and nondescription of fungi are universal features of Australian environmental legislation, although most statutes include fungi at least impliedly. Implied inclusion is generally effective, and it means that fungi are usually permitted to be conserved or restored under law; but the significance of this inclusion in reality is limited by the fact that very few fungi are listed under law for protection.

Chapter Four considers by way of case studies whether the inclusion of fungi in Australian environmental legislation has been effective in terms of the practical

consequences for fungus conservation or restoration. It argues that the effectiveness to date has been limited. In environmental litigation, there have been no cases in which the protection of fungi has been a real issue in the proceedings. Fungi are virtually absent from protected area management planning, whether public or private. Only where fungi are expressly included in legislation and there is an express legal obligation to conserve them does the inclusion appear to be effective, as this results in the demonstrable allocation of management resources to fungus conservation and restoration. The chapter shows that relying on implications in law is an unreliable way to ensure the effective inclusion of fungi.

Chapter Five considers what would be required to include fungi more effectively in Australian environmental law. It argues that three types of reforms are required: expressly and correctly recognising fungi; integrating fungi into the operative and other provisions; and innovating laws for the benefit of biodiversity generally and fungi in particular.

Chapter Six concludes the thesis with a summary of the argument and findings and directions for future research, showing how fungi could open a new, rich field of inquiry for scholars of environmental law.

IV METHODOLOGY

This thesis uses a combination of four research methodologies.

The first and foremost methodology is doctrinal research.[8] Doctrinal research underpins Chapter Three, which applies the contemporary principles of statutory interpretation to ascertain whether fungi are included in environmental legislation.[9] The following considerations underpin the analysis:

1. Whether fungi are included or excluded by the statute.
2. Whether the inclusion or exclusion is express or implied.[10]

[8] This being the two-part process of finding the law, then interpreting and analysing its text: Terry C M Hutchinson, *Researching and Writing in Law* (Lawbook Co, 4th ed, 2018) 51.

[9] The contemporary principles require meaning to be assigned to a statutory provision having regard to its text, context, and purpose: see, eg, *SZTAL v Minister for Immigration and Border Protection* (2017) 262 CLR 362, 368 [14] (Kiefel CJ, Nettle and Gordon JJ) (citations omitted). Legislation has also been passed in each jurisdiction governing how statutes are to be interpreted.

[10] In this thesis, an express reference is the use of any fungus-related term, including the following in particular: 'fung!' (ie, 'fungus' and its cognates), 'lichen', 'mould', 'mushroom', 'mycelium',

3. If fungi are included, whether the statute requires or merely permits fungus conservation or restoration, expressly or impliedly.

The other three methodologies are used to a lesser extent. The first of these is comparative research. This is used incidentally in the discussion in Chapter Three, primarily, to comment on the variability of the inclusion of fungi in environmental legislation across the Australian jurisdictions. The second is empirical research. This is used primarily in Chapter Four to consider the practical consequences of the current inclusion of fungi under law. The empirical research is both quantitative and qualitative, comprising desktop reviews of documents as well as interviews with Australian conservation mycologists. The final methodology is policy research. This is used in Chapter Five to the extent it underpins the reform recommendations and the analysis of the barriers that might need to be overcome to give effect to those recommendations.

V PARAMETERS

It is not possible in one thesis to discuss the full breadth of Australian environmental law in relation to fungi. Some parameters are required.

'mycorrhiza', 'mycota', 'saprophyte', 'toadstool', or 'truffle'. This particular set of terms was chosen to be consistent with existing literature about the inclusion of fungi in documents (see especially Pouliot, 'A Thousand Days in the Forest' (n 3) app 6).

An implied reference is the use of a term that is agnostic as to taxa (being organisms of particular taxonomic ranks or classifications, such as 'animals' or 'plants'). For example, terms such as 'ecosystem', 'environment', 'landscape', 'nature', and 'species' each ordinarily include fungi by implication: *Macquarie Dictionary* (online at 26 April 2025) 'ecosystem' (def 1); *Macquarie Dictionary* (online at 26 April 2025) 'environment' (def 8); *Macquarie Dictionary* (online at 26 April 2025) 'landscape' (def 5); *Macquarie Dictionary* (online at 26 April 2025) 'nature' (def 5); *Macquarie Dictionary* (online at 26 April 2025) 'species' (def 1).

It should be noted that the *Macquarie Dictionary* — which was just cited in support of the proposition that fungi are impliedly included within the ordinary meanings (and thus, as a first indication, the legal meanings) of general biodiversity-related terms — uses scientifically outdated language in its definitions of some important terms used in environmental law. In particular, it defines 'biodiversity' as 'the variety of species of plants, animals and microorganisms, their genes, and the ecosystems they comprise' (*Macquarie Dictionary* (online at 26 April 2025) 'biodiversity') and 'habitat' as 'the native environment or kind of place where a given animal or plant naturally lives or grows' (*Macquarie Dictionary* (online at 26 April 2025) 'habitat' (def 1)). While the fungal blindness of these definitions is unfortunate, it is ultimately of little consequence for the purposes of this thesis because fungi can still be read into the definitions: fungi are members of the 'ecosystems' that plants, animals, and (other) micro-organisms comprise, in the case of 'biodiversity'; and they are parts of the 'environments' where plants and animals live or grow, in the case of 'habitats'. Thus, fungi are still impliedly included within the ordinary meanings of these terms.

With respect to 'fungi', this thesis only considers organisms that are currently classified as fungi. It does not consider fungus-like organisms such as slime moulds, water moulds, or any other taxa that might have once been considered as fungi but are no longer, except where environmental law misdescribes these organisms as fungi.

With respect to 'Australian environmental law', in this thesis:

1. 'Australian' environmental law refers to the laws of the Commonwealth, the Australian Capital Territory ('ACT'), New South Wales ('NSW'), Tasmania, and Victoria. This thesis does not consider the laws of the other states or territories.[11] It does not consider local or international environmental laws.
2. 'Environmental' law refers to laws that are directly concerned with terrestrial biodiversity conservation and restoration and the management of terrestrial protected areas.[12] Other areas of law that may be significant for fungi — including climate change, development, natural resources, and planning — are not considered. Laws applying specifically to the aquatic environment are also not considered.
3. 'Law' refers to legislation, both primary and secondary, as well as the relevant dependent common law.[13] The independent common law is not considered.[14]

This thesis also considers instruments made under or in relation to those laws, such as conservation strategies for threatened species and protected area management plans.

VI TERMINOLOGY

This thesis uses a variety of terms to refer to fungi. It is useful to distinguish these terms before continuing to Chapter Two:

1. 'Fungus' is the singular noun for the organism, equivalent to 'plant' or 'animal'.
2. 'Fungi' is the plural of fungus, equivalent to 'plants' or 'animals'.[15]

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[11] Two limited exceptions are the count of listed threatened fungi across Australia in Chapter Three and the discussion of literature with respect to protected area management plans in Chapter Four.

[12] The discussion of protected areas in this thesis only relates to publicly and privately managed protected areas, which are referred to as 'public reserves' and 'private protected areas' respectively. Indigenous Protected Areas and shared management reserves are not considered.

[13] 'Dependent' in the sense of being about, or premised on, statutory law: Brian J Preston, 'The Many Facets of a Cutting-edge Court: A Study of the Land and Environment Court of New South Wales' in Elizabeth C Fisher and Brian J Preston (eds), *An Environmental Court in Action: Function, Doctrine and Process* (Hart Publishing, 2022) 1, 17.

[14] With respect to environmental matters, there is very little of it anyway: see Rosemary Lyster et al, *Environmental and Planning Law in New South Wales* (Federation Press, 5th ed, 2021) 1–16.

[15] In some writing, 'funguses' or even 'fungus' is used as the plural of 'fungus'. 'Fungi' is the most accepted plural: *Fowler's Dictionary of Modern English Usage* (online at 26 April 2025) 'fungus'.

3. ‘Funga’ refers to the fungi of a particular region or period, equivalent to ‘flora’ or ‘fauna’.[16] It can be either a singular or plural noun depending on its context.
4. ‘Fungal’ is the adjective used to describe something that is of or caused by, or that relates to, fungi.[17]

[16] Equivalent terms such as ‘mycota’ and ‘mycoflora’ appear in older writing, but ‘funga’ is now the preferred term: Francisco Kuhar et al, ‘Delimitation of Funga as a Valid Term for the Diversity of Fungal Communities: The Fauna, Flora & Funga Proposal (FF&F)’ (2018) 9(2) *IMA Fungus* 71.

[17] The alternative adjective, ‘fungous’ (see *Macquarie Dictionary* (online at 26 April 2025) ‘fungous’ (def 1)), is rare and not used by this author. ‘Fungoid’ has a differently meaning entirely: see *Macquarie Dictionary* (online at 26 April 2025) ‘fungoid’ (def 1).

Club fungus (*Clavaria* sp) at Blackbutt Creek Track, Gordon

CHAPTER TWO

A LAWYER'S INTERPRETATION OF FUNGI

I INTRODUCTION

This chapter provides a lawyer's interpretation of fungi. Its purpose is to set the premise that fungi are worth conserving.

It is argued in this chapter that fungi generally, and the funga of Australia in particular, are unique organisms that play critical roles in creating and maintaining ecosystems and that have unique conservation and restoration requirements. It is also argued that fungi have diverse values — instrumental, intrinsic, and relational — which make them essential to human (and more-than-human) flourishing. It is concluded that, despite their hidden nature, fungi warrant specific attention in environmental law.

This chapter has three substantive parts. The first asks, what is a fungus? It examines the Kingdom *Fungi* from the perspective of mycology — the scientific study of fungi — through the lenses of biology, evolution, and ecology. It identifies some of the complexities of fungi and their unique conservation and restoration requirements. The second part looks at the state of the Australian funga and threats to it. The third part is a synopsis of the values of fungi. It adapts a typology proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services ('IPBES') for the values of nature to identify some of the ways fungi are valued from different perspectives. It then proceeds to give an overview of some of the specific instrumental, intrinsic, and relational values of fungi, illustrating why fungi warrant specific conservation attention.

II WHAT IS A FUNGUS?

A *Fungal Biology*

A fungus, defined simply, is an organism that has hyphae and reproduces by spores.[18] Most fungi live their lives by stretching, branching, and fusing their hyphae — fine,

[18] This 'simple' definition appears in May et al, 'The Impacts of the 2019–20 Wildfires on Australian Fungi' (n 4) 128, with the qualification that it does not account for single-celled yeasts. For a more sophisticated definition, see, eg, Royal Botanic Gardens Kew, 'State of the World's Fungi 2018'

tubular structures — into a network known as a mycelium.[19] Fungi reproduce by 'felting together' their hyphal tips, rapidly inflating them with water and creating sporing bodies such as mushrooms.[20]

Fungi are neither plants nor animals. They constitute their own kingdom of life. Unlike plants, fungi rely on external sources of carbon for food. They cannot create their own food through photosynthesis. Unlike animals, fungi do not digest their food internally and excrete the waste. Rather, they secrete enzymes and digest their food externally as they find it in their environment. Other unique characteristics of fungi are their cell walls, which are made of chitin (the same substance that makes up the exoskeletons of insects and crustaceans); their storage of food reserves as glycogen and lipids; and their DNA.[21] Fungi are unlike plants and animals in that they have indeterminate growth, meaning their growth is shaped to, and only limited by, their environmental conditions.[22] Furthermore, while most plants and animals are macroscopic, fungi are well represented across both macro- and microscopic scales of life. Most fungi are microfungi,[23] meaning their sporing bodies (if they produce any) can only be seen through a microscope. The remaining fungi are macroscopic, meaning their sporing bodies are visible to the unaided human eye. Some fungi are truly gargantuan; the largest fungus known to science is at least 2,500 years old and weighs 4×10^5 kg.[24]

All life on land depends on fungi and their continued ability to form healthy relationships with other organisms.[25] Fungi live almost everywhere, making habitats out of animals, plants, soils, and other fungi; in or on rocks, caves, deserts, and mines;

(Research Report, 2018) 6 <https://kew.iro.bl.uk/downloads/b4f234b7-49b4-4e4e-be6f-cb7d5e45123e?locale=en>. Cf *Macquarie Dictionary* (online at 26 April 2025) 'fungus' (def 1).

[19] Merlin Sheldrake, *Entangled Life: How Fungi Make Our Worlds, Change Our Minds and Shape Our Futures* (Vintage, 2021) 6–7 ('*Entangled Life*').

[20] Ibid 7, 60.

[21] Royal Botanic Gardens Kew (n 18) 6.

[22] Ibid.

[23] May, 'Fungi' (n 3) 49.

[24] James B Anderson et al, 'Clonal Evolution and Genome Stability in a 2500-year-old Fungal Individual' (2018) 285(1893) *Proceedings of the Royal Society B* 20182233:1–6.

[25] Tuula Niskanen et al, 'Pushing the Frontiers of Biodiversity Research: Unveiling the Global Diversity, Distribution, and Conservation of Fungi' (2023) 48(1) *Annual Review of Environment and Resources* 149, 150.

in polar and glacier systems; and in freshwater and marine ecosystems.[26] However, the diversity of fungi is not distributed uniformly across these habitats. For example, species richness (the diversity of species in an area) increases from the poles to the tropics and tracks the diversity of fungal symbionts, whereas species abundance (the number of individuals of the same species in an area) varies with the amount of nitrogen in the environment.[27]

B *Fungal Evolution*

Fungus-like organisms appear in the fossil record as early as 2,400 million years ago. However, it is more generally accepted that fungi evolved between 1,481 and 900 million years ago.[28] Fungi and animals share a common ancestor; they are more closely related to each other than they are to plants.[29] It is thought that fungi colonised land approximately 720 million years ago and, through symbiotic relationships, facilitated the colonisation of land by plants at least 400 million years ago.[30]

The fungal tree of life has many branches. Currently, the Kingdom *Fungi* is understood to have nine subkingdoms and comprise some 19 phyla.[31] The most well-known fungi belong to two phyla: *Ascomycota* and *Basidiomycota*. *Ascomycota* include endophytes, lichens, moulds, parasitic microfungi, and yeasts. *Basidiomycota* include all mushroom-forming fungi, as well as brackets, jelly fungi, rusts, and smuts. *Ascomycota* and *Basidiomycota* are the most well-known because they include the most iconic mushroom-forming fungi, the first fungi to be domesticated by humans, and fungi with some of the greatest impacts on humanity (eg, agricultural pests).[32] Fungi

[26] See Lotus A Lofgren and Jason E Stajich, 'Fungal Biodiversity and Conservation Mycology in Light of New Technology, Big Data, and Changing Attitudes' (2021) 31(19) *Current Biology* R1312, R1312–R1313.

[27] Ibid R1313–R1314 (citations omitted).

[28] Mary L Berbee, Timothy Y James, and Christine Strullu-Derrien, 'Early Diverging Fungi: Diversity and Impact at the Dawn of Terrestrial Life' (2017) 71(1) *Annual Review of Microbiology* 41.

[29] Patricia O Wainright et al, 'Monophyletic Origins of the Metazoa: An Evolutionary Link with Fungi' (1993) 260(5106) *Science* 340.

[30] François Lutzoni et al, 'Contemporaneous Radiations of Fungi and Plants Linked to Symbiosis' (2018) 9 *Nature Communications* 5451:1–11.

[31] Nalin N Wijayawardene et al, 'Classes and Phyla of the Kingdom *Fungi*' (2024) 128(1) *Fungal Diversity* 1. Cf K D Hyde et al, 'The 2024 Outline of *Fungi* and Fungus-like Taxa' (2024) 15(1) *Mycosphere* 5149.

[32] Royal Botanic Gardens Kew (n 18) 16.

were traditionally classified as plants,[33] but for more than 50 years have been recognised by taxonomists as constituting their own kingdom of life.[34] Biological nomenclature, the system of naming organisms, has officially distinguished fungi from plants since 2011.[35]

Fungi are estimated to comprise approximately 20% of all eukaryotic species.[36] The vast majority of fungi are unknown to science: fewer than 10% of the estimated 2.5 million species are described, compared to 80–85% of plant species and less than 20% of animal species.[37] Lichens account for 13% of known fungi but only 1–2% of estimated diversity.[38] Even if the rate of description increased by an order of magnitude (from 2,000 to 20,000 species per year), it would take 100 years to describe the remaining species in the Kingdom *Fungi*.[39]

C *Fungal Ecology*

Fungi are perhaps best understood by their ecology. In that regard, they have three distinctive features. The first is their numerous relationships with other organisms. The second is their ability to decompose matter. The third is their ability to lichenise.

1 *Relationships With Plants and Animals*

One of the most important ecological relationships between organisms is symbiosis. A relationship is symbiotic if one organism relies on another to complete its life cycle. Symbiosis can be understood as a continuum from mutualistic (mutually beneficial) through commensal (beneficial to one but neither beneficial nor harmful to the other) to parasitic (beneficial to one but harmful to the other). The location of any given

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[33] Li-Wei Zhou and Tom W May, 'Fungal Taxonomy: Current Status and Research Agendas for the Interdisciplinary and Globalisation Era' (2023) 14(1) *Mycology* 52, 52, discussing Carl Linnaeus, *Species Plantarum* (Impensis Laurentii Salvii, 1753).

[34] See especially Robert H Whittaker, 'New Concepts of Kingdoms or Organisms – Evolutionary Relations Are Better Represented by New Classifications Than by the Traditional Two Kingdoms' (1969) 163(3863) *Science* 150.

[35] This was when the *International Code of Botanical Nomenclature* changed to the *International Code of Nomenclature for Algae, Fungi, and Plants*, with 'rules solely applying to fungi governed by mycologists': Zhou and May (n 33) 52. The former editions of that code had traditionally included fungi and algae as 'plants': Nicholas Turland, *The Code Decoded: A User's Guide to the International Code of Nomenclature for Algae, Fungi, and Plants* (Pensoft Publishers, 2nd ed, 2019) 127.

[36] Niskanen et al (n 25) 150.

[37] Ibid 151–152. Science has described more species of animals than species of plants or fungi, but the extremely high diversity of invertebrates means that, as a proportion of the estimated diversity of the animal kingdom, the number of animal species described remains low.

[38] Ibid 156.

[39] Ibid.

relationship on the symbiosis continuum can change as environmental conditions change.

The symbioses between fungi and plants and fungi and animals exemplify the critical importance of fungi in ecosystems. Some of these symbioses, among other interspecies relationships, are considered in this section.

(a) Fungi and Plants

The two most important symbioses between plants and fungi are formed by two types of fungi: mycorrhizal fungi and endophytic fungi.

(i) Mycorrhizal Fungi

A mycorrhizal fungus is a fungus that forms a symbiotic relationship with the root system of a plant.[40] Ninety-two percent of plants form mycorrhizal relationships;[41] they are the most abundant of all symbioses in terrestrial ecosystems.[42]

The mycorrhizal relationship, or 'mycorrhiza', is an exchange: fungi give plants mineral nutrients such as phosphorus and nitrogen in return for carbon produced by the plants via photosynthesis.[43] The carbon drawdown effect of mycorrhizal fungi is significant, estimated on the global scale to be 36% of current annual CO_2 emissions from fossil fuels.[44] In addition to facilitating energy and nutrient exchanges, mycorrhizal relationships protect plants from threats such as herbivory and water stress.[45] Mycorrhizal fungi also help to balance plant populations and community

[40] There are several different types of mycorrhizal fungi, each differing in morphology, physiology, and evolution: see, eg, Andrea Genre et al, 'Unique and Common Traits in Mycorrhizal Symbioses' (2020) 18(11) *Nature Reviews Microbiology* 649; Mark C Brundrett, 'Distribution and Evolution of Mycorrhizal Types and Other Specialised Roots in Australia' in Leho Tedersoo (ed), *Biogeography of Mycorrhizal Symbiosis* (Springer, 2017) 361.

[41] Mark C Brundrett and Leho Tedersoo, 'Evolutionary History of Mycorrhizal Symbioses and Global Host Plant Diversity' (2018) 220(4) *New Phytologist* 1108.

[42] Eun-Hwa Lee et al, 'Diversity of Arbuscular Mycorrhizal Fungi and Their Roles in Ecosystems' (2013) 41(3) *Mycobiology* 121, 123.

[43] Genre et al (n 40) 649, citing S E Smith and D Read, *Mycorrhizal Symbiosis* (Academic Press, 3rd ed, 2008).

[44] Heidi-Jayne Hawkins et al, 'Mycorrhizal Mycelium as a Global Carbon Pool' (2023) 33(11) *Current Biology* R560.

[45] Adam Frew et al, 'Plant Herbivore Protection by Arbuscular Mycorrhizas: A Role for Fungal Diversity?' (2022) 233(3) *New Phytologist* 1022; Anne Kakouridis et al, 'Routes to Roots: Direct Evidence of Water Transport by Arbuscular Mycorrhizal Fungi to Host Plants' (2022) 236(1) *New Phytologist* 210.

ecologies by influencing plant coexistence, dispersal, and establishment.[46] Indeed, many plants cannot survive without their mycorrhizal partners.[47]

Research in the Northern Hemisphere has shown that mycorrhizas can connect diverse fungi and plants into a common mycorrhizal network, sometimes known as a 'Wood Wide Web'.[48] Plants connected by mycorrhizal networks can share resources and communicate using chemical signals, improving the resilience of the fungus–plant community.[49] These networks may also promote community continuity by facilitating preferential chemical signalling and nutrient transfers between 'mother trees' and plants of the same kin, species, or type.[50]

(ii) Endophytic Fungi

An endophytic fungus is a fungus that partners with a plant and lives inside its tissues in the leaves, roots, or stems.[51] These fungi are rich, with different species tending to live cooperatively,[52] and abundant, with as many as 100 million individuals of a single

[46] See Leho Tedersoo, Mohammad Bahram, and Martin Zobel, 'How Mycorrhizal Associations Drive Plant Population and Community Biology' (2020) 367(6480) *Science* eaba1223:1–9.

[47] The best examples of this are mycoheterotrophs (plant parasites of fungi) such as orchids, whose seeds rely on the supply of carbohydrates from mycorrhizal fungi to germinate: Hawkins et al (n 44) R563, citing Mark C Brundrett, 'Coevolution of Roots and Mycorrhizas of Land Plants' (2002) 154(2) *New Phytologist* 275.

[48] Suzanne W Simard et al, 'Net Transfer of Carbon Between Ectomycorrhizal Tree Species in the Field' (1997) 388(6642) *Nature* 579. Scientists assume that common mycorrhizal networks exist in Australia, but that assumption is yet to be fully tested: Sapphire McMullan-Fisher, 'Management Ideas to Help Fungi Keep Working in Ecosystems' (Conference Paper, Moorabool Mushroom Festival, 15 April 2023); Camille Truong, 'The Wood-wide Web – A Story Too Good for Its Own Good?' (Webinar, Fungimap Inc, 14 September 2023).

[49] Simard et al (n 48); Zdenka Babikova et al, 'Underground Signals Carried Through Common Mycelial Networks Warn Neighbouring Plants of Aphid Attack' (2013) 16(7) *Ecology Letters* 835. But see Justine Karst, Melanie D Jones, and Jason D Hoeksema, 'Positive Citation Bias and Overinterpreted Results Lead to Misinformation on Common Mycorrhizal Networks in Forests' (2023) 7(4) *Nature Ecology & Evolution* 501.

[50] Tedersoo, Bahram, and Zobel (n 46); Suzanne Simard, *Finding the Mother Tree: Uncovering the Wisdom and Intelligence of the Forest* (Allen Lane, 2021). But see Nils Henriksson et al, 'Re-examining the Evidence for the Mother Tree Hypothesis – Resource Sharing Among Trees via Ectomycorrhizal Networks' (2023) 239(1) *New Phytologist* 19; David G Robinson et al, 'Mother Trees, Altruistic Fungi, and the Perils of Plant Personification' (2024) 29(1) *Trends in Plant Science* 20.

[51] There are many different types of endophytic fungi: see R J Rodriguez et al, 'Fungal Endophytes: Diversity and Functional Roles' (2009) 182(2) *New Phytologist* 314.

[52] Marissa R Lee et al, 'Good Neighbors Aplenty: Fungal Endophytes Rarely Exhibit Competitive Exclusion Patterns Across a Span of Woody Habitats' (2019) 100(9) *Ecology* e02790:1–15.

species inhabiting a single plant.[53] Most, if not all, plants growing in natural ecosystems have endophytic fungal symbionts.[54]

Like mycorrhizas, endophytic relationships are critical to the survival and flourishing of both the fungi and the plants. For the plants, endophytic fungi can improve biomass, nutrient absorption, stress tolerance, and resistance to herbivory and disease. For the fungi, plants provide essential nutrients and improve tolerance to stresses (eg, temperature and salinity).[55] Thus, when a coastal dunegrass and its endophytic fungal symbionts are forced to live separately in their saline native habitat, the dunegrass dies and the fungi are stunted in their growth; but when the organisms are allowed to live symbiotically, they can tolerate the salinity.[56]

(b) Fungi and Animals

Fungi are intimately involved in the lives of animals: they live in and on them, hunt them in the soil, are eaten by them, reproduce from the substrate of their excrement, and aid in the decomposition of their bodies when they die.[57]

The full scope of animal–fungus relationships is extremely wide.[58] For example, many animals (not just humans) use fungi as food and medicine. In Australia, at least 66 mammal species are known to consume truffles and spread their spores; several of these mammals are known to be specialist fungivores.[59] Bees are thought to self-medicate with fungi,[60] and this is currently being investigated as a means to ameliorate colony collapse disorder.[61] Like plants, animals host fungi as part of a diverse microbiome — or in this context, a 'mycobiome'. For example, in humans, whose

[53] See, eg, Timothy L McCutcheon and George C Carroll, 'Genotypic Diversity in Populations of a Fungal Endophyte from Douglas Fir' (1993) 85(2) *Mycologia* 180.
[54] Rodriguez et al (n 51) 314 (citation omitted).
[55] See generally Rodriguez et al (n 51).
[56] Ibid 320.
[57] May, 'Fungi' (n 3) 50.
[58] For detailed accounts of some of these relationships in the Australian context, see Anthony E Orchard (ed), *Fungi of Australia Volume 1B, Introduction—Fungi in the Environment* (Australian Biological Resources Study, 1996).
[59] T F Elliott et al, 'Mammalian Mycophagy: A Global Review of Ecosystem Interactions Between Mammals and Fungi' (2022) 9(1) *Fungal Systematics and Evolution* 99; Conor Nest et al, 'Seasonal Consumption of Mycorrhizal Fungi by a Marsupial-dominated Mammal Community' (2023) 64 *Fungal Ecology* 101247:1–10.
[60] Cristiano Menezes et al, 'A Brazilian Social Bee Must Cultivate Fungus to Survive' (2015) 25(21) *Current Biology* 2851.
[61] Peter McCoy, *Radical Mycology: A Treatise on Seeing and Working With Fungi* (Chthaeus Press, 2016) 57–58.

mycobiome is perhaps the most studied, fungi are found on the skin and in the guts, oral cavity, genitourinary tract, and respiratory tract. These fungi are essential to maintaining homeostasis — ie, ensuring our bodies maintain a steady internal state.[62]

(c) Parasites

Fungi are infamous parasites. They come in two forms (and can switch between them): biotrophs, which are consumers of living matter; and necrotrophs, which are consumers of dead matter. Most parasitic fungi are also pathogenic, causing disease in their hosts.[63]

Parasitic fungi are known for wreaking ecological havoc. In Australia, the spread of chytridiomycosis has caused seven amphibian species to become extinct and threatens at least 36 more.[64] Myrtle rust (*Austropuccinia psidii*) affects a wide range of genera such as *Corymbia*, *Eucalyptus*, *Leptospermum*, and *Melaleuca*, and has caused at least two myrtle species to become critically endangered.[65] However, one of the most threatening invasive pathogens in Australia commonly referred to as a fungus,[66] phytophthora (*Phytophthora cinnamomi*), is not actually so classified; rather, it is an oomycete or 'pseudofungus' in the Kingdom *Chromista*.[67]

Despite their infamy, parasitic fungi play important ecological roles in ecosystems that have not been compromised by human activity. For example, recent research has found that plant pathogens (including fungi) play positive and significant roles in the functioning, productivity, and stability of unmanaged and partly managed plant populations and communities.[68] Similarly, fungal parasites of insects, known as entomopathogenic fungi, not only balance insect populations but can also play a number of 'unexpected' roles, including protecting plants against disease and promoting plant growth.[69]

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[62] Paulina Belvoncikova et al, 'The Human Mycobiome: Colonization, Composition and the Role in Health and Disease' (2022) 8(10) *Journal of Fungi* 1046:1–26.
[63] May, 'Fungi' (n 3) 49.
[64] Ian Cresswell, Terri Janke, and Emma L Johnston, 'Australia State of the Environment 2021: Overview' (Report, 2021) 118 <https://soe.dcceew.gov.au/sites/default/files/2022-07/soe2021-overview.pdf>.
[65] Ibid.
[66] Including in environmental legislation: see Chapter Three.
[67] See Adrienne R Hardham and Leila M Blackman, '*Phytophthora cinnamomi*' (2018) 19(2) *Molecular Plant Pathology* 260.
[68] David S Ingram, 'A Case for Conserving Plant Pathogens' (2022) 71(1) *Plant Pathology* 98.
[69] Fernando E Vega et al, 'Fungal Entomopathogens: New Insights on Their Ecology' (2009) 2(4) *Fungal Ecology* 149.

2 *Decomposition*

Fungi are essential partners in both life and death. Fungi mediate the nutrient cycle and are particularly crucial for decomposing the most recalcitrant of terrestrial organic matter.[70] Critically, fungi are the only organisms that can break down the lignin in wood. Without fungi, woody plants could not decompose. This would effectively stop the nutrient cycle, severely limiting the capacity of life to flourish anywhere on Earth.[71]

Decomposition relies on a succession of organisms. For example, in the case of a dying tree, the succession of fungi starts with pathogenic basidiomycetes existing in the living plant. These are succeeded by saprotrophic basidiomycetes, whose spores land on exposed decaying wood. Once the tree has fallen to the forest floor, it is further decomposed by ascomycetes and other fungi in the leaf litter. Rhizosphere fungi — which live near, but do not connect to, plant roots — decompose the remaining matter and release the nutrients back into the soil.[72] The fungi involved in these ecological successions are highly diverse and can include many rare taxa.[73]

Fungi also break down inorganic matter. Geomycology has revealed the critical roles played by fungi that live in and on rocks. These roles include weathering rocks, forming soils, transforming and accumulating metals, and cycling nutrients through the environment.[74]

3 *Lichenisation*

As was noted earlier, approximately 13% of known fungi lichenise.[75] A lichen is a mutualistic symbiosis between a fungus (the 'mycobiont') and one or more green algae or photosynthesising cyanobacteria (the 'photobiont').[76] There are three main 'growth

[70] Annemieke van der Wal et al, 'A Thready Affair: Linking Fungal Diversity and Community Dynamics to Terrestrial Decomposition Processes' (2013) 37(4) *FEMS Microbiology Reviews* 477.
[71] Royal Botanic Gardens Kew (n 18) 6.
[72] This succession was described in Keith Seifert, *The Hidden Kingdom of Fungi: Exploring the Microscopic World Around Us* (University of Queensland Press, 2022) 82.
[73] Ian A Dickie, Angela Wakelin, and Sarah J Richardson, 'Rare Species of Wood-inhabiting Fungi Are Not Local' (2020) 30(7) *Ecological Applications* e02156:1–10.
[74] Anna Rosling, Roger D Finlay, and Geoffrey M Gadd, 'Geomycology' (2009) 23(4) *Fungal Biology Reviews* 91.
[75] Niskanen et al (n 25) 156.
[76] Johan Asplund and David A Wardle, 'How Lichens Impact on Terrestrial Community and Ecosystem Properties' (2017) 92(3) *Biological Reviews* 1720, 1721. There are many other symbionts besides, including bacteria ('bacteriobionts'), yeasts, and other fungi: Robert Lücking and Toby Spribille, *The Lives of Lichens: A Natural History* (Princeton University Press, 2024) 40–59.

types' of lichens: crustose lichens, which tightly adhere to their substrate; foliose lichens, which loosely adhere to their substrate; and fruticose lichens, which 'stand out' from the surface of their substrate.[77] Although lichens are now both classified and named as fungi, they have historically been understood variously as mosses, algae, and as a transitional group between fungi and algae.[78] The scientific study of lichens, lichenology, remains a distinct field from mycology.[79]

Lichens occur in most terrestrial ecosystems — indeed, they dominate approximately 8% of Earth's land surface.[80] Lichens perform diverse ecological functions depending on their functional traits, growth form, pigmentation, secondary compounds, types of photobiont, and water holding capacity.[81] They are best known for performing two ecological functions: mining minerals from rock through weathering; and creating soils when they die.[82] Lichens are also well known for surviving in extreme conditions.[83] For example, some lichens form biological soil crusts, or 'biocrusts', where they reduce erosion, fertilise soils, influence water cycling, and affect plant germination and growth.[84] They are comparable in ecological importance to old-growth trees.[85] Other ecological roles lichens play include litter decomposition, providing habitat for micro-organisms and invertebrates, providing food to animals, intercepting rainfall and nutrients, accumulating nutrients, and regulating plant growth.[86]

D *Fungal Complexities*

Understanding fungi comes with numerous complexities. While some of these are of mostly scientific interest, five are immediately relevant for the present purposes.

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[77] Asplund and Wardle (n 76) 1722. For a more complete overview of the various growth types, see Lücking and Spribille (n 76) 114–115.

[78] Toby Spribille et al, 'Evolutionary Biology of Lichen Symbioses' (2022) 234(5) *New Phytologist* 1566, 1566–1567.

[79] In Australia, one conspicuous manifestation of this distinction is in the Australian National Species List, which lists Australian lichens separately from other Australian fungi: Council of Heads of Australasian Herbaria, 'The Australian National Species List', *The Australian National Species List* (Web Page, 2025) <https://biodiversity.org.au/nsl/>.

[80] Asplund and Wardle (n 76) 1721 (citation omitted).

[81] See generally Asplund and Wardle (n 76).

[82] Sheldrake, *Entangled Life* (n 19) 85.

[83] See Spribille et al (n 78) 1569.

[84] Bettina Weber et al, 'What Is a Biocrust? A Refined, Contemporary Definition for a Broadening Research Community' (2022) 97(5) *Biological Reviews* 1768, 1769–1770 (citations omitted).

[85] McMullan-Fisher (n 48).

[86] Asplund and Wardle (n 76) 1723 fig 2.

The first is that fungi are generally 'small, cryptic, morphologically variable, ephemeral, and … found in poorly explored niches'.[87] Only a minority of fungi are macroscopic, and even these fungi are only usually seen when they produce conspicuous sporing bodies. The size of a sporing body does not reliably indicate the size or age of the organism, 'upending scales of time and space'.[88] Furthermore, while a few taxa such as bracket fungi produce sporing bodies that last many months or years, most do not. And sporing bodies of most fungi do not reliably arise year to year — in some years they might arise, and in others not at all, or only from one part of the mycelium.[89] The consequence is that fungi are generally hidden from human view.

The second complexity is that the ecological roles of fungi, like their bodies, are not fixed: they are emergent properties responsive to their environment. Some fungi play different ecological roles as their partners, life stage, and environmental variables change over time.[90] Other fungi appear to be in the process of evolving from one trophic mode to another, possibly as a result of human activity (eg, monoculture plantations).[91] For example, a *Mycena* fungus that was only known to decompose plant matter was recently discovered growing out of the flank of a living frog.[92] This complexity means that a species may have significantly different life requirements, and therefore conservation requirements, depending on its specific context in time and space.

A third and related complexity is that fungi can be pleomorphic — ie, the same organism can take on completely different physical forms. This has led to taxonomic confusion, as multiple species names have been given to the same organism.[93] This taxonomic confusion may make listing a species for conservation more complex. It can also make it more difficult correctly to identify a species that is being monitored for conservation or restoration purposes.

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[87] Vanessa J McPherson, Max M Gillings, and Michael R Gillings, 'Diversity and Abundance of Club and Coral Fungi in the Upper Lane Cove Valley' (2023) 145 *Proceedings of the Linnean Society of New South Wales* 25, 26.

[88] Pouliot, *The Allure of Fungi* (n 3) 243.

[89] May et al, 'The Victorian *Flora and Fauna Guarantee Act* and the Conservation of Lesser Known Groups of Biota' (n 3) 250.

[90] Lofgren and Stajich (n 26) R1314.

[91] See, eg, Christoffer Bugge Harder et al, '*Mycena* Species Can Be Opportunist-Generalist Plant Root Invaders' (2023) 25(10) *Environmental Microbiology* 1875.

[92] Chinmay C Maliye and Lohit Y T, 'Mushroom Sprouting Out of a Living Frog' (2024) 31 *Reptiles & Amphibians* e20966:1–2.

[93] See Nicholas P Money, 'Against the Naming of Fungi' (2013) 117 *Fungal Biology* 463, 464.

The fourth complexity comes from the difficulty in identifying whether any given fungus is exotic or native to an area. For example, when a taxon is identified in an area where it was not previously recorded, it can be difficult conclusively to determine whether it is an introduced taxon or native to the area.[94] The nativeness of fungi is critical given this is often a decisive factor in determining whether any given fungus is eligible to receive conservation attention (including, as will be shown, under law).

The final complexity comes from fungal biology. For fungi that exist in networks, it can be difficult to identify one fungal 'individual' from another. In some cases, a genetically uniform mycelium may occupy one small area as one unit. In other cases, a genetically uniform mycelium may occupy several square metres (or kilometres) as multiple genetically identical units. A flush of sporing bodies is an unreliable indicator of the number of fungal individuals present in an area: it may come from one extensive mycelium, or many different (genetically distinct) mycelia.[95] Further complexity arises when a single fungal mycelium mates at multiple different points in the network at the same time, turning into a 'genetic mosaic'.[96] The confounding nature of the fungal individuality makes it difficult to count fungi. It is preferable instead to measure whether a fungus species remains viable in an area.[97] However, in current conservation frameworks, counting numbers of organisms is essential for understanding whether a particular organism is threatened with extinction and eligible to be listed for protection.[98]

E *Unique Requirements*

Fungi have unique conservation and restoration requirements compared to plants and animals. Although it is difficult to be precise about these requirements for individual fungus species,[99] there has for a while been enough scientific knowledge to make

[94] See Pouliot, *The Allure of Fungi* (n 3) 132 ff.
[95] May, 'Fungi' (n 3) 54.
[96] Nicholas P Money, *Mushrooms: A Natural and Cultural History* (Reaktion Books, 2017) 165 ('*Mushrooms*').
[97] Sietse van der Linde et al, 'Now You See It, Now You Don't: The Challenge of Detecting, Monitoring and Conserving Ectomycorrhizal Fungi' (2012) 5(5) *Fungal Ecology* 633, 638.
[98] Interview with Tom May, Principal Research Scientist (Mycology) at the Royal Botanic Gardens Victoria (Lachlan Penninkilampi, Zoom Meeting, 15 November 2024).
[99] This is because of the general lack of scientific knowledge about fungi. May describes this as an 'elephant in the room' in any discussion about the unique conservation and restoration requirements of fungi. We have not described most fungus species, and even for most well-known species there is not

certain generalisations about the unique requirements of fungi. For example, Arnolds argues that 'special attention to fungi is justified' in the conservation context because some types of habitats are important for fungi but not for vascular plants and animals (eg, certain forests on very poor soils, certain old pastures, and roadsides with old trees); decreases in fungi may not coincide in some habitats with decreases in other organisms, and different factors may be responsible; and some fungal assemblages require special measures to maintain them.[100] In the restoration context, fungi have unique requirements because of their biology and ecology: they have different reproductive outputs to animals and most plants (ie, spores (in most cases) rather than eggs, live young, or seeds); and they have particular ecological requirements (eg, if the symbionts that spread their spores have become functionally extinct, those symbionts need to be restored (eg, through rewilding) or substituted with human activity if the fungi are to be restored).[101] Although there are ways to practise plant and animal conservation and restoration such that fungi are better included,[102] the unique requirements of fungi suggest they warrant specific attention.

The unique conservation requirements of fungi are well illustrated by reference to protected area management. It is unknown how well the Australian funga is represented in Australia's protected area system, the National Reserve System ('NRS');[103] but there are reasons to suppose that it might not be as well represented as are the Australian flora and fauna. First, protected areas globally are typically designed around the needs of plants and animals, not those of fungi.[104] Second, aboveground biodiversity, such as that of plants and animals, does not reflect belowground biodiversity, such as that of fungi — meaning areas that may seem to be species-poor aboveground could be fungal

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the depth of knowledge that there is for many plant and animal species. Although this is slowly changing, it remains 'a huge challenge': ibid.

[100] Eef Arnolds, 'Mycologists and Nature Conservation' in David L Hawksworth (ed), *Frontiers in Mycology: Honorary and General Lectures from the Fourth International Mycological Congress, Regensburg, Germany, 1990* (CAB International, 1991) 243, 244–245.

[101] Interview with Sapphire McMullan-Fisher, Fungal Ecologist, Fun Fungi Ecology (Lachlan Penninkilampi, Zoom Meeting, 20 December 2024).

[102] For example, conservation practices that focus on the needs of plants and animals should be tested to ascertain whether they also meet the needs of fungi: Interview with Tom May (n 98).

[103] May, 'Fungi' (n 3) 65.

[104] Leho Tedersoo et al, 'Global Patterns in Endemicity and Vulnerability of Soil Fungi' (2022) 28(22) *Global Change Biology* 6696, 6706 (citation omitted).

diversity hotspots, and vice versa.[105] Third, as much as 90% of the predicted area of mycorrhizal fungal diversity hotspots globally is not covered by existing protected areas.[106] Finally, there are local Australian studies that seem to confirm these global phenomena. For example, a recent study of club and coral fungi in the Upper Lane Cove Valley in Sydney, which includes the Lane Cove National Park, found that none of the club and coral diversity hotspots occurred within that protected area; rather, they occurred in small patches of undisturbed remnant bushland along creek lines outside the protected area.[107] None of this is to say that fungi are not being protected by plant- and animal-focused approaches. Any area-based conservation will, to some extent, 'carry along' fungi.[108] But focusing on plants and animals — or perhaps even ecosystems, habitats, and landscapes — without paying specific attention to the needs of fungi and hoping that they will still be conserved seems to this author to be an exercise in wishful thinking.

III THE FUNGA OF AUSTRALIA

Australia has been described as both a 'fungal paradise' and a 'fungal utopia'.[109] Its great variety in bioregions and endemic taxa, together with its huge size and relative isolation from the rest of the world, has fostered the evolution of a unique, megadiverse

[105] Leho Tedersoo et al, 'Global Diversity and Geography of Soil Fungi' (2014) 346(6213) *Science* 1256688:1–10.

[106] Michael Van Nuland, 'Mycelial Methods for Action: Applying Knowledge of Fungi to Confront Ecological Emergencies' (Webinar, More Than Human Rights Project, 1 December 2023).

[107] McPherson, Gillings, and Gillings (n 87) 33. But that is not to say that all of these fungi lack area-based protection. While the authors suggested that the fungi 'are currently less well protected than they could be' by virtue of not being within the Lane Cove National Park's boundaries (see ibid), at least one of the diversity hotspots identified by the authors falls within the Sheldon Forest, Rofe Park and Comenarra Creek Reserve Biodiversity Stewardship Site managed by the Ku-ring-gai Council (see 'Bushland Plans and Policies', *Ku-ring-gai Council* (Web Page, 2025) <https://www.krg.nsw.gov.au/Environment/Your-local-environment/Bushland/Bushland-plans-and-policies>). As noted in Chapter Three Part II(B)(1), biodiversity stewardship sites are private protected areas and form part of the NRS. So, in this regard, the area-based protection these fungi enjoy is not materially different from what they would enjoy if they were in a public reserve such as the Lane Cove National Park.

[108] May, 'Fungi' (n 3).

[109] Alison Pouliot and Tom May, *Wild Mushrooming: A Guide for Foragers* (CSIRO Publishing, 2021) 2 ('*Wild Mushrooming*'); Pouliot, *The Allure of Fungi* (n 3) 6.

funga.[110] Fungi are recorded in all major Australian habitats,[111] with particularly high diversity in areas with relatively high rainfall, diverse habitats, old-growth forest, and remnant bushland with few invasive species.[112] Truffles,[113] being well adapted to harsh, variable, and fire-prone environments, are particularly diverse in Australia, with one-third of the world's species found on this continent.[114] Australian fungi are generally widespread across the continent,[115] being limited not so much by distance but rather by the distribution of their partners and habitats.[116]

A *The State of the Australian Funga*

The most current information available about the state of the Australian funga is in the 'Biodiversity' chapter of *Australia State of the Environment 2021*, a statutory report published in mid-2022.[117] The authors of that report stated, with 'adequate' confidence, that the status of native and threatened fungi in 2021 was poor, noting that while data were deficient, the pressures of high levels of human activity were likely having a detrimental effect.[118] The authors found, with 'low' confidence, that the status of fungi in highly modified ecosystems was poor, noting that while very little is known about the population state and trends for most species, the pressures on these fungi are likely increasing from changed fire regimes, extreme fires, and human disturbance to habitat.[119] Finally, while noting that in undisturbed areas fungi are likely to be in a 'relatively good' condition, they still concluded, with 'very limited' confidence, that the status of these fungi is poor.[120]

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[110] Pouliot, *The Allure of Fungi* (n 3) 6; NSW Department of Environment and Climate Change, 'Best Practice Guidelines: Hygrocybeae Community of Lane Cove Bushland Park' (Guidelines, June 2008) 6 <http://ecouncil.lanecove.nsw.gov.au/trim/DocumentLink.asp?RecId=8149/11> ('Best Practice Guidelines').

[111] May, 'Fungi' (n 3) 50.

[112] Pouliot, *The Allure of Fungi* (n 3) 62; McPherson, Gillings, and Gillings (n 87) 30.

[113] Distinctions can be made between true truffles, truffle-like fungi, and false-truffle fungi, but for the purposes of this thesis it suffices to refer to all of these fungi as 'truffles'.

[114] Karl Vernes, 'Truffles & Mammals: A Mutual Affair' (2013) 50(2) *Wildlife Australia* 27, 27.

[115] See Gregory M Mueller et al, 'Global Diversity and Distribution of Macrofungi' (2007) 16(1) *Biodiversity and Conservation* 37; Tom W May, 'Where Are the Short-range Endemics Among Western Australian Macrofungi?' (2002) 15(4) *Australian Systematic Botany* 501.

[116] Pouliot, *The Allure of Fungi* (n 3) 69, 240.

[117] Helen Murphy and Stephen van Leeuwen, 'Australia State of the Environment 2021: Biodiversity' (Report, 2021) 53–55 <https://soe.dcceew.gov.au/sites/default/files/2022-07/soe2021-biodiversity.pdf>.

[118] Ibid 54.

[119] Ibid.

[120] Ibid 55.

The International Union for Conservation of Nature ('IUCN') has created and maintained a 'Red List' database cataloguing the global extinction risk to species.[121] The IUCN Red List is used by national and subnational government agencies worldwide, including in Australia, to inform decisions about whether to list species for protection under environmental laws. Slowly, fungi are being recognised on the IUCN Red List. In Version 2025-1 of the IUCN Red List, there are 1,300 listed fungus species worldwide, compared to 74,751 plants and 93,351 animals. There are 64 Australian fungus species on the IUCN Red List, compared to 4,658 Australian plants and 9,101 Australian animals. Of these listed Australian fungus species, 1 is critically endangered, 5 are endangered, 9 are vulnerable, 4 are near threatened, 36 are of least concern, and 9 are data deficient. However, there are still too few Red-Listed fungus species, and the well-known species are too overrepresented, to infer global status or trends reliably.[122]

It is difficult to make confident pronouncements about the state of the Australian funga when the vast majority of fungi are still unknown to science. As of 2021, only 5–10% of Australian fungus species have been described.[123] This figure comes from a 2009 estimate of the numbers of Australian biota, which estimated that there are between 50,000 and 250,000 species of fungi in Australia out of approximately 1.5 million species worldwide.[124] This estimate may need revision in light of more recent global studies that suggest there may be between 2.2 million and 13.2 million fungus species worldwide (2.5 million being the current 'best estimate').[125]

It is not just the numbers of Australian fungi that are unknown to science. Knowledge of Australian fungal biology and ecology is also very limited.[126] May puts it thus:

> Most fungal species … are yet to be formally described and we remain in total ignorance of all aspects of their biology. For those relatively few species that have been formally described, most are known by name and a brief description only. There is little

[121] See IUCN, *The IUCN Red List of Threatened Species (Version 2025-1)* (Web Site, 2025) <https://www.iucnredlist.org>.
[122] Eimear Nic Lughadha et al, 'Extinction Risk and Threats to Plants and Fungi' (2020) 2(5) *Plants, People, Planet* 389, 390. Cf Gregory M Mueller et al, 'What Do the First 597 Global Fungal Red List Assessments Tell Us About the Threat Status of Fungi?' (2022) 14(9) *Diversity* 736:1–23.
[123] Murphy and van Leeuwen (n 117) 15.
[124] Arthur D Chapman, *Numbers of Living Species in Australia and the World* (Australian Biological Resources Study, 2nd ed, 2009) 52.
[125] Kevin D Hyde, 'The Numbers of Fungi' (2022) 114(1) *Fungal Diversity* 1; Niskanen et al (n 25) 153–156.
[126] Murphy and van Leeuwen (n 117) 53.

> information on nutritional mode, niche specifications (including host or substrate range), spore dissemination, breeding biology, and genetic structure of populations, especially in natural ecosystems. … Knowledge of distribution and abundance of known species is poor.[127]

There are many reasons for this lack of knowledge. First, fungi are complex organisms, as was discussed in Part II(D) above. Second, they lack the 'charisma' of birds and mammals; fungi are often stigmatised, seen as unglamorous and sometimes dangerous.[128] Third, there is no comprehensive catalogue of fungal DNA, making it difficult confidently to distinguish and identify new species.[129] Fourth, even when a new species is identified, it can take decades before the funding is granted properly to understand the fungus's basic biology, ecology, and where it sits on the fungal tree of life.[130] Finally, there are very few mycologists working professionally in Australia, and virtually no Australian universities are teaching comprehensive mycology.[131]

B *Threats to the Australian Funga*

Virtually all major human-caused environmental impacts cause problems for fungi. This is to be expected given their ubiquity in the environment and their numerous and diverse ecological relationships.[132]

Figure 1 below identifies the key threats to the Australian funga.[133] Many of these threats are cumulative. For example, a study of temperate wet eucalypt forests in Tasmania one month after fire showed that logging and high intensity fire together significantly reduced the biomass and diversity of soil fungi.[134] Many of these threats have likely also created extinction debts for fungi. For symbionts like mycorrhizal and endophytic fungi and parasites, that debt is compounded by losses of plant and animal

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[127] May, 'Fungi' (n 3) 51, 52.
[128] Cresswell, Janke, and Johnston (n 64) 54; Lofgren and Stajich (n 26) R1316.
[129] Michael Lim and Yun Shu, *The Future Is Fungi: How Fungi Can Feed Us, Heal Us, Free Us and Save Our World* (Thames & Hudson Australia, 2022) 21.
[130] Ibid.
[131] See Peter J Irga, Katherine Barker, and Fraser R Torpy, 'Conservation Mycology in Australia and the Potential Role of Citizen Science' (2018) 32(5) *Conservation Biology* 1031.
[132] Pouliot, *The Allure of Fungi* (n 3) 5.
[133] This table draws primarily from May, 'Fungi' (n 3) 62–63 and Pouliot and May, *Wild Mushrooming* (n 109) 17 and corresponds with the threats listed for Australian fungi on the IUCN Red List. For threats to fungi globally, see Niskanen et al (n 25) 164–165.
[134] Hans Ammitzboll et al, 'Diversity and Abundance of Soil Microbial Communities Decline, and Community Compositions Change With Severity of Post-Logging Fire' (2021) 30(10) *Molecular Ecology* 2434.

partners in ecosystems.[135] Any loss of fungi may have significant repercussions up the food chain and throughout the ecosystem, given the critical ecological roles that fungi play.

[135] See Nic Lughadha et al (n 122) 396.

Figure 1: Threats to the Australian Funga

Threats to All Biota That Also Threaten All Fungi	*Threats to All Fungi but Not All Biota*	*Threats to Some Fungi but Not All Fungi or All Biota*
Human population growth, to the extent that it drives processes of production and consumption that cause the other threats listed in this table.	Loss of symbionts (eg, plants for mycorrhizal and endophytic fungi; specialist fungivores for truffles; hosts for pathogens).	Alien invasive fungivores that disturb traditional ecological relationships.
Human-induced climate change.	Loss of organic substrates (eg, leaf litter and dead wood of certain ages, sizes, and compositions) through firewood collection and 'cleaning up' the bush.	Human over-harvesting of wild fungi for food, medicine, or other uses, including destruction from harvesting practices like raking and lighting fires.
Land clearing and habitat loss (including fragmentation and loss of connectivity) from, eg: ▪ Converting native forests and grasslands to exotic pastures, monocultures, and plantations. ▪ Intensive agriculture. ▪ Urban development.	Loss of age diversity in habitats (eg, through silviculture), preventing ecological succession.	Removal of bush rock.
Pollution from fertilisers, fungicides, herbicides, and pesticides.	Altered or inappropriate fire regimes.	
Gross soil disturbance (eg, from mining).	Invasion by alien species.	
Air pollution.	Roadworks, trail clearing, and other activities in forested areas that compact soil and change micro-climates by opening tree canopies.	
Physical and chemical soil alteration (eg, changes to moisture, pH, and salinity) and practices like compaction, irrigating, and tilling.		

IV THE VALUES OF FUNGI

A *A Values Typology for Fungi*

The IPBES recently conducted a methodological assessment of the diverse values and valuations of nature.[136] It found that nature's values 'vary greatly across knowledge systems, languages, cultural traditions and environmental contexts'.[137] There are over 50 different established methods in the literature for valuing nature.[138]

Rather than prefer one or more worldviews over others, the IPBES proposes that discussions of the values of nature be understood using a 'values typology'. A values typology:

> requires value perspectives that encompass the richness of people's relationships with nature, including: (i) *world-views*, the ways in which people conceive and interact with the world; (ii) *knowledge systems*, bodies of knowledge, practices and beliefs such as academic, indigenous and local knowledge systems embodied in world-views; (iii) *broad values*, the moral principles and life goals that guide people-nature interactions; (iv) *specific values*, judgements regarding the importance of nature in particular contexts, grouped into instrumental values (i.e., means to a desired end often associated with the notion of "ecosystem services"), relational values (i.e., the meaningfulness of human-nature interactions), and intrinsic values (i.e., independent of people as valuers); and (v) *value indicators*, the quantitative measures and qualitative descriptors used to denote nature's importance in terms of biophysical, monetary or sociocultural metrics.[139]

Figure 2 below is a values typology for fungi adapted from one proposed by the IPBES.[140] It gives examples of how fungi might be seen from different worldviews and how diverse values of fungi might be held as a result. The sections that follow describe some of the specific instrumental, intrinsic, and relational values of fungi identified in this typology.

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[136] IPBES, 'Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (Report, 2022) <https://zenodo.org/records/7687931> ('Values Assessment').
[137] Ibid XV.
[138] Ibid XXVII.
[139] Ibid XV–XVI.
[140] Ibid XXIII.

Figure 2: A Values Typology of Fungi, Adapted From the IPBES

Values Typology	*Illustrative examples of how aspects of the values typology are highlighted by certain life frames*	**Living From Fungal Resources**	**Living in a Fungal Landscape**	**Living With Fungus Species and Habitats**	**Living as Fungi as Part of Us**
Worldviews	*Ways through which people conceive and interact with the world*	Anthropocentric.	Anthropocentric.	Bio-/ecocentric.	Pluricentric.
				Cosmocentric.	
Knowledge Systems	*Bodies of knowledge, practices, and beliefs* Academic; indigenous; local.				
Broad Values	*Guiding principles and life goals*	Prosperity; livelihood.	Belonging; health.	Stewardship; responsibility.	Oneness; harmony with nature.
Specific Values	*Judgements regarding the importance of nature in particular situations*				
	Instrumental: means to an end; nature as a resource and asset; satisfaction of needs and preferences; usefulness to people.	Use of fungi for food, industry, and medicine.	Health benefits of foraging and foraying for wild fungi.	Fungi as creators and members of habitats.	
	Intrinsic: agency of more-than-human beings; inherent worth of biodiversity as an end in itself.		Intrinsic value of heritage fungi.	The right of fungi to exist.	Fungi as co-inhabitants.
	Relational: importance of desirable, meaningful, and often reciprocal human relationships.	Cultural meanings of certain fungi.	Sense of place of a foraging community.	Respect for fungal life cycles.	Fungi as part of kinship or clan relationships.

Value Indicators	*Quantitative measures and qualitative descriptors*				
	Biophysical	Kilograms of fungi.	Physiological benefits of being in nature.	Number of fungus species.	Nutrition of fungi.
	Monetary	Market price of fungal harvest.	Willingness to pay for recreation.	Existence value.	
	Sociocultural	Diverse and inclusive participation in foraging and foraying.	Ratings of special places.	Legal standing of natural entities.	References to personhood of fungi.

B *Instrumental Values of Fungi*

Instrumental values 'relate to things that are a means to a desired end and tend to be associated with nature (e.g., as asset, capital, resources) and its contributions to people'.[141] Instrumental values dominate discourses about nature. Internationally, valuation studies elicited instrumental values in 74% of cases, whereas intrinsic values were elicited 20% of the time and relational values just 6%.[142]

Fungi are incredibly useful to humans. They contribute an estimated USD 54.57 trillion to the global economy.[143] Some of the instrumental values of fungi include use for food, industry, and medicine; health benefits arising from foraging and foraying; and 'ecosystem services' provided by fungi.

1 *Use of Fungi for Food, Industry, and Medicine*

(a) Food

Globally, there are over 2,000 species of fungi known to be edible.[144] Of these, approximately 90 are in cultivation and 30 are grown commercially.[145] Fungi are a distinct food kingdom that provides a 'good' or 'excellent' source of several vitamins and minerals, as well as being a sustainable food choice that is associated with higher diet quality.[146] Consumption of fungi for food is increasingly prevalent, rising 21-fold since about 1950.[147] Harvesting of wild fungi remains widespread both for subsistence and pleasure.[148]

Fungi are the drivers of fermentation, a process by which foods are both transformed and preserved. Fermented foods are commonplace in human food cultures, including

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[141] Ibid XXIV.
[142] Ibid XXVIII.
[143] Allen Grace T Niego et al, 'The Contribution of Fungi to the Global Economy' (2023) 121 *Fungal Diversity* 95.
[144] Huili Li et al, 'Reviewing the World's Edible Mushroom Species: A New Evidence-based Classification System' (2021) 20(2) *Comprehensive Reviews in Food Science and Food Safety* 1982, 1987.
[145] Ibid 1984 (citations omitted).
[146] Mary Jo Feeney, Amy Myrdal Miller, and Peter Roupas, 'Mushrooms—Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom"' (2014) 49(6) *Nutrition Today* 301.
[147] Li et al (n 144) 1984 (citation omitted).
[148] Ibid 1983.

foods such as breads and cheeses and alcoholic drinks.[149] Fermentation has also enabled the creation of culturally important foods such as VEGEMITE.[150]

Fungi are also key to the production of other foods. A clear example is the role of mycorrhizal fungi in plant foods. Not only are mycorrhizas essential to the health and sustainable production of these crops, but they can also affect their taste and nutritional values. Sheldrake gives the examples of artichokes, basil, coriander, fennel, lettuce, mint, strawberries, and tomatoes, and notes that differences in taste and nutrition have even been detected in breads made with wheats grown with different fungal partners.[151]

(b) Industry

Fungi have extremely numerous industrial applications. Sixty percent of industrial enzymes derive from fungi.[152] Applications of these fungal enzymes range from paper pulping to washing detergents and breaking down agricultural waste to make bioethanol.[153] Itaconic acid derived from fungi is used to make car parts and synthetic rubber,[154] while other fungal enzymes are used in leather processing.[155] Fungi are also being exploited in industrial design to make sustainable alternatives to traditional building materials like foams and timber,[156] as well as plastics,[157] leather,[158] and product packaging.[159]

The decompositional talents of fungi mean that fungi are also prodigious at using and breaking down human-made substances. For example, fungi can digest substances like crude oil and polyurethane plastics; recycle waste products like cigarette butts; harness the energy emitted by radioactive particles; and break down many other toxic

[149] See the discussion in Lim and Shu (n 129) 46–51.
[150] Royal Botanic Gardens Kew (n 18) 26.
[151] See Sheldrake, *Entangled Life* (n 19) 148–149, 285 nn 19–20.
[152] Kevin D Hyde et al, 'The Amazing Potential of Fungi: 50 Ways We Can Exploit Fungi Industrially' (2019) 97 *Fungal Diversity* 1, 70.
[153] Royal Botanic Gardens Kew (n 18) 29, 31 (citations omitted).
[154] Ibid 27 (citations omitted).
[155] Ibid.
[156] Mitchell Jones et al, 'Engineered Mycelium Composite Construction Materials From Fungal Biorefineries: A Critical Review' (2020) 187 *Materials & Design* 108397:1–16.
[157] Tiberius Balaeș, Bianca-Mihaela Radu, and Cătălin Tănase, 'Mycelium-Composite Materials—A Promising Alternative to Plastics?' (2023) 9(2) *Journal of Fungi* 210.
[158] See, eg, 'Made With Reishi™', *MycoWorks* (Web Page, 2025) <https://www.mycoworks.com/product-launches>.
[159] See, eg, 'Ecovative', *Ecovative* (Web Page, 2024) <https://www.ecovative.com>.

pollutants.[160] This has given rise to the field of mycorestoration: the use of fungi to restore environments following human pollution or other disturbance. While some view it as an 'infant science and … largely experimental',[161] mycorestoration has many promising applications, ranging from microbial and chemical filtration to forestry, contaminated land remediation, and industrial agriculture.[162] For example, fungi have been found degrading polyester polyurethane in a dumping area in Islamabad;[163] and Australian research has found that relatively common fungi can biodegrade polypropylene.[164]

(c) Medicine

Because humans and fungi are so closely related, our bodies can take advantage of many of the biochemical innovations deployed by fungi to protect themselves in the environment.[165] A wide range of commercial pharmaceuticals owe their origins to fungi. These include antibiotics such as penicillin, immunosuppressants such as cyclosporine and fingolimod, immunostimulators, cholesterol-lowering statins, and migraine relief compounds.[166] Fifteen percent of all vaccines are made in yeast.[167] In Australia, the psychedelic compound psilocybin, found in a dozen genera of fungi including magic mushrooms (*Psilocybe* spp), may now be prescribed by authorised psychiatrists for people with treatment-resistant depression.[168]

Many other fungi have significant medicinal potential.[169] This has seen the use of many wild fungi in diverse traditional and complementary medicine practices over

[160] Sheldrake, *Entangled Life* (n 19) 5, 201–203 (citations omitted).
[161] Lim and Shu (n 129) 169. See also Sheldrake, *Entangled Life* (n 19) 206–207.
[162] See Paul Stamets, *Mycelium Running: How Mushrooms Can Help Save the World* (Ten Speed Press, 2005) pt II; McCoy (n 61) ch 10.
[163] Sehroon Khan et al, 'Biodegradation of Polyester Polyurethane by *Aspergillus tubingensis*' (2017) 225 *Environmental Pollution* 469.
[164] Amira Farzana Samat, Dee Carter, and Ali Abbas, 'Biodeterioration of Pre-treated Polypropylene by *Aspergillus terreus* and *Engyodontium album*' (2023) 7(1) *NPJ Materials Degradation* 28:1–11.
[165] Sheldrake, *Entangled Life* (n 19) 10.
[166] Royal Botanic Gardens Kew (n 18) 31 (citations omitted).
[167] Ibid 26.
[168] 'Change to Classification of Psilocybin and MDMA to Enable Prescribing by Authorised Psychiatrists', *Therapeutic Goods Administration* (Web Page, 3 February 2023) <https://www.tga.gov.au/news/media-releases/change-classification-psilocybin-and-mdma-enable-prescribing-authorised-psychiatrists>.
[169] Rishi Man Chugh et al, 'Fungal Mushrooms: A Natural Compound With Therapeutic Applications' (2022) 13 *Frontiers in Pharmacology* 925387:1–16. But see Nicholas P Money, 'Are Mushrooms Medicinal?' (2016) 120(4) *Fungal Biology* 449.

thousands of years.[170] It is virtually certain, given the number of undiscovered fungi, that more fungal compounds will be discovered for human medicinal use.

2 *Health Benefits of Foraging and Foraying for Wild Fungi*

Separately from the nutritional and medicinal benefits of consuming fungi, foraging and foraying for wild fungi comes with numerous health benefits, including improved mental health and increased physical exercise.[171] Many of these benefits likely come from simply 'being in nature' and interacting with other species. An individual exposed to 'natural settings' experiences among other benefits happiness, stress relief, and improved cognitive and immune function.[172] These benefits are probably enhanced by the fact that many macrofungi produce sporing bodies with significant aesthetic qualities, providing sources of beauty and joy in the environment.[173]

3 *Fungi as Creators and Members of Habitats*

Fungi provide 'ecosystem services' to humans through their creation and membership of habitats. Many of these services, such as decomposition, carbon drawdown, population control, and the fostering of ecological resilience and integrity, were described in Part II above. These services ensure the viability of habitats like forests and grasslands on which human civilisation depends.[174]

C *Intrinsic Values of Fungi*

Intrinsic values 'relate to the values of nature expressed independently of any reference to people as valuers and include entities such as habitats or species that are worth protecting as ends in and of themselves'.[175] Two dimensions of the intrinsic value of fungi include the heritage value of certain fungi and the right of fungi to exist.

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[170] See McCoy (n 61) ch 7; Sandra Lawrence, *The Magic of Mushrooms: Fungi in Folklore, Superstition and Traditional Medicine* (Welbeck, 2022).

[171] See Tatiana Marquina et al, 'The "Quiet Hunt": The Significance of Mushroom Foraging Among Russian-speaking Immigrants in New York City' (2022) 18(1) *Ecosystems and People* 226.

[172] See IPBES, 'Thematic Assessment Report on the Sustainable Use of Wild Species' (Report, 2022) 339–343 <https://zenodo.org/records/10925382>.

[173] Arnolds (n 100) 244.

[174] Money, *Mushrooms* (n 96) 170. On the importance of ecosystem services generally, see IPBES, 'Global Assessment Report on Biodiversity and Ecosystem Services' (Report, 2019) <https://zenodo.org/records/6417333>.

[175] IPBES, 'Values Assessment' (n 136) XXIV.

1 *Heritage Fungi*

The first view of intrinsic value comes from the anthropocentric perspective, which is that some fungi have intrinsic value because they are seen as having heritage value.

In Australia, there are few fungi with recognised heritage value. Heritage value may be gleaned from their presence or absence in heritage lists maintained by government agencies. Of these, the only fungi that are recognised as having national heritage value are the *Hygrocybeae* of the Lane Cove Bushland Park in Sydney, NSW ('LCBP'), an ecological community now listed as critically endangered under the *Biodiversity Conservation Act 2016* (NSW) ('*BC Act*').[176] The LCBP was registered on the Commonwealth's Register of the National Estate ('RNE') specifically because of the heritage value of these fungi.[177] However, this heritage listing does not have any legal effect.[178]

2 *Right of Fungi to Exist*

The second view of intrinsic value comes from the ecocentric perspective, which is that fungi have a right to exist for their own sake.

Typically, this argument is expressed in more general terms — that all life, or the diversity of life, has intrinsic value. May, a conservation mycologist, exemplifies this approach. He distinguishes the 'primary reason' for conserving fungi from the 'primary practical reason'. The 'primary practical reason', he states, is 'because of their ecological roles, in which they are very important because of their mode of nutrition

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[176] See Chapters Three and Four.

[177] The Statement of Significance for the listing notes that LCBP 'is a nationally important site for fungi'; it has 'a unique assemblage of fungi' with species 'believed to provide important ancestral information on the evolution of plants and fungi': See 'Lane Cove Bushland Park, River Rd, Osborne Park, NSW, Australia', *Australian Heritage Database* (Web Page, 21 November 2000) <https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DLane%2520Cove%2520Bushland%2520Park%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=101451>.

[178] The RNE was established under the *Australian Heritage Commission Act 1975* (Cth). That Act provided protection of heritage places from actions by Commonwealth agencies. However, the Act has since been repealed. It is not discussed further in this thesis.

and their position in food webs and nutrient and energy cycles'.[179] The 'primary reason', however, 'is that all biodiversity should be conserved'.[180]

D *Relational Values of Fungi*

Relational values 'refer to the meaningfulness of people-nature interactions, and interactions among people (including across generations) through nature (e.g., sense of place, spirituality, care, reciprocity)'.[181] Relational values are held both by the First Peoples and in contemporary non-Indigenous Australian cultures.

1 *First Peoples' Traditional Relationships*

The deepest relational values with the Australian funga would, of course, be those that have been held by First Peoples. It may be that First Peoples have kinship, clan, totemic or other spiritual or Dreamtime relationships with certain fungi that have lasted millennia. However, knowledge of these relationships is largely inaccessible.[182]

2 *Contemporary Australia*

Additional sets of relational values have emerged since Australia was colonised in 1788. These values can be seen from two perspectives: foraying (looking for fungi without picking them for consumption) and foraging (looking for fungi to pick for consumption). In both activities, multiple relational values emerge: the cultural meanings that are prescribed to all or certain fungi; the value of understanding and respecting fungal life cycles; and the value of belonging to foraying and foraging communities.

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[179] May, 'Fungi' (n 3) 58. This reflects the 'ecosystem services' values of fungi described earlier in this section.

[180] Ibid. May reiterated this opinion in a recent interview with the author: Interview with Tom May (n 98).

[181] IPBES, 'Values Assessment' (n 136) XXIV.

[182] Most of the information available about these relational values comes from Arpad C Kalotas, 'Aboriginal Knowledge and Use of Fungi' in Anthony E Orchard (ed), *Fungi of Australia Volume 1B, Introduction—Fungi in the Environment* (Australian Biological Resources Study, 1996) 269, which is based on colonial ethnomycological records. However, it has been suggested that much of the knowledge in these records has probably been lost and continues to be lost with the passing of generations, and probably no longer reflects current practice by First Peoples in any event: Pouliot and May, *Wild Mushrooming* (n 109) 19; Pouliot, *The Allure of Fungi* (n 3) 184–185. Sustained efforts to recover that knowledge are now being made: 'First Nations PhD Candidate Leads the Way on Native Fungi', *The University of Queensland* (Web Page, 30 May 2023) <https://qaafi.uq.edu.au/article/2023/05/first-nations-phd-candidate-leads-way-native-fungi>.

Foraying for fungi is a small pastime in Australia, but one with a lengthy history. The Field Naturalists Club of Victoria has been foraying for fungi since the 1880s.[183] Local mycological societies have since formed around Australia and host regular forays to explore, discover, and appreciate fungi and their life cycles, and to develop social connections between like-minded naturalists.[184] Foraying for fungi is a 'mycological tradition [that] verges on the devotional, representing communion and companionship with fungi in their natural element'.[185]

Foraging for fungi is a rapidly growing pastime.[186] Foraging traditions have been created as influxes of migrants have brought their knowledges and experiences into Australia, adapted them to the Australian environment, and built new foraging communities. The growth of interest in foraging has been enabled by the rapidly growing knowledge of Australian mushrooms and a greater public interest in foraging for wild foods more broadly.[187]

Australians also forage for fungi for spiritual purposes. This foraging is primarily, if not exclusively, for psychedelic fungi such as magic mushrooms (*Psilocybe* spp). For some, psychedelic fungi are used for personal liberation; for others, they are used to reconnect with shamanic rituals.[188] The rapid growth in membership of Australian-based Facebook groups dedicated to these practices is a reasonable indication of the significant number of people who share relational values associated with psychedelic fungi.[189]

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[183] Pouliot, 'A Thousand Days in the Forest' (n 3) 18.

[184] See, eg, 'Home', *Sydney Fungal Studies Group Inc* (Web Page, 2025) <http://www.sydneyfungalstudies.org.au>.

[185] Doug Bierend, *In Search of Mycotopia: Citizen Science, Fungi Fanatics, and the Untapped Potential of Mushrooms* (Chelsea Green Publishing, 2021) 5.

[186] For example, a recent study of the member numbers in 2018 and 2020 of 21 regionally based social media groups about fungi found that the groups, on average, experienced an increase in members of 381% over two years: Peter J Irga, Laura Dominici, and Fraser R Torpy, 'The Mycological Social Network: A Way Forward for Conservation of Fungal Biodiversity' (2020) 47(4) *Environmental Conservation* 243, 247.

[187] See Pouliot and May, *Wild Mushrooming* (n 109) ch 1.

[188] Lim and Shu (n 129) 15.

[189] For example, a Facebook group dedicated specifically to psychedelic fungi has grown to about 24,000 members at the time of writing since it was created at the start of the COVID-19 pandemic in February 2020 (although it should be noted that this group also includes members from New Zealand): 'Psilocybin Mushroom (and Other) Community Australia & New Zealand – Members', *Facebook* (Web Page, 2025) <https://www.facebook.com/groups/666900690781435/members/>.

V A HIDDEN KINGDOM THAT WARRANTS SPECIFIC ATTENTION

This chapter provided a lawyer's interpretation of fungi. It explained what fungi are, described the funga of Australia, and proposed a values typology to illustrate some of the many instrumental, intrinsic, and relational values of fungi. The purpose of doing so was to set the premise that fungi are worth conserving. Fungi warrant specific conservation and restoration attention because they have unique requirements, being different organisms compared to plants and animals. But even if they had exactly the same requirements, they would still warrant specific attention because of the diverse and critically important ecosystem functions that they perform. By partnering with plants and animals to flourish, recycling nutrients and energy, and keeping populations in check — among many other ecological functions not discussed in this chapter — fungi secure the integrity of ecological systems and provide the foundation for the flourishing of terrestrial life on Earth. Furthermore, by providing essential and culturally important foods, medicines, symbols, and relationships, fungi have also become deeply entangled in human lives. A human life without diverse fungi would be unrecognisable — indeed, it would be impossible.

Although fungi warrant specific attention by all disciplines concerned with biodiversity conservation and restoration, it is the discipline of law with which this thesis is chiefly concerned. It is time to consider what, if anything, is being done by Australia's environmental laws to protect this diverse and important kingdom of life.

Rock shield lichens (*Xanthoparmelia* spp) at Mount Canobolas State Conservation Area, Canobolas

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CHAPTER THREE

FUNGI IN ENVIRONMENTAL LEGISLATION

I INTRODUCTION

This chapter considers the inclusion of fungi in Australian environmental legislation. It argues that Australian environmental legislation generally neglects fungi. The extent of neglect in each jurisdiction exists on a spectrum. In some jurisdictions, such as the Commonwealth, ACT, and NSW, fungi are clearly eligible to be listed as threatened species and ecological communities. In others, such as Tasmania and Victoria, there does not appear to be any clear lawful basis for listing fungi for protection. Each jurisdiction impliedly includes fungi in its protected area legislation, but only in NSW are fungi mentioned expressly in this context. No Australian environmental statute recognises fungi as constituting their own kingdom of life: fungi are either not mentioned at all or, if they are mentioned, they are defined as 'plants'. While the express and implied forms of inclusion are mostly effective to allow fungi to enjoy the benefits of environmental legislation — which result in significant consequences for their conservation and restoration — it is not wholly effective. This is particularly so where fungi are included by statutory definition rather than by being substantively referred to in the legislation, given statutory defintions are liable to be displaced where the context requires it. An example of this displacement is identified in ACT legislation in the context of native vegetation. Finally, only 45 fungus species and 2 ecological communities of fungi are listed under Australian environmental legislation. None are listed as nationally threatened by the Commonwealth. These listings are few, relative to the expected diversity of Australian fungi.

This chapter has two substantive parts. The first is an analysis of the key terrestrial biodiversity conservation and protected area management statutes of the Commonwealth, NSW, Victoria, Tasmania, and the ACT. The second is a discussion of the analysis that characterises the state of neglect and draws some conclusions about the inclusion of fungi in Australian environmental legislation.

II ANALYSIS

A *Commonwealth*

The key Commonwealth environmental law for the purposes of this thesis is the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) ('*EPBC Act*').[190]

It is argued that fungi are effectively included in the *EPBC Act*. Fungi are expressly included in the definition of 'plants', but are otherwise impliedly included in the Act's definitions of the more general terms on which it relies such as 'biodiversity', 'ecological community', and 'species'. These inclusions bring fungi within the scope of key operative provisions of the *EPBC Act*, such as the listing of threatened species and ecological communities, the making of conservation agreements, and the creation and management of Commonwealth reserves. The ability to list lookalike species is of significant potential benefit to fungi given the difficulty of identifying most fungi to the species level based on morphology alone. However, the significance of this inclusion is limited in reality given there are no species or ecological communities of fungi listed for protection under the *EPBC Act*.

1 Environment Protection and Biodiversity Conservation Act 1999 *(Cth)*

The *EPBC Act* is the Commonwealth's chief environmental statute. Its objects include providing for the protection of the environment, especially 'matters of national environmental significance'; promoting the conservation of biodiversity; and promoting a cooperative approach to the protection and management of the environment.[191]

The Act provides for a broad range of matters, many of which are beyond the scope of this thesis to discuss. This analysis is confined primarily to the provisions of Chapter 2 relating to the protection of the environment, and Chapter 5, Parts 13, 14, and 15 relating to terrestrial biodiversity conservation, private land conservation, and the management of terrestrial Commonwealth reserves.

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[190] The Commonwealth has been active in recent years preparing, tabling, and, in fewer instances, passing significant reforms to its environmental legislation. Of note is the *Nature Repair Act 2023* (Cth), which establishes a new 'Nature Repair Market' for private land conservation. These reforms, having either not passed or only just commenced, are not discussed in this thesis.

[191] See *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 3 ('*EPBC Act*').

Chapter 2 of the *EPBC Act* provides protections against actions that are likely to have significant impacts on matters of national environmental significance or Commonwealth land. The protections are prohibitions that carry either civil or criminal penalties. For example, one of the nine matters of national environmental significance is Commonwealth-listed threatened entities — species or ecological communities listed as threatened under the *EPBC Act*. A person is prohibited from taking an action without approval that has, will have, or is likely to have a significant impact on a listed threatened entity.[192] A similar prohibition applies to the taking of an action that has, will have, or is likely to have a significant impact on the environment on Commonwealth land.[193]

Part 13 of Chapter 5 of the *EPBC Act* provides for the conservation of biodiversity. Division 1 provides for the listing of threatened species and ecological communities. Under this Division, the Minister must establish lists of threatened species, threatened ecological communities, and key threatening processes ('KTPs').[194] The eligibility criteria for listings under each of these categories are not referable to any particular kingdom of life — for example, the listing of threatened species is not limited to plants and animals.[195] In the case of threatened species, the Minister is permitted in certain circumstances to list lookalike species also — species that have not been assessed as eligible to be listed as threatened, but which closely resemble species that have been so listed.[196] For a species or ecological community that is ineligible to be listed, the Minister may receive advice from the Threatened Species Scientific Committee established under the Act about actions that are necessary to prevent that entity from becoming listed, and the Minister must consider such advice when exercising a function under the Act.[197] As part of the nomination and listing process,[198] the Minister may determine 'conservation themes' for an assessment period, whereby priority is given to particular taxa or regions of Australia.[199] Adding to the offences in Chapter 2, Part 13

[192] See ibid ss 18, 18A.
[193] See ibid ss 26, 27A.
[194] Ibid ss 178, 181, 183.
[195] See ibid ss 179, 182, 188.
[196] See ibid s 186(3)–(5).
[197] Ibid s 190. The provisions about the Threatened Species Scientific Committee are set out in ch 6 pt 19 div 1 of the Act. Notably, the qualifications of its members (eg, expertise in particular fields) is determined by the Minister in writing, not by the statute: ibid s 502(2).
[198] Set out in ibid ch 5 pt 13 div 1 subdiv AA.
[199] Ibid s 194D.

of Chapter 5 provides offences that prohibit the injuring, keeping, killing, moving, taking, or trading of a member of a listed threatened species or ecological community in a Commonwealth area.[200] The Minister must also keep a 'critical habitat' register, being a register in which the Minister may list habitats critical to the survival of listed threatened species or ecological communities.[201] It is an offence to take an action in a Commonwealth area knowing that the action significantly damages, or will significantly damage, a critical habitat.[202]

Division 5 of Part 13 provides for conservation advices, recovery plans, and threat abatement plans.[203] The Minister is required to ensure that there is an approved conservation advice for each listed threatened species and ecological community that includes, among other things, the main factors causing the entity to be eligible for listing, information about how to arrest the decline of the entity and support its recovery, or a statement to the effect that nothing can be done.[204] The Minister must make an initial decision whether to have a recovery plan for a listed threatened species or ecological community, and subsequently has a discretion as to whether to have one.[205] A recovery plan is a written document made for the purposes of the conservation, management, and protection of a listed threatened entity.[206] For a listed KTP, the Minister must make an initial decision within 90 days of the listing on whether to have a threat abatement plan and, if the decision is not to have one, must revisit that decision every five years.[207] A threat abatement plan is a written document made for the purposes of reducing the effect of a KTP.[208] Recovery and threat abatement plans have mandatory content requirements, including research and management actions to maximise the survival chances of native species and ecological communities, and must have regard to particular considerations, including the objects of the Act.[209] The Commonwealth

[200] See ibid ss 196–198.
[201] Ibid s 207A.
[202] Ibid s 207B.
[203] Division 5 of Part 13 also provides for wildlife conservation plans, but these plans apply to entities that are not relevant to this thesis (namely listed migratory species, listed marine species, cetacean species, and conservation dependent species (primarily fish species)).
[204] Ibid s 266B.
[205] Ibid s 269AA(1).
[206] See ibid s 269A(2).
[207] Ibid s 270A(1).
[208] Ibid s 270B(2).
[209] See ibid ss 270, 271.

must implement recovery and threat abatement plans to the extent they apply in Commonwealth areas.[210]

Part 14 provides for conservation agreements. The Minister may enter into an agreement with any person for the protection or conservation of, among other things, 'biodiversity in the Australian jurisdiction'.[211] The Minister must not enter into such an agreement unless satisfied in respect of various matters, including that, where an agreement is wholly or partly for the protection or conservation of biodiversity, the agreement will result in a 'net benefit' to biodiversity.[212] A conservation agreement cannot cover any part of a Commonwealth reserve.[213]

Part 15 provides for protected areas, including Commonwealth reserves. Commonwealth reserves are created by proclamations that, among other things, name the reserve, state the purposes of reservation, and assign the reserve to an IUCN management category.[214] A management plan is required to be made as soon as practicable after the reserve is declared and at all times after the first management plan takes effect.[215] A management plan is required to have certain content, including among other things the IUCN category of the reserve; a statement of how the reserve is to be managed; how the 'natural features' of the reserve are to be protected and conserved; and activities that may or may not be carried out in reserves.[216] A management plan must not be inconsistent with the Australian IUCN reserve management principles, which are currently prescribed in Schedule 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth) ('*EPBC Regs*').[217] Both the 'general administrative principles' and the 'principles for each IUCN category' in the *EPBC Regs* are expressed by reference to general terms like 'ecosystems', 'habitats', and

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[210] Ibid s 269.
[211] See ibid s 305(1).
[212] See ibid s 305(2).
[213] Ibid s 305(4).
[214] See ibid s 346(1); *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth) reg 10.03H ('*EPBC Regs*'). On the various IUCN management categories, see Nigel Dudley (ed), *Guidelines for Applying Protected Area Management Categories* (IUCN, 2008) 11–24; Natural Resource Management Ministerial Council, 'Australia's Strategy for the National Reserve System 2009–2030' (Public Strategy, May 2009) 42 <https://www.dcceew.gov.au/sites/default/files/documents/nrsstrat.pdf>.
[215] *EPBC Act* (n 191) s 366.
[216] See ibid s 367(1).
[217] See ibid s 348; *EPBC Regs* (n 214) reg 10.04.

'native species', largely without restriction to any particular kingdom of life.[218] Once a management plan is approved,[219] the Director of National Parks must give effect to it.[220] Civil and criminal penalties apply to, among other things, the injuring, keeping, killing, moving, taking, or trading of a member of a native species in a Commonwealth reserve, unless such actions are in accordance with a management plan.[221] Numerous additional offences are prescribed by the *EPBC Regs*.[222]

Fungi are expressly mentioned in the *EPBC Act* just once: 'plant' is defined by this Act to mean members of the 'plant' kingdom or the 'fungus' kingdom.[223] In doing so, the *EPBC Act* enlarges the ordinary meaning of 'plant' to include fungi wherever it is referred to in the Act. This has significant legal effects. It means that fungi, as 'plants', are included in the Act's definitions that are drafted by reference to plants, such as 'ecosystem',[224] as well as the relatively few provisions that use those terms or that are otherwise specific to plants.[225]

However, the more important inclusion of fungi by the *EPBC Act* is their implied inclusion in more general terms like 'biodiversity', 'ecological community', 'environment', 'habitat', and 'species', which are not defined by reference to any particular kingdom of life.[226] This implied inclusion is more important because, as was shown by the lengthy foregoing review of the Act, it is upon these more general terms rather than 'plants' or 'animals' that the vast majority of the provisions rely. The implied inclusion of fungi in these more general terms means that fungi are brought within the scope of the protections in Chapter 2; are eligible to be listed, and consequently conserved and restored, as threatened entities under Part 13 of Chapter 5; may be protected or conserved under conservation agreements under Part 14 of Chapter

[218] *EPBC Regs* (n 214) sch 8. The only exception is the principle applying to botanic gardens managed as IUCN Category IV reserves, which refers to 'plants' and 'plant heritage': ibid sch 8 pt 2 cl 5.07. However, these references include fungi by virtue of the definition of 'plant' in the *EPBC Regs*, which refers to the *EPBC Act* definition: see ibid Dictionary (definition of 'plant') as well as n 223 and the body text it accompanies.
[219] See *EPBC Act* (n 191) s 370.
[220] Ibid s 362(1).
[221] See ibid ss 354, 354A.
[222] See *EPBC Regs* (n 214) pt 12.
[223] *EPBC Act* (n 191) s 528 (definition of 'plant').
[224] Ibid s 528 (definition of 'ecosystem').
[225] See, eg, the references to plants discussed in n 218.
[226] See *EPBC Act* (n 191) s 528 (definitions of 'biodiversity', 'ecological community', 'environment', 'habitat', 'species').

5; and may be protected and managed as part of Commonwealth reserves under Part 15 of Chapter 5. The ability to list lookalike species is of potentially great significance to fungi because most fungi cannot be identified confidently to the species level without applying DNA technology (and those that can are only reliably identifiable by persons with taxonomic expertise).[227]

Despite their express and implied inclusion by the *EPBC Act*, no fungi are currently listed as threatened species or ecological communities.[228] This limits the significance of their inclusion in reality. There is, however, one fungus directly implicated in the listed KTPs, namely the infection of amphibians with chytrid fungus resulting in chytridiomycosis.[229] Another KTP, dieback caused by the 'root rot fungus' (*Phytophthora cinnamomi*),[230] misattributes the threat to fungi even though the organism is not even a fungus.[231] Many of the other listed KTPs would of course also affect fungi; but whether any of the listing advices or threat abatement plants refer to fungi in any substantive way is a question that could only be answered by empirical analysis beyond the scope of this thesis.

B *New South Wales*

The two key environmental statutes in NSW for the purposes of this thesis are the *BC Act*, in relation to biodiversity conservation and private protected areas, and the *National Parks and Wildlife Act 1974* (NSW) ('*NPW Act*'), in relation to public reserves.

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[227] Sarah C Watkinson, 'Molecular Ecology' in Sarah C Watkinson, Lynne Boddy, and Nicholas P Money (eds), *The Fungi* (Academic Press, 2016) 189, 189.

[228] It is possible that some of the listed ecological communities include fungi as their members. But to confirm the extent they do so and draw any meaningful conclusions about that inclusion would require extensive empirical analysis that is beyond the scope of this thesis.

[229] Commonwealth Threatened Species Scientific Committee, 'Commonwealth Listing Advice on Infection of Amphibians With Chytrid Fungus Resulting in Chytridiomycosis', *Species Profile and Threats Database* (Web Page, 2002) <https://www.dcceew.gov.au/environment/biodiversity/threatened/key-threatening-processes/chytridiomycosis-due-to-amphibian-chytrid-fungus>.

[230] Commonwealth Threatened Species Scientific Committee, 'Dieback Caused by the Root-rot Fungus (*Phytophthora cinnamomi*)', *Species Profile and Threats Database* (Web Page, 16 July 2000) <https://www.environment.gov.au/cgi-bin/sprat/public/publicshowkeythreat.pl?id=2>.

[231] See Chapter Two Part II(C)(1)(c). The current threat abatement plan corrects this error: Commonwealth Department of the Environment and Energy, 'Threat Abatement Plan for Disease in Natural Ecosystems Caused by *Phytophthora cinnamomi*' (Threat Abatement Plan, 2018) <https://www.dcceew.gov.au/sites/default/files/documents/tap-phytophthora-cinnamomi-2018.pdf>.

It is argued that fungi are effectively included in NSW environmental laws. Both the *BC Act* and *NPW Act* define 'plants' as including fungi. Under the *BC Act*, this definition is critical to bringing fungi within the scope of the Act, including the provisions relating to listing threatened entities, environmental crimes, and the concept of 'biodiversity', each of which would otherwise only apply to plants and animals. Under the *NPW Act*, fungi are within the scope of management principles and plans for public reserves and are protected by the offences that apply in respect of 'plants' and 'vegetation'.

1 Biodiversity Conservation Act 2016 *(NSW)*

Like the *EPBC Act*, the *BC Act* includes many provisions that are beyond the scope of this thesis to discuss. This analysis confines itself primarily to Parts 2–5, which relate to the protection of plants and animals, areas of outstanding biodiversity value ('AOBVs'), the listing of entities, and private land conservation.

The purpose of the *BC Act* is 'to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future', and includes some 15 particularised purposes.[232] The Act expressly applies 'in relation to plants and animals'.[233]

Part 2 of the *BC Act* provides for the protection of plants and animals. It does so by creating a range of offences relating to biodiversity. For example, it is an offence to pick, deal, or attempt to deal in a plant that is a member of a listed threatened species, threatened ecological community, or that is a 'protected' plant.[234] It is also an offence knowingly to damage the habitat of a threatened species or ecological community.[235]

Part 3 allows the Minister to declare any area in NSW to be an AOBV.[236] An AOBV may be declared if, in accordance with the criteria prescribed in the regulations,[237] the

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[232] See *Biodiversity Conservation Act 2016* (NSW) s 1.3 ('*BC Act*').
[233] Ibid s 1.4.
[234] Ibid ss 2.2, 2.5. See also the definition of 'pick' in s 1.6(1). The list of 'protected' plants is in Schedule 6 of the Act.
[235] Ibid s 2.4.
[236] Ibid s 3.1. For more information about current AOBVs (of which there are currently four), see 'Areas of Outstanding Biodiversity Value Register', *NSW Department of Climate Change, Energy, the Environment and Water* (Web Page, 18 January 2022) <https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/areas-of-outstanding-biodiversity-value/area-of-outstanding-biodiversity-value-register>.
[237] *Biodiversity Conservation Regulation 2017* (NSW) cl 3.1 ('*BC Reg*').

Minister forms the opinion that the area is important at a subnational or greater scale and the area makes a significant contribution to the persistence of certain matters such as ecological integrity, ecological processes, irreplaceable biological distinctiveness, or listed threatened species or ecological communities.[238]

Part 4 provides for the listing of threatened species, threatened ecological communities, and KTPs.[239] An entity is only eligible to be listed as a threatened species or part of a threatened ecological community if the species is a plant native to NSW or an animal native or migratory to NSW.[240] A threatening process is eligible to be listed as a KTP if it could threaten species or ecological communities or adversely affect already threatened entities.[241] Notably, while a threatened entity may only consist of plants or animals, a threatening process is not so constrained — it can be anything biotic or abiotic.[242] The Act and regulations specify further criteria and the process for the listing of entities, including provisional listings on an emergency basis.[243] Similarly to the *EPBC Act*, the *BC Act* allows listing themes to be determined 'to fill gaps in current listings'.[244] Part 4 also requires the Environment Agency Head to establish the 'Biodiversity Conservation Program' ('BCP'), a program with objectives to maximise the long-term security of threatened species and ecological communities and minimise the impacts of KTPs.[245] The program must consist of strategies to achieve the objectives in relation to each threatened species and ecological community, a framework to guide priority setting, and a process for monitoring and reporting.[246] Strategies to minimise the impacts of KTPs may, but need not be, included in the program.[247] The Environment

[238] *BC Act* (n 232) s 3.2.
[239] These lists are kept in schs 1, 2, and 4 of the *BC Act* respectively.
[240] *BC Act* (n 232) s 4.3.
[241] Ibid s 4.32.
[242] See ibid s 1.6(1) (definition of 'threatening process').
[243] See ibid pt 4 divs 2–5; *BC Reg* (n 237) pt 4. NSW is unique in that the Threatened Species Scientific Committee established under the *BC Act*, not the Minister, is the decision-maker for threatened entity listings. A person appointed to the committee is required to have expertise in one of a number of areas of study, ranging from animal and plant biology to genetics, limnology, population dynamics, and various fields of ecology: *BC Act* (n 232) s 4.41(3).
[244] *BC Act* (n 232) s 4.12(3).
[245] Ibid s 4.35.
[246] Ibid s 4.36(1).
[247] Ibid s 4.36(2).

Agency Head must ensure that a strategy for a listed threatened species or ecological community is included in the program within two years of listing.[248]

Part 5 provides for private land conservation. Private land conservation under the *BC Act* takes three forms:[249] biodiversity stewardship agreements, which are permanent agreements entered into between the Minister and landholders to establish biodiversity stewardship sites;[250] conservation agreements, which are permanent or timebound agreements entered into between the NSW Biodiversity Conservation Trust established by the Act ('BCT') and landholders for the purposes of conserving or studying biodiversity on the land;[251] and wildlife refuge agreements, which are similar to conservation agreements but without any provision to have effect in perpetuity.[252] Part 5 also requires the Minister to make a Biodiversity Conservation Investment Strategy to guide the BCT in prioritising investments in biodiversity conservation.[253]

Like the *EPBC Act*, the *BC Act* expressly mentions fungi in its definition of plants, enlarging its ordinary meaning to include 'fungi and lichens'.[254] This inclusion has cascading effects across the *BC Act* and brings fungi within the scope of its key operative provisions. As 'plants', fungi are eligible to be listed as threatened or protected 'plant' species or parts of threatened ecological communities. This means threatened fungi, if listed, can benefit from the management obligations under the BCP as well as the criminal offences that apply in respect of listed threatened plant species and ecological communities and their habitats.[255] The definition also brings fungi

[248] Ibid s 4.36(3). See Chapter Four Part III(A)(3) for further discussion of the BCP.

[249] See also *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (NSW) pt 5 ('*BC (S&T) Reg*') for older forms of private land conservation transitioned to the *BC Act* regime.

[250] See *BC Act* (n 232) pt 5 div 2. Biodiversity stewardship sites are private protected areas that are part of the NRS: see 'Terrestrial CAPAD 2022 NSW Summary', *Commonwealth Department of Climate Change, Energy, the Environment and Water* (Spreadsheet, 21 July 2023) <https://www.dcceew.gov.au/sites/default/files/documents/capad2022-terrestrial-nsw.xlsx>.

[251] *BC Act* (n 232) pt 5 div 3. Permanent conservation agreements also create private protected areas that are part of the NRS: see 'Terrestrial CAPAD 2022 NSW Summary' (n 250).

[252] *BC Act* (n 232) pt 5 div 4. The BCT maintains a public register of current private land conservation agreements: see 'Public Register of Private Land Conservation Agreements', *NSW Biodiversity Conservation Trust* (Web Page, 2025) <https://www.bct.nsw.gov.au/resources/public-register-private-land-conservation-agreements>.

[253] *BC Act* (n 232) pt 5 div 1.

[254] Ibid s 1.6(1) (definition of 'plant'). The distinction between lichens and other fungi is perplexing; it is unclear why this drafting decision was made given lichens are classified as fungi.

[255] Note that the definitions of 'ecological community', 'habitat', and 'species' are not themselves defined by reference to any particular taxa: see ibid s 1.6(1).

within the statutory concept of 'biodiversity', which is defined by reference to 'animal and plant life'.[256] This inclusion is critical as it brings fungi within the scope of provisions that relate to biodiversity more broadly, such as AOBVs and private land conservation agreements.

Unlike the Commonwealth, NSW has included fungi in its lists of threatened species and threatened ecological communities — meaning at least some fungi are, in reality, being conserved as a result of their inclusion by the *BC Act*. Currently, there are 5 endangered species,[257] 4 vulnerable species,[258] 1 critically endangered ecological community,[259] and 1 endangered ecological community.[260] There are no fungi listed as 'protected plants'. Fungi are also directly implicated in two KTPs: infection of frogs by amphibian chytrid causing the disease chytridiomycosis; and introduction and establishment of exotic rust fungi of the order *Pucciniales* pathogenic on plants of the family *Myrtaceae*.[261] Of course, as noted in the context of the *EPBC Act*, many of the other KTPs listed under the *BC Act* would also affect fungi; but it is beyond the scope of this thesis to consider whether they have been considered in those listings or in any strategies included under the BCP.

2 National Parks and Wildlife Act 1974 *(NSW)*

The *NPW Act* is the chief protected area management statute in NSW. It has numerous objects, including objects about 'the conservation of nature' and the provision for management of public reserves in accordance with certain management principles.[262] In carrying out functions under the Act, the Minister, Secretary, and NSW National Parks and Wildlife Service are required to give effect to those objects as well as the public interest.[263]

Part 4 provides for the reservation of Aboriginal areas, historic sites, karst conservation reserves, national parks, nature reserves, regional parks, and state

[256] Ibid s 1.5(1).
[257] Ibid sch 1 pt 2 div 2.
[258] Ibid sch 1 pt 3 div 2.
[259] Ibid sch 2 pt 1. For a case study of this listed ecological community, see Chapter Four Part III(A).
[260] Ibid sch 2 pt 2.
[261] Ibid sch 4. Infection of native plants by *Phytophthora cinnamomi* is also listed as a KTP, but as noted in Chapter Two Part II(C)(1)(c), this organism is not a fungus.
[262] See *National Parks and Wildlife Act 1974* (NSW) s 2A(1) ('*NPW Act*').
[263] See ibid s 2A(3).

conservation areas.[264] Land is reserved by the Governor by notice published in the *NSW Government Gazette*.[265] Each of these management categories is given a purpose by the *NPW Act* and is required to be managed in accordance with various principles, such as the conservation of biodiversity or natural values.[266] The Secretary, or in certain circumstances other entities, has responsibility for the care, control, and management of these reserves.[267]

Part 5 provides for public reserve management plans. The Secretary is required to prepare management plans for most reserves.[268] Some 23 matters are required to be considered when preparing a management plan, including 'the relevant management principles' and 'the conservation of biodiversity'.[269] A management plan must include objectives and the operations proposed to be carried out on the land, which must be consistent with the relevant management principles and the objects of the Act.[270] Once adopted,[271] a management plan must be carried out and given effect to by the Secretary.[272] No operations may be undertaken in relation to the land unless they are in accordance with the management plan.[273]

The *NPW Act* provides for various other matters relating to protected area management. For example, the Minister has powers to acquire land for future reservation[274] and may, for the purpose of managing, maintaining, or improving reserved land, enter into and give effect to an agreement with an owner or lessee of land that adjoins the reserve or is otherwise in the reserve's vicinity.[275] The Act also provides

[264] In relation to 'conservation agreements' and 'wildlife refuges' under this Act, see *BC (S&T) Reg* (n 249) pt 5, which brings these matters under the *BC Act* private land conservation regime.
[265] See *NPW Act* (n 262) pt 4 div 1. Reservations are also created directly by Acts of Parliament: see, eg, ibid schs 1, 1A.
[266] See ibid pt 4 div 2.
[267] See ibid ss 31, 47B, 47C, 47OA, 48, 58K, 63.
[268] See ibid s 72.
[269] See ibid s 72AA(1).
[270] See ibid s 72AB.
[271] See ibid s 73B.
[272] Ibid s 81(1). See Chapter Four Part III(B)(3) for a discussion of *Neilson v Secretary, Department of Planning and Environment* (2024) 260 LGERA 108 ('*Neilson*') in relation to this requirement.
[273] *NPW Act* (n 262) s 81(4).
[274] See ibid ss 145, 146.
[275] Ibid s 146(3).

for the recognition and protection of 'assets of intergenerational significance' ('AIS'), being reserves with special environmental or cultural values.[276]

The *NPW Act* also provides for numerous offences in relation to public reserves. Most relevantly, there is a general offence prohibiting the damaging of reserved land, including by damaging or removing, or causing or permitting to be damaged or removed, 'any vegetation, rock, soil, sand, stone or similar substance'.[277] Under the *National Parks and Wildlife Regulation 2019* (NSW) ('*NPW Reg*'), it is an offence to pick or possess vegetation in, or take vegetation into, a public reserve or land acquired by the Minister.[278]

Like the *BC Act*, the *NPW Act* expressly includes fungi by defining 'plant' to include fungi and lichens.[279] This definition brings fungi within the provisions of the Act that relate to plants, such as the offences against picking plants[280] and the inclusion of 'plants' in the offence protecting vegetation prescribed by the *NPW Reg*.[281] Fungi are also protected by the offence in s 156A(1)(b) of the Act prohibiting the damaging of 'vegetation', which, although undefined and not expressly referable to the statutorily defined concept of 'plants', seems to have been interpreted by the courts as including fungi.[282]

Additionally, and more importantly, fungi are impliedly included by the more general, undefined concepts on which the *NPW Act* relies, such as 'biodiversity' and

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[276] See ibid pt 12A; *National Parks and Wildlife Regulation 2019* (NSW) pt 7A ('*NPW Reg*'). For the current AIS (other than those that are 'sensitive'), see 'Assets of Intergenerational Significance (AIS)', *NSW National Parks and Wildlife Service* (Web Page, 2025) <https://www.nationalparks.nsw.gov.au/conservation-programs/assets-of-intergenerational-significance/map>.

[277] *NPW Act* (n 262) s 156A.

[278] *NPW Reg* (n 276) cl 21(1).

[279] *NPW Act* (n 262) s 5(1) (definition of 'plant'). This definition was only included in 2010: see *National Parks and Wildlife Amendment Act 2010* (NSW) sch 1 item 2. It is not clear from the second reading speech or other extrinsic materials reviewed by this author what caused this amendment to be made or why, in the drafting of the amendment, lichens were distinguished from other fungi.

[280] See *NPW Act* (n 262) ss 57, 58R.

[281] See *NPW Reg* (n 276) cl 21(6), noting that the word 'plant' in this context takes its meaning from the *NPW Act*: *Interpretation Act 1987* (NSW) s 11.

[282] See *Chief Executive, Office of Environment & Heritage v Orica Pty Ltd* [2015] NSWLEC 109, [75] ('*Orica*'), in which Preston CJ in the NSW Land and Environment Court ('NSWLEC') considered the removal of lichens from rocks as part of the environmental harm caused by an offence under this section. The implication seems to be that at least lichens, if not all fungi, are 'vegetation' that could be 'damaged' within the meaning of this section.

'natural values', given these concepts include fungi by their ordinary meaning.[283] The inclusion of fungi in these concepts means that fungi are within the scope of the objects of the Act, which must be given effect in its administration, as well as the reservation and management of land pursuant to the relevant purposes, principles, and plans. This implied inclusion permits fungus conservation and restoration to be part of the management of existing public reserves and allows fungi to be considered in decisions about lands to be acquired for future reservations.

C *Victoria*

Three Victorian environmental statutes are relevant for the purposes of this thesis: the *Flora and Fauna Guarantee Act 1988* (Vic) ('*FFG Act*'), in relation to biodiversity conservation; the *National Parks Act 1975* (Vic) ('*NP Act*'), in relation to public reserves; and the *Victorian Conservation Trust Act 1972* (Vic) ('*VCT Act*'), in relation to private land conservation.[284]

It is argued that Victoria's inclusion of fungi is partly ineffective. The ineffectiveness lies in the *FFG Act*. While funga are impliedly included in the Act's provisions relating to biodiversity generally, they do not seem to be within the scope of provisions relating to flora or fauna, given neither of these terms are defined in such a way that, in this author's view, include funga. The consequent exclusion of funga is significant as it removes funga from the scope of key operative provisions of the *FFG Act*, including the listing of threatened taxa and communities. Most troublingly, the exclusion calls into question the validity of the existing funga listings under the *FFG Act*. Under Victoria's protected area legislation, fungi are impliedly included in the key operative provisions with respect to the reservation and management of protected areas and are thus permitted to be conserved and restored as parts of these areas.

1 Flora and Fauna Guarantee Act 1988 *(Vic)*

The *FFG Act* is Victoria's chief statute relating to biodiversity conservation. The Act is so named because of its first objective, which is 'to guarantee that all taxa of Victoria's flora and fauna, other than taxa specified in the Excluded List, can persist

[283] See the definitions in n 10.

[284] Part 8 of the *Conservation, Forests and Lands Act 1987* (Vic) is also relevant to private land conservation, but it is not discussed in this thesis.

and improve in the wild and retain their capacity to adapt to environmental change'.[285] The Act's other objectives include the prevention of taxa of flora and fauna from becoming threatened; the recovery of threatened flora and fauna; the conservation, enhancement, protection, and restoration of biodiversity generally; the identification and mitigation of potentially threatening processes ('PTPs'); ensuring the ecologically sustainable use of biodiversity as a natural resource; and the identification and conservation of critical habitats in Victoria.[286] A Minister or public authority must give 'proper consideration' to these objectives when exercising a function under any Act that may reasonably be expected to impact biodiversity in Victoria.[287]

The main operative provisions of the *FFG Act* are in Parts 3–5. Part 3 provides for the listing of entities. Taxa or communities of flora and fauna may be included in the 'Threatened List' and PTPs may be included in the 'Processes List'.[288] Part 4 provides for management processes. These include, among other processes, the making of a 'Biodiversity Strategy' in relation to the objectives of the Act;[289] the preparation of 'action statements' for listed entities, setting out what must be done to conserve or manage them;[290] the determination of areas of 'critical habitat' in respect of taxa or communities that either are listed or are in the process of being listed;[291] and the making of management plans for taxa or communities of flora or fauna or PTPs, whether or not they are listed.[292] Part 5 provides for conservation and control measures. Under Division 1, habitat conservation orders may be made for the purpose of conserving, managing, or protecting any critical habitat or proposed critical habitat if the Minister considers it

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[285] *Flora and Fauna Guarantee Act 1988* (Vic) s 4(a) ('*FFG Act*'). The only item currently on the Excluded List is human disease organisms: 'Flora and Fauna Guarantee Act 1988 – Establishment of the List of Taxa, the Members of Which Constitute a Serious Threat to Human Welfare, the List of Taxa and Communities of Flora and Fauna Which Are Threatened and the List of Potentially Threatening Processes' in Victoria, *Victoria Government Gazette*, No G 26, 29 June 2000, 1509, 1510.

[286] *FFG Act* (n 285) s 4(b)–(f). See also the Act's 'purpose' and 'principle' in ss 1, 4A.

[287] Ibid s 4B(1).

[288] The Minister, in deciding on listings under this part, is assisted by the Scientific Advisory Committee established under s 8 of the Act. All members of the committee are required to 'be knowledgeable and experienced in the sciences of flora or fauna conservation or ecology', and each member must have particular expertise in either fauna or flora biology, taxonomy, or particular fields of ecology: see ibid s 8(4)–(5).

[289] See ibid pt 4 div 1.

[290] Ibid s 19.

[291] Ibid ss 20–20F.

[292] Ibid pt 4 div 3.

necessary in certain circumstances.[293] A habitat conservation order can provide for various matters, including 'the conservation, protection or management of flora, fauna, land or water'.[294] It is an offence to contravene a habitat conservation order.[295] Under Division 2, flora may also be listed as 'protected'. The Governor in Council may declare a taxon of flora to be protected[296] and, additionally, subject to a restriction on use.[297] It is an offence to take 'protected flora' or 'restricted use protected flora'.[298] Special offences apply to persons who take protected or restricted use protected flora in a way that is likely to cause a significant detrimental impact on the flora taxon or community.[299]

Funga are not expressly mentioned in the *FFG Act*. In particular, they are not expressly mentioned in the definition of 'fauna', which refers to 'animal-life', or 'flora', which refers to 'plant-life'.[300] However, both terms are defined also to include 'any other living thing generally classified as' fauna or flora. This raises the question of whether funga are so classified. Funga were historically classified as 'flora', but they have been recognised as constituting their own kingdom of life since 1969 — well before the *FFG Act* was enacted.[301] Consistently with this classification, Australian taxonomic authorities distinguish funga from fauna and flora, including for example in the Australian National Species List[302] and in the Australian Biological Resources Study series on the 'Fauna of Australia', 'Flora of Australia', and 'Fungi of Australia'.[303] There is no scientific evidence of which this author is aware to suggest

[293] See ibid s 26.
[294] See ibid s 27.
[295] Ibid s 32.
[296] Ibid s 46(1).
[297] Ibid s 46(2).
[298] See ibid ss 47, 47B.
[299] See ibid 3(4), 47A, 47C.
[300] Ibid s 3(1) (definitions of 'fauna', 'flora').
[301] See n 34 and the body text it accompanies.
[302] Council of Heads of Australasian Herbaria (n 79).
[303] 'Fauna of Australia', *Commonwealth Department of Climate Change, Energy, the Environment and Water* (Web Page, 13 February 2025) <https://www.dcceew.gov.au/science-research/abrs/publications/fauna-of-australia>; 'Flora of Australia', *Commonwealth Department of Climate Change, Energy, the Environment and Water* (Web Page, 5 February 2025) <https://www.dcceew.gov.au/science-research/abrs/publications/flora-of-australia>; 'Fungi of Australia', *Commonwealth Department of Climate Change, Energy, the Environment and Water* (Web Page, 24 January 2025) <https://www.dcceew.gov.au/science-research/abrs/publications/fungi-of-australia>. Note however that lichens were included in the 'flora' publications rather than the 'fungi' publications.

that funga are generally classified as fauna or flora, either in Victoria or elsewhere in Australia.[304] Thus, there does not seem to be any apparent basis on which funga could be argued to be 'generally classified' as either fauna or flora under the *FFG Act*.[305] Yet, there are 8 funga listed under the *FFG Act*: 2 species are listed as critically endangered, and 6 are listed as endangered.[306] Given funga are not 'generally classified' as flora (or fauna), there is no clear legal basis for these listings.

The apparent exclusion of funga from the definitions 'flora' and 'fauna' means that funga are excluded from many of the key operative provisions of the *FFG Act*. Funga cannot lawfully be listed, and thus cannot be the direct subject of management processes that are afforded to listed threatened taxa such as action statements and critical habitat determinations. Flora and fauna management plans are not available to funga. Funga are arguably excluded from the concept of 'community', which is defined by reference to flora and fauna,[307] making it doubtful whether a listed community could lawfully identify any funga as its members.[308] Funga also cannot be listed as 'protected flora'. Indeed, funga are excluded from the very guarantee after which the Act is named.

Despite these significant exclusions, funga are not entirely excluded from the *FFG Act*. For example, the definition of PTP is not limited to any particular taxon.[309] This means the current listed PTPs that directly implicate funga — namely, infection of amphibians with chytrid fungus resulting chytridiomycosis and human activity that results in artificially elevated or epidemic levels of myrtle wilt in *Nothofagus*-

[304] May, the principal mycologist at the Royal Botanic Gardens Victoria, confirmed this point in an interview with the author — it is an 'established scientific fact' that fungi are not classified as plants or animals: Interview with Tom May (n 98).

[305] Despite this, May's experience is that there has been no practical impediment to nominating fungi for listing under the Victorian legislation. Indeed, the secretariat has facilitated the listings: ibid.

[306] See Victorian Department of Energy, Environment and Climate Action, 'Flora and Fauna Guarantee Act 1988 Threatened List' (Statutory List, March 2025) 68 <https://www.environment.vic.gov.au/__data/assets/pdf_file/0027/741627/FFG_Threatened_List_March_2025.pdf>.

[307] *FFG Act* (n 285) s 3(1) (definition of 'community').

[308] There is a possible counterargument in that the community must only be 'substantially' made up of taxa of flora or fauna. If the community is substantially identified as comprising flora or fauna, and some funga are also included, then perhaps it is still a 'community' within the meaning of the Act. If so, then perhaps that community — with its funga — could still lawfully be listed under the Act.

[309] *FFG Act* (n 285) s 3(1) (definition of 'potentially threatening process'). However, a PTP is defined as a process that may affect 'flora or fauna'. Thus, any process that might affect funga but not flora or fauna is ineligible to be listed as a PTP under the *FFG Act*.

dominated cool temperate rainforests[310] — are listed on a clear legal basis (unlike the threatened taxa listings). Funga are also impliedly included in the Act's definition of 'biodiversity', which refers to 'the variability among living organisms from all sources'.[311] This implied inclusion brings funga within the scope of many of the objectives of the Act and the duty imposed on Ministers and public authorities to consider the impact on biodiversity when exercising statutory functions. It also brings funga within the scope of the Biodiversity Strategy made under Part 4, Division 1. Finally, there is a reasonable argument that funga are within the scope of habitat conservation orders, given such orders may provide for the conservation, protection, or management of 'land' as well as flora and fauna. However, it seems unlikely funga would ever be the focus of such orders given the orders relate to the critical habitat of listed threatened flora and fauna rather than the land generally.

2 National Parks Act 1975 *(Vic)*

The *NP Act* is Victoria's chief statute relating to the creation and management of protected areas. Its objects include making provision for the preservation and protection of the natural environment, indigenous flora and fauna, features of ecological and other interest or significance, and responsible management of protected areas.[312]

The main operative provisions for the reservation and management of protected areas are in Part III and the schedules of the *NP Act*. Part III and the schedules create terrestrial protected areas in the categories of landscape conservation areas (including nature conservation areas, community use and education areas, and natural features areas),[313] national park,[314] state park,[315] wilderness park,[316] and other categories of 'park';[317] as well as the other area-based conservation categories of remote and natural

[310] See Victorian Department of Environment, Land, Water and Planning, 'Flora and Fauna Guarantee Act 1988 – Potentially Threatening Processes List' (Statutory List, May 2023) 3 <https://www.environment.vic.gov.au/__data/assets/pdf_file/0029/634682/FFG-Processes-List-May-2023.pdf>. There are also phytophthora-related listed PTPs; but, as has been noted repeatedly now, the responsible organism is not a fungus.

[311] *FFG Act* (n 285) s 3(1) (definition of 'biodiversity').

[312] See *National Parks Act 1975* (Vic) s 4 ('*NP Act*').

[313] Ibid s 17E(1), sch Nine.

[314] Ibid s 17(1), sch Two.

[315] Ibid s 17(1A), sch Two B.

[316] Ibid s 17A(1), sch Two A.

[317] Ibid s 18(1), sch Three.

area[318] and wilderness zone.[319] The obligations of the relevant authority for these areas vary with the categories of the areas, but in each case include obligations to the effect that the relevant authority must control and manage the area in accordance with the objects of the Act in a manner that will conserve and, in some cases, restore the area, including the natural environment, indigenous flora and fauna, and features of ecological interest or significance.[320] Management plans are required to be prepared for protected areas,[321] although, unlike the protected area statutes of other jurisdictions, there is no express obligation in the *NP Act* to implement such plans. Other notable provisions include an offence prohibiting the cutting or taking away of fallen or felled trees[322] and, in the *National Parks Regulations 2024* (Vic) ('*NP Regs*'), offences prohibiting cutting, damaging, destroying, felling, picking, removing, or taking vegetation,[323] damaging, defacing, removing, or otherwise interfering with rocks or similar natural objects,[324] and digging or removing soil or other similar material.[325]

Fungi are not expressly mentioned in the *NP Act*. While there are many references to 'flora' and 'fauna' in the *NP Act*,[326] the key operative provisions are cast in broader terms such as 'the natural environment' and 'features of … ecological … interest' or 'significance', which, by their ordinary meaning, include fungi. Fungi are thus impliedly within the scope of the management obligations under the *NP Act*. The offence prohibiting the cutting or taking away of fallen or felled trees is particularly notable for fungus conservation because it has the consequence of protecting fungal habitat, preserving the ecological successions of saprotrophic fungi involved in decomposing dead trees (described in Chapter Two).

Although fungi are not mentioned expressly in the *NP Act*, they are expressly mentioned in the *NP Regs*. 'Vegetation' is defined expressly to include the whole or

[318] Ibid s 21B, sch Six.
[319] Ibid s 22, sch Five.
[320] See ibid ss 17(2)(a), 17A(2)(a), 17E(3), 17F(a), 18(2)(a), 21C(1).
[321] See ibid ss 17(2)(d), 17B, 17F(c), 18(2)(d). In the case of wilderness zones, see s 22(4)(b). Management plans are not required to be prepared for remote and natural areas: see s 21D.
[322] Ibid s 44A.
[323] *National Parks Regulations 2024* (Vic) reg 41 ('*NP Regs*').
[324] Ibid reg 46.
[325] Ibid reg 50.
[326] These terms are undefined in the *NP Act*, so on their face, by their ordinary meaning, do not include fungi.

part of a fungus, in any stage of biological development, whether alive or dead.[327] This inclusion brings fungi clearly within the scope of the protections provided by Part 6 of the *NP Regs* to vegetation. Fungi also benefit from the other prescribed offences relating to the natural values of protected areas more generally.

3 Victorian Conservation Trust Act 1972 *(Vic)*

The *VCT Act* is Victoria's most significant private land conservation statute. It establishes the Trust for Nature (Victoria) ('TFN').[328] The TFN is a not-for-profit organisation with objects that include assisting in the preservation of areas that are ecologically significant, naturally beautiful, or of historical interest; conserving wildlife and native plants; and conserving and creating areas for scientific study relating to those matters.[329] The TFN has power to do all things necessary or convenient for, or in connection with, carrying out these objects.[330] Most significantly, the TFN is responsible for conservation covenants in Victoria, which are agreements with private landowners that bind those owners and, once registered, their successors in title as to the development or use of land or the conservation or care of buildings, bushland, formations, rocks, trees, or other objects.[331]

Fungi are not expressly mentioned in the *VCT Act*. However, despite some express focus on wildlife and native plants, the TFN's key objects relate not to these taxa but to preserving areas of ecological significance or natural interest generally. Such objects, drafted using general terms like 'areas', 'ecological significance', and 'natural interest', impliedly include fungi by their ordinary meaning. Fungus conservation and restoration are therefore permitted impliedly in the exercise of the TFN's powers under the Act to give effect to those objects, including for example by administering conservation covenants on private land for the benefit of fungi.[332]

D *Tasmania*

Three Tasmanian environmental statutes are relevant for the purposes of this thesis: the *Threatened Species Protection Act 1995* (Tas) ('*TSP Act*'), relating to biodiversity conservation; and the *Nature Conservation Act 2002* (Tas) ('Tas *NC Act*') and *National*

[327] *NP Regs* (n 323) reg 5(1) (definition of 'vegetation').
[328] *Victorian Conservation Trust Act 1972* (Vic) s 2 ('*VCT Act*').
[329] Ibid s 3(1).
[330] Ibid s 3(2).
[331] Ibid s 3A.
[332] See Chapter Four Part III(C) for a case study of the TFN.

Parks and Reserves Management Act 2002 (Tas) ('*NPRM Act*'), relating to protected area management.

It is argued that Tasmania's environmental legislation, like Victoria's, is partly ineffective with respect to the inclusion of fungi. In particular, the *TSP Act*, with its focus on 'native flora and fauna', excludes funga from virtually every conservation measure it provides. Like in Victoria, in Tasmania there does not appear to be any lawful basis for listing funga; yet there are numerous lichens in fact listed. In the protected area context, fungi are impliedly included in the key operative provisions about acquisition, reservation, and management of protected areas under the Tas *NC Act* and *NPRM Act*, which relate to 'biological diversity' or 'natural values' more generally rather than flora or fauna specifically.

1 Threatened Species Protection Act 1995 *(Tas)*

The *TSP Act* is Tasmania's chief statute relating to biodiversity conservation.

The key operative provisions of the Act are in Part 3. Division 1 requires the Secretary to prepare a 'threatened species strategy', being 'a strategy for the conservation of threatened native flora and fauna specifying the means by which the objectives of this Act are to be achieved'.[333] Division 2 provides a process for the listing of 'threatened flora and fauna' as 'endangered', 'vulnerable', or 'rare'.[334] Division 3 requires the Secretary to prepare a 'listing statement' for taxa of flora and fauna as soon as practicable after the taxa are listed. Division 4 provides a process for determining critical habitats of listed flora or fauna. Divisions 5 and 6 provide for recovery plans and threat abatement plans in respect to listed flora and fauna.[335] Division 7 allows for land management plans to be made for the purpose of protecting listed flora and fauna. Other notable provisions of the Act include a regime for interim protection orders, which are issued to conserve the habitats of listed threatened fauna, flora, and land

[333] *Threatened Species Protection Act 1995* (Tas) s 10(1) ('*TSP Act*').

[334] The Minister, in deciding on listings under this Division, is assisted by the Scientific Advisory Committee established under s 8 of the Act. All members of the committee are required to have 'special knowledge and experience in the sciences of flora or fauna conservation or ecology', and each member must have particular expertise in either fauna or flora biology, taxonomy, or particular fields of ecology: see ibid s 8(4)–(5).

[335] Notably, unlike the biodiversity legislation of other jurisdictions, the *TSP Act* does not provide for the listing of threatening processes. Threat abatement plans are instead prepared in respect of any process that the Secretary is of the opinion is a threatening process: ibid s 27(1).

within such habitats,[336] and criminal offences that include prohibitions against the taking of listed taxa, the disturbance of listed taxa on land subject to an interim protection order, the disturbance of listed taxa contrary to a land management agreement, and the disturbance of any specimen of a listed taxon contrary to a conservation covenant entered into under Part 5 of the Tas *NC Act*.[337]

Schedule 1 to the *TSP Act* contains 'objectives of the resource management and planning system of Tasmania' ('RMPS Objectives') and 'objectives of the threatened species protection system established by this Act' ('TSP Objectives'). The RMPS Objectives include, among other things, 'promot[ing] the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity'.[338] The TSP Objectives, which are 'in support of' the RMPS Objectives, each relate to the conservation of 'native flora and fauna'.[339] Persons on whom functions are conferred by the *TSP Act* must exercise those functions in such a manner as to further those objectives.[340] Persons exercising functions in the administration of a public authority must, in doing so, consider the objectives for the conservation and management of native flora and fauna.[341]

The *TSP Act* excludes funga from its key operative provisions. Under this Act, 'species' is defined by reference to 'individual flora or fauna'.[342] The definitions of flora and fauna are consistent with their ordinary meanings and are not widened to include funga or any other organisms.[343] Thus, funga are not included within the definitions of 'fauna' or 'flora', and accordingly are not considered 'species' under the *TSP Act*. Yet, there are 28 fungus species — each of them lichens — in fact listed: 9 endangered extant species;[344] 1 endangered species presumed to be extinct;[345] 4

[336] Ibid s 33(a).
[337] Ibid s 51.
[338] Ibid sch 1 s 1(a).
[339] See ibid sch 1 s 3.
[340] Ibid s 4.
[341] Ibid s 5.
[342] Ibid s 3(1) (definition of 'species').
[343] See ibid s 3(1) (definitions of 'fauna', 'flora').
[344] Ibid sch 3 pt 1 div 2 subdiv 4.
[345] Ibid sch 3 pt 2 div 2 subdiv 4.

vulnerable species;[346] and 14 rare species.[347] Like in Victoria, in Tasmania there does not appear to be a clear legal basis for any of these listings.[348]

As was made clear in the preceding paragraphs, virtually every part of the *TSP Act* is focused on flora and fauna. Each of the key measures provided by the Act for conserving biodiversity — the threatened species strategy, listing process, listing statements, recovery plans, threat abatement plans, land management plans, and the offences — relates to native flora and fauna.[349] The only arguable exception is the ability of interim protection orders to specify measures to protect 'the land' within the habitat of listed flora and fauna. However, such orders, like habitat conservation orders made under the *FFG Act*, are unlikely ever to focus on funga given they are clearly intended to be made for the benefit of listed flora or fauna.

2 Nature Conservation Act 2002 *(Tas)*

The Tas *NC Act* is one of two cognate statutes that govern protected area management in Tasmania (the other being the *NPRM Act*). The Tas *NC Act* deals primarily with the reservation and acquisition of land. The *NPRM Act* deals primarily with the management of reserved land.

The main operative provisions for the reservation of land are in Part 3 of the Tas *NC Act*.[350] The Governor may proclaim Crown land as a game reserve, national park, nature recreation area, nature reserve, regional reserve, or state reserve, land vested in a public authority as a conservation area, or private land as a private sanctuary or private nature reserve, if the Governor is of the opinion that such land should be set aside for a

[346] Ibid sch 4 pt 2 div 5.

[347] Ibid sch 5 pt 2 div 6.

[348] Kantvilas, a lichenologist in the Tasmanian Herbarium, confirms that '[s]trictly speaking, and certainly from the perspective of the professional taxonomist, lichens are not plants': Gintaras Kantvilas, 'The Lichen Flora of Tasmania', *Flora of Tasmania Online* (Web Page, 18 June 2023) <https://flora.tmag.tas.gov.au/about/lichens/>. However, cf *The Honourable Mr Llewellyn v The Resource Management and Planning Appeal Tribunal* [2007] TASSC 21, in which Underwood CJ in the Tasmanian Supreme Court seems to have assumed, without considering or deciding the point, that lichens do fall within the meaning of 'flora' under the *TSP Act*. See also Makinson (n 3) 18, who asserts that funga are 'flora' under the *TSP Act*, but without providing any authority, evidence, or reasoning to support the assertion.

[349] See *TSP Act* (n 333) pt 3 and s 51.

[350] Also of note is s 5, which requires a person exercising functions under the *Nature Conservation Act 2002* (Tas) ('Tas *NC Act*') to have regard to the RMPS Objectives specified in Schedule 2. These are the same objectives as are in the *TSP Act*.

conservation purpose.[351] A 'conservation purpose' is defined as any of the purposes for reserving land in a particular class specified in Schedule 1 or any other purpose in the Governor's opinion that would promote the better management or more effective use of any reserved land.[352] The criteria for proclaiming a reserve of a particular class are that the land must possess the values for land of that class specified in Schedule 1 or adjoin an area of already reserved land in that class with those values, and be reserved for a purpose specified in Schedule 1 or any purpose that, in the Governor's opinion, would promote the better management or more effective use of that land or the adjoining reserved land.[353] The Governor and Minister are empowered respectively to acquire or take a lease of land for a conservation purpose.[354] The Minister may enter into management agreements in respect of private land if the Minister is of the opinion that to do so would tend to promote the relevant conservation purposes.[355]

Part 4 of the Tas *NC Act* relates to the 'conservation of fauna and flora'. It does so principally by delegating various conservation matters relating to wildlife and plants to the regulations.[356] The current regulations prescribe matters relating to wildlife[357] but not plants.

Part 5 of the Tas *NC Act* provides for conservation covenants, which, together with the two classes of private protected areas under the Act, provide the principal statutory basis for private land conservation in Tasmania. The Tas *NC Act* authorises the Minister on behalf of the Crown to enter into a conservation covenant with a landowner if the Minister considers it necessary or desirable to do so for a conservation purpose.[358] A conservation covenant may contain such provisions as the Minister and landowner agree to.[359] Conservation covenants run with the land and must be registered on title.[360]

[351] Tas *NC Act* (n 350) ss 11–13.
[352] Ibid s 3(1) (definition of 'conservation purpose').
[353] See ibid s 16.
[354] Ibid ss 14, 15.
[355] Ibid s 25.
[356] See ibid ss 26–28.
[357] See *Nature Conservation (Wildlife) Regulations 2021* (Tas).
[358] Tas *NC Act* (n 350) s 34(1).
[359] Ibid s 34(2).
[360] Ibid ss 34(6), 37.

It is an offence for a person against whom a conservation covenant is enforceable to contravene that covenant.[361]

Fungi are not expressly mentioned in the Tas *NC Act*. However, fungi are arguably included in the definition of 'biological diversity'. This expression is defined to mean the variety of plants, animals and micro-organisms; and the genes contained in plants, animals and micro-organisms; and the ecosystems of which plants, animals and micro-organisms form part.[362] While this definition is inapt for fungi — fungi are neither plants nor animals, nor are all fungi micro-organisms — fungi are part of the ecosystems of which plants, animals, and (non-fungal) micro-organisms also form part, and are thus arguably included in the Act's references to biological diversity. This inclusion is important because the conservation of biological diversity is part of both the values of land and purposes of reservation for many of the classes of reserved land specified in Schedule 1. Thus, as part of biological diversity, fungi can be recognised as part of the values and purposes of reserved lands under the Tas *NC Act*. Schedule 1 also uses more general terms such as 'natural values', 'natural regions, features or scenery', 'natural areas', 'natural states', and 'natural sites of significance', each of which has the potential to include fungi whether or not 'natural biological diversity' is also specified as a value of land or purpose of reservation. The inclusion of fungi in 'biological diversity' and the other general terms also brings fungi impliedly within the scope of 'conservation purposes' under the Act — a concept used not only in the reservation of lands under the Act, but also in acquisitions, conservation covenants, leases, and management agreements. This is significant as, taken together, the various implied inclusions of fungi in the Tas *NC Act* allow lands to be acquired, taken lease of, and reserved partly or wholly for the conservation of their fungal diversity.

Some of the other provisions are also notable for fungi. The first is the ability under this Act to reserve lands based on the mere fact that they adjoin already reserved lands, in cases where reserving such lands would promote the relevant conservation purpose. The clear ability to reserve such lands as 'buffers' — rather than merely enter into agreements in respect of them, as is the case in for example NSW — has potentially great significance for fungus conservation given recent findings, discussed in Chapter

[361] Ibid s 46.
[362] Ibid s 3(1) (definition of 'biological diversity').

Two, that many fungal diversity hotspots seem to be outside protected areas.[363] Also of note is that fungi are not included in the definitions of 'plant' or 'wildlife' under the Tas *NC Act*, which refers to plants (only) and animals respectively.[364] This has the unfortunate consequence that fungi are beyond the scope of the regulation-making powers relating to conservation provided by Part 4 of the Act. Thus, while fungi are within the scope of the key operative provisions relating to the reservation and acquisition of land, as well as conservation covenants, they are beyond the scope of any potential regulations that might have otherwise sought to conserve them.

3 National Parks and Reserves Management Act 2002 *(Tas)*

The *NPRM Act* is the other of the two cognate Acts that govern protected area management in Tasmania. It deals with the management of lands that have been reserved under the Tas *NC Act*.

Underpinning the *NPRM Act* are 'objectives for management of reserved land' ('Reserve Management Objectives'). The objectives are provided for each class of reserved land established under the Tas *NC Act*. Each class includes, among other things, objectives to conserve natural biological diversity and to protect the reserve against, and rehabilitate the reserve following, adverse impacts on natural values and assets within and adjacent to the reserve.[365] The Act also includes the RMPS Objectives and, like the *TSP Act* and Tas *NC Act*, requires persons exercising functions under the Act to have regard to those objectives.[366] However, the Reserve Management Objectives and any management plans made under the *NPRM Act* prevail over the RMPS Objectives to the extent of an inconsistency.[367]

Part 3 of the *NPRM Act* contains the main operative provisions for the management of reserved land in Tasmania. Under s 19, the Governor may approve plans for the use, development, and management of reserved land. A management plan must specify matters such as the purposes for which the land was reserved, the relevant Reserve

[363] See in particular n 107 and the body text it accompanies.
[364] See Tas *NC Act* (n 350) s 3(1) (definitions of 'plant', 'wildlife'). Somewhat unscientifically, 'plant' is defined by reference to the 'vegetable' kingdom, and 'wildlife' is defined by reference to 'living creatures'.
[365] *National Parks and Reserves Management Act 2002* (Tas) sch 1 table col 2 rows 1(a), 1(g), 2(a), 2(h), 3(a), 3(g), 4(a), 4(i), 5(a), 5(k), 6(a), 6(h), 7(c), 7(i), 8(b), 8(g), 9(a), 9(f), 10(a), 10(f) ('*NPRM Act*').
[366] Ibid s 5(1), sch 2.
[367] Ibid s 5(2)–(3).

Management Objectives for the land, and how those management objectives are to be achieved.[368] The formulation of management plans is the responsibility of the Director of National Parks and Wildlife, who must, before preparing a draft management plan, give notice to the Secretary under the Tas *NC Act* and invite the Secretary of the responsible Department in relation to that Act to provide information and prescriptions in relation to, among other things, 'flora' and 'fauna'.[369] The Director in preparing the draft management plan must consider the purposes of the reservation and the Reserve Management Objectives for the relevant class.[370] Following public consultation and reviews,[371] the Minister must submit a draft management plan to the Governor for approval after considering, among other things, the purposes of the reservation and the management objectives for the relevant class of reserved land.[372] The managing authority for the reserved land must give effect to a management plan once made,[373] and otherwise must manage the land consistently with the purposes for which it was reserved and having regard to Reserve Management Objectives for the relevant class.[374]

The *NPRM Act* makes various provisions to protect reserved lands. For example, it is an offence to 'cut down a tree, or damage or otherwise destroy a tree or a fallen tree, that is on reserved land without the approval of the managing authority'.[375] However, most of the minutiae about the care, control, and management of reserved lands is delegated to the regulations.[376] The *National Parks and Reserves Management Regulations 2019* (Tas) ('*NPRM Regs*') prescribe various offences for the general protection of reserved land.[377] Most relevantly, the *NPRM Regs* make it an offence to 'interfere with, dig up, cut up, collect or remove … any timber, firewood, humus or other natural substance' on reserved land.[378]

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[368] See ibid s 27.
[369] Ibid s 20(2)–(3). A management plan in respect of a private sanctuary or private nature reserve may only be prepared in consultation with the landowner: ibid s 20(8).
[370] Ibid s 20(11).
[371] Ibid ss 20(12), 21–24.
[372] Ibid ss 25(2), 26(2)(a).
[373] Ibid s 30(1)(a).
[374] Ibid s 30(1)(b).
[375] Ibid s 36.
[376] Ibid s 60(1)(a)–(c).
[377] See *National Parks and Reserves Management Regulations 2019* (Tas) pt 2 ('*NPRM Regs*').
[378] Ibid reg 5(2)(c).

Fungi are not mentioned expressly in the *NPRM Act*. The Act has the same definitions of 'biological diversity', 'plant', and 'wildlife' as the Tas *NC Act*[379] — thus, as argued in Part II(D)(2) above, fungi are impliedly included in references to 'biological diversity' but are not included in references to 'plants' or 'wildlife'. The inclusion of fungi in 'biological diversity' is key, given the management objectives of each class of reserved land include an objective to conserve 'biological diversity'. This objective permits the conservation of fungi as part of biodiversity. Similarly, each class of reserved lands has a management objective relating to protecting the reserve against, and rehabilitating it following, adverse impacts to 'natural values'. Arguably, fungi are included within the scope of 'natural values' and thus would be permitted to be protected and rehabilitated as part of management actions taken in accordance with this objective. The implied inclusion of fungi in these general terms means that fungus conservation and restoration are permitted to be considered in the process of making management plans, the content of such plans, and management actions taken to implement such plans. Furthermore, for reserves without management plans, fungus conservation and restoration may be permitted in pursuance of the same Reserve Management Objectives consistently with which the land must be managed. However, it is unfortunate that the Secretary under the Tas *NC Act* is only required to be invited to provide information and prescriptions about flora and fauna and not funga, as this may be a key input for the Director of National Parks and Wildlife in deciding what to include in a management plan.

Fungi also fall within the other protections in the *NPRM Act*. The offence in s 36 prohibiting the destruction of trees, including fallen trees, would protect the many diverse fungi that inhabit living, dying, and dead trees. The offence in the *NPRM Regs* against interfering with 'natural substances' would arguably extend to include all types of fungi, no matter their substrate. Fungi are thus impliedly included in the key operative provisions for the management of reserved lands in Tasmania.

E *Australian Capital Territory*

The chief biodiversity and protected area statute in the ACT is the *Nature Conservation Act 2014* (ACT) ('ACT *NC Act*'). It is supplemented by the *Planning Act 2023* (ACT) ('*Planning Act*') to the extent that Act provides for the creation of public reserves.

[379] *NPRM Act* (n 365) s 3(1) (definitions of 'biological diversity', 'plant', 'wildlife').

It is argued that fungi are included in the ACT *NC Act* both expressly and impliedly. Fungi are expressly included by the Act's enlarged definition of 'plants'. Fungi are impliedly included by the Act's general definitions of terms like 'biodiversity', 'conservation', 'ecological community', 'nature', and 'species'. The express and implied inclusions have the effect of bringing fungus conservation and restoration within the scope of much of the ACT *NC Act*. While no fungi are currently listed under the ACT *NC Act*, it is argued that the Act's potential for protecting fungi is of great significance. The ability to list lookalike species, the diverse categories of listing, and the proactive approach to biodiversity conservation are each particularly notable for fungi. However, the inclusion of fungi by statutory enlargement of the ordinary meaning of 'plants' is argued to be ineffective in the Act's provisions relating to native vegetation — revealing a critical weakness in the approach of including fungi in environmental legislation as plants. In the *Planning Act*, fungi are not expressly mentioned. Instead, fungi impliedly fall within the scope of the natural environment, which is required to be conserved as an objective of protected areas established by that statute.

1 Nature Conservation Act 2014 *(ACT)*

The main object of the ACT *NC Act* is 'to protect, conserve and enhance the biodiversity of the ACT'.[380] The Minister is required to have regard to this object in exercising functions under the Act.[381]

The Act establishes various administrative entities, including the 'Conservator of Flora and Fauna' ('Conservator').[382] The Conservator's main functions are to develop and oversee plans, policies, and programs for the effective management of nature conservation in the ACT, monitor the state of nature conservation in the ACT, and provide information for state of the environment reporting.[383] The Conservator has other functions imposed on it by the Act,[384] which include preparing a native conservation strategy for the ACT.[385]

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[380] *Nature Conservation Act 2014* (ACT) s 6(1) ('ACT *NC Act*').
[381] Ibid s 6(3).
[382] Ibid ch 2 pt 2.1.
[383] Ibid s 21(1).
[384] Ibid s 21(2).
[385] See ibid ch 3.

Like Commonwealth and NSW environmental legislation, the ACT *NC Act* provides for the listing of threatened species and ecological communities and KTPs.[386] The eligibility criteria for these listings are not specific to any kingdom of life.[387] Any person may nominate a species or ecological community for listing, transfer, or delisting to the Scientific Committee established by the Act.[388] The Scientific Committee may assess the nomination and advise the Minister, who then makes a decision about the nomination.[389] The Scientific Committee must prepare a conservation advice and the Conservator must prepare an action plan for each item included in a list.[390] The Conservator must implement and monitor the effectiveness of an action plan.[391] Like the *EPBC Act*, the ACT *NC Act* allows the Minister to amend the threatened species list to include (or omit) lookalike species.[392]

The ACT *NC Act* provides a separate regime for the listing of 'protected' species.[393] The current categories of protection are 'restricted trade', 'rare', and 'data deficient'.[394] The Conservator may prepare a native species conservation plan for protected species and any other species the Conservator considers appropriate.[395] Once made,[396] the plan must be implemented.[397] The Conservator must monitor the effectiveness of the plan.[398]

The ACT *NC Act* also provides for the management of protected areas.[399] Three types of public reserves are provided under the ACT *NC Act*: national parks, nature

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[386] See ibid ch 4.

[387] Ibid ch 4 pts 4.1, 4.2; *Nature Conservation (Key Threatening Processes Eligibility) Criteria 2016*; *Nature Conservation (Threatened Native Species Eligibility) Criteria 2016* (ACT); *Nature Conservation (Threatened Ecological Communities Eligibility) Criteria 2016* (ACT). One exception is the limitation of the 'conservation dependent' category of threatened species listing to fish, but this limitation is irrelevant for the purposes of this thesis.

[388] ACT *NC Act* (n 380) s 81.

For the provisions about the Scientific Committee, see ch 2 pt 2.4. Committee members are required to have 'appropriate scientific expertise in biology, ecology, conservation science, or conservation management': s 36(3). No taxon-specific expertise is required.

[389] See ibid ch 4 pt 4.4.

[390] Ibid ch 4 pt 4.4 div 4.4.4, pt 4.5.

[391] Ibid ss 107, 108.

[392] Ibid ss 95, 96.

[393] Ibid ch 5.

[394] Ibid s 111(2).

[395] Ibid s 117.

[396] Ibid s 122.

[397] See ibid s 124.

[398] Ibid s 125.

[399] Ibid ch 8. The reservation of public lands is a process under the *Planning Act 2023* (ACT) ('*Planning Act*'), which is discussed in the next section.

reserves, and wilderness areas.[400] The 'custodian' of a reserve[401] is required to prepare a management plan for the reserve that, among other things, describes how the 'planning and development management objectives' for the reserve are to be implemented or promoted in the reserve.[402] The planning and development management objectives are those specified in the *Planning Act*.[403] Once the Minister has approved a management plan for a reserve,[404] the custodian of a reserve must take reasonable steps to implement the plan and report every five years on its implementation.[405]

The ACT *NC Act* provides two key sets of offences: one relating to the protection of native species; the other relating to reserves.[406] Relevantly, for native 'plant' species, it is an offence to take, sell, import, or export a 'protected native species' (ie, listed protected native species[407]) or a species that has 'special protection status' (ie, it is listed in the ACT or Commonwealth as a threatened species or in the Commonwealth as a migratory species[408]).[409] It is an offence to take or sell any native plant on unleased land.[410] Fallen native timber is protected by offences that prohibit damaging fallen native timber more than 10 cm in diameter on unleased land or taking such timber from unleased land or leased land outside a built-up urban area.[411] In reserves, it is an offence to damage a native plant, take into the reserve a plant or plant reproductive material, plant a plant, remove soil or stone, or damage, destroy, or remove natural structures or features.[412] It is also an offence to clear 'native vegetation' or damage land in a

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[400] ACT *NC Act* (n 380) ss 169, 170.
[401] This being the 'administrative unit or other entity with administrative responsibility for [the] land': ibid Dictionary (definition of 'custodian'); *Planning Act* (n 399) Dictionary (definition of 'custodian').
[402] See ACT *NC Act* (n 380) ch 8 pt 8.3. For a reserve that is assigned to an IUCN category, the plan must also be consistent with the IUCN reserve management objectives for that category and describe how those objectives are to be implemented or promoted: s 176(c). However, the IUCN reserve management objectives are those prescribed by the regulations, and the current regulations do not prescribe any such objectives: see s 173; *Nature Conservation Regulation 2015* (ACT).
[403] ACT *NC Act* (n 380) Dictionary (definition of 'planning and development management objectives'). See Part II(E)(2) below.
[404] Ibid s 183.
[405] Ibid ss 188, 189.
[406] See ibid chs 6 and 9 respectively.
[407] Ibid s 110.
[408] Ibid s 109.
[409] Ibid ss 142, 143, 148, 150, 151.
[410] Ibid ss 140, 141.
[411] Ibid s 146.
[412] Ibid ss 218–222.

reserve,[413] including by causing loss to a listed ecological community.[414] It is not an offence under the ACT *NC Act* to cause loss to a listed ecological community outside a reserve.

Fungi are expressly included in the ACT *NC Act* as plants. 'Plant' is defined to mean, among other things, 'a member, alive or dead, of the … fungus kingdom'.[415] Thus, the references to 'plants' in the Act include fungi, subject to any contrary intention.[416] This means, for example, that all of the offences applying to native plant species under the Act also apply to native fungus species. The inclusion of fungi in the offence of taking and selling native plants from unleased land is particularly beneficial, given that no fungi are listed as protected under the Act. The inclusion of fungi as plants also means that fungi are included in the definition of 'ecosystem', which is otherwise inaptly defined (for reasons given earlier) as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'.[417] This permits the inclusion of fungi in the ecosystem-level approaches to conservation and restoration under the Act, such as proposals for conserving significant ecosystems or restoring habitats in a nature conservation strategy made under the Act.[418]

There are, however, instances where the statutory enlargement of the meaning of 'plants' to include fungi is arguably displaced. The clearest example is in the native vegetation-related offences. Native vegetation is defined under the Act as indigenous 'trees', 'understorey plants', 'groundcover consisting of any kind of grass or herbaceous vegetation', and 'plants occurring in a wetland or stream in the area'.[419] At first blush, this definition would seem to include fungi — the statutory definition of 'plant' enlarges that word's ordinary meaning to include a fungus, and the word 'plant' is used in the definition of 'native vegetation'. But the definition uses botanical categories that do not translate easily to fungi. No fungi are 'trees'; fungi may or may not be 'understorey plants' depending on what the 'understorey' includes (eg, does it include epiphytic

[413] Ibid ch 9 pts 9.4, 9.5.
[414] See the definitions of 'serious harm' in ibid ss 235 and 244 and the offences against causing serious harm to a reserve in ss 236 and 245.
[415] Ibid s 13(a)(ii) (definition of 'plant').
[416] *Legislation Act 2001* (ACT) s 155(1) ('*Legislation Act*').
[417] ACT *NC Act* (n 380) Dictionary (definition of 'ecosystem').
[418] See ibid ch 3.
[419] Ibid s 232.

lichens that attach to plants in the understorey?); no fungi are 'herbaceous'; and fungi can occur in wetlands or streams. This inclusion — wetland fungi and perhaps fungal epiphytes in the understorey — seems so inconsistent as to be nonsensical. The categories of native vegetation given by the Act cannot be construed more expansively to include other types of fungi without 'gap-filling' the legislation, which is an illegitimate interpretive exercise.[420] If this is accepted, then the definition of 'native vegetation' in the ACT *NC Act* seems to be an instance where the statutory definition of 'plant' does not apply insofar as it extends to fungi.[421] It follows that the offences protecting native vegetation do not apply to fungi.

The inclusion of fungi in the ACT *NC Act* goes beyond the definition of 'plant'. Fungi are also impliedly included in the general definitions of terms such as 'biodiversity',[422] 'conservation',[423] 'ecological community',[424] 'nature',[425] and 'species'.[426] This brings fungi within the scope of the key operative provisions of the Act, including the main object relating to biodiversity, the provisions for listing a species or ecological community as threatened or protected, and the nature conservation strategy. This also means that, despite the title of the office, the Conservator (of 'Flora and Fauna') can also exercise functions under the Act in respect of funga.[427]

Currently, there are no listed threatened native species, protected native species, or threatened ecological communities of fungi in the ACT, nor any KTPs that directly

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[420] *Taylor v Owners – Strata Plan No 11564* (2014) 253 CLR 531, 548 [38] (French CJ, Crennan and Bell JJ), quoting *Marshall v Watson* (1972) 124 CLR 640, 649 (Stephen J).

[421] See *Legislation Act* (n 416) s 155(1). This provision, which is included in various forms in the interpretation legislation across Australia, is consistent with the common law rule that a definition applies to the construction of a statutory provision except insofar as the context or subject-matter otherwise indicates or requires: see, eg, *Hall v Jones* (1942) 42 SR (NSW) 203. This is because of a definition is not a substantive law, but rather an aid to construing a statute: *Kelly v The Queen* (2004) 218 CLR 216, 253 [103] (McHugh J) ('*Kelly*'). See further Dennis C Pearce, *Statutory Interpretation in Australia* (LexisNexis, 10th ed, 2024) 317–320 [6.17]–[6.21].

The argument just made about the ACT *NC Act* is equally applicable to other legislation that defines 'native vegetation' by reference to botanical categories and where fungi are purported to be included by an enlarged definition of 'plant': see, eg, the definition of 'native vegetation' in *Local Land Services Act 2013* (NSW) ss 60B(1) ('*LLS Act*'), which is adopted by the *BC Act* (n 232) in s 1.6(1).

[422] ACT *NC Act* (n 380) s 19.

[423] Ibid s 10.

[424] Ibid s 17.

[425] Ibid s 9.

[426] Ibid s 15.

[427] See ibid s 21(1)(a)–(b).

implicate fungi as a threat.[428] However, the potential for fungus conservation and restoration under this Act is particularly noteworthy compared to other Australian environmental statutes considered in this chapter. First, as with the *EPBC Act*, any future listed threatened fungus species would benefit significantly from the ability to list lookalike species. Second, it is possible to list fungi that do not meet the eligibility criteria for being threatened with extinction for other reasons — being rare, data deficient, or a restricted trade species is enough to qualify for protection under the ACT *NC Act*. Third, the proactive approach to conservation also benefits fungi — a native fungus need not be listed to enjoy some protection under the law.[429] Finally, there are provisions that do not expressly attend to fungi but still have the effect of conserving or restoring fungi to some extent. The clearest of these is the offence against damaging fallen native timber, which would protect the ecological successions of fungi that are involved in the decomposition of dead wood.

2 Planning Act 2023 *(ACT)*

The *Planning Act* is relevant insofar as it provides for the creation of public reserves in the ACT.

The *Planning Act* allows the Conservator or the custodian of an area of unleased land to recommend to the Territory Planning Authority that the Territory Plan be amended to designate an area of land as public land and reserve that land for a particular

[428] See *Nature Conservation Threatened Native Species List 2024* (ACT); *Nature Conservation Protected Native Species List 2023* (ACT); *Nature Conservation Threatened Ecological Communities List 2020* (ACT); *Nature Conservation Key Threatening Processes List 2019* (ACT).

[429] This may be a hollow victory given the successful prosecution of the offences protecting unlisted biodiversity still requires the identification of the fungus, given the 'nativeness' element of the offences. It seems impossible to prove beyond doubt that a particular fungus is 'native' to the ACT without also identifying the fungus. In many cases this difficulty may reduce the prospects of the prosecutor's success to near-zero, not only because of the dearth of mycological information in Australia generally but also the reported dearth of mycological expertise among, or accessible to, enforcement officers on whom prosecutors rely to give evidence in criminal proceedings: see Ray Kearney and Elma Kearney, Submission No 91 to Independent Biodiversity Legislation Review Panel, *Biodiversity Legislation Review* (31 August 2014) 6 <https://www.environment.nsw.gov.au/resources/biodiversity/reviewsubmissions/91DrRayKearney.pdf >.

purpose.[430] The purposes for which public land may be reserved include national parks, nature reserves, and wilderness areas.[431] Each of these reserves is part of the NRS.[432]

Once designated as public land,[433] the land must be managed by the custodian in accordance with the public land management plan for the area and the management objectives applying to the area.[434] For a reserve, a public land management plan is a reserve management plan under the ACT *NC Act*.[435] The management objectives applying to the area are provided for in sch 3 pt 3.2 col 3 of the *Planning Act*.[436] National parks and nature reserves have two objectives, one of which is 'to conserve the natural environment'.[437] Wilderness areas have a similar objective, which is 'to conserve the natural environment in a manner ensuring that disturbance to that environment is minimal'.[438]

Fungi are not expressly mentioned in the *Planning Act*. However, neither are plants or animals. The most important term is 'natural environment', the conservation of which is a management objective for public reserves in the ACT. The 'natural environment' is defined to mean 'all biological, physical and visual elements of the earth and its atmosphere, whether natural or modified'.[439] Clearly, fungi are 'biological … elements of the earth' and thus included impliedly by this definition. This means that the management objective 'to conserve the natural environment' extends to fungi. Fungi are thus permitted to be conserved as part of management actions taken in public reserves in accordance with this objective.

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[430] *Planning Act* (n 399) s 384. The 'Territory Plan' is a notifiable instrument made under the *Planning Act* that maps districts and land use zones in the ACT and sets out planning principles and policies: see ibid ch 5. The 'Territory Planning Authority' is the chief planner in the ACT and has functions that include preparing and administering the Territory Plan: see ibid ch 3.

[431] Ibid s 385.

[432] See 'Terrestrial CAPAD 2022 ACT Summary', *Commonwealth Department of Climate Change, Energy, the Environment and Water* (Spreadsheet, 21 November 2023) <https://www.dcceew.gov.au/sites/default/files/documents/capad2022-terrestrial-act.xlsx>.

[433] The processes for amending the Territory Plan are set out in the *Planning Act* (n 399) ch 5 pts 5.3, 5.4.

[434] Ibid s 386.

[435] Ibid s 388.

[436] Additional management objectives may be determined by the Conservator: ibid s 387.

[437] Ibid sch 3 pt 3.2 rows 2(a), 3(a).

[438] Ibid sch 3 pt 3.2 row 1(a).

[439] Ibid sch 3 pt 3.1 (definition of 'natural environment').

III Discussion and Conclusion

The previous chapter argued that fungi warrant specific attention. This chapter has sought to understand whether Australian environmental legislation pays fungi specific attention — or indeed any attention all.

The analysis has shown that Australian environmental legislation rarely pays specific attention to fungi. Indeed, the law's treatment of fungi can be understood as being on a spectrum of neglect.

While some statutes include fungi in most or all of their key operative provisions, either expressly or impliedly (or both), all statutes are neglectful in that they universally misdescribe or fail to recognise fungi. If Australian environmental legislation mentions fungi at all, it is only to define them as 'plants' — as is the case in the Commonwealth, ACT, and NSW. No environmental statute reflects the long-held scientific understanding that fungi constitute their own kingdom of life. In the instances where statutes fail to describe fungi, in some instances this is relatively benign as fungi are still impliedly included — for example, in the protected area statutes considered in this chapter.[440] But in other cases, nondescription means that fungi are excluded from key operative provisions of environmental legislation — for example, the *FFG Act* in respect of threatened taxa and communities and the *TSP Act*.

As would be expected when considering five different jurisdictions in a federation, there is significant variation in how the environmental statutes considered in this chapter actually include, or may potentially be apt for, fungi. The actual inclusion depends significantly on the drafting of statutory definitions — an aspect of environmental legislation that this chapter has thrown into sharp relief. Words or expressions that may on first reading be glossed over, assumed only to deal with minor technical matters, have been shown to have radical effects on the scope of a statute. For example, a definition may clearly, effectively, and expressly extend the application of a statute to fungi (eg, the *BC Act*); may make it unclear whether, and if so on what basis, a statute can be applied to fungi (eg, the *FFG Act*); or may attempt to include fungi but fail in particular statutory contexts (eg, the ACT *NC Act* in respect of 'native

[440] The word 'relatively' should be emphasised in light of the discussion in the next chapter, which considers whether this manner of including fungi (as opposed to paying them specific attention in the statute) has resulted in any significant practical consequences for their conservation or restoration.

vegetation'). In terms of the aptness of particular statutes for fungus conservation or restoration, this seems to be a consequence of the statutes' approach to biodiversity conservation generally rather than because of any special attention paid to the conservation or restoration needs of fungi. For example, in the Commonwealth it is only possible to list species that are threatened with extinction, whereas in the ACT it is also possible to list species that are data deficient, rare, or restricted in trade — categories of potential significance to fungus conservation, given so many Australian fungi are data deficient (and may well be rare or trade exposed also). Similarly, in the Commonwealth and the ACT it is possible to list lookalike species, but this does not seem possible in NSW, Tasmania, or Victoria.

One of the starkest findings of this analysis is how relatively few fungi are listed as threatened or otherwise in need of protection under any environmental legislation. Only 45 out of the estimated 50,000–250,000 fungus species in Australia, and only 2 ecological communities of fungi, are listed under environmental law for protection.[441] It is particularly notable that there are no fungus species or ecological communities listed under the *EPBC Act*. It seems improbable that not a single Australian fungus species is threatened at the national scale, especially considering there are Australian fungi listed as globally threatened under the IUCN Red List.[442] The lack of listings is consequential for fungus conservation: there is an unknowably large number of

[441] See Appendix One Figure 1 for a complete statement of the entities listed for protection.,Obviously, this does not include entities that have been nominated but not yet determined or for which nominations are being prepared. There are at least two such entities: *Hypocreopsis amplectens*, a species proposed to be listed as critically endangered under the *EPBC Act*; and *Cyttaria septentrionalis*, a species proposed to be listed as vulnerable under the *BC Act*: Interview with Sapphire McMullan-Fisher (n 101).

Although consideration of the other Australian jurisdictions is strictly outside the scope of this thesis, an initial review by this author indicates there are no other fungi listed under law for protection in Australia. Thus, the numbers given in this thesis represent the total number of listings across Australia. It must be emphasised that this number reflects the listings under law, not under government policy or some other administrative determination. For example, Western Australia maintains a non-statutory list of 'priority' species that warrant monitoring or evaluation: see 'Threatened Species and Communities', *Western Australian Department of Biodiversity, Conservation and Attractions,* (Web Page, 2025) <https://www.dbca.wa.gov.au/management/threatened-species-and-communities>.

The findings given here are generally consistent with the most recent mycological literature: see, eg, 'Australasian Fungi Conservation Group' (n 3); May et al, 'The Impacts of the 2019–20 Wildfires on Australian Fungi' (n 4) 129 (although in both cases the 'priority' species in Western Australia are mistakenly included as listings under law). The findings are inconsistent with the numbers of species and ecological communities reported by Fungimap Inc, but this seems simply to be because their report is out of date: 'How Well Are They Conserved?' (n 3).

[442] See Chapter Two Part III(A).

potentially threatened fungus species and ecological communities that may be prone to 'secret extinctions'[443] without the protections conferred to listed entities by environmental law. By contrast, efforts have been made in the majority of jurisdictions to list fungi as threats.[444] While this is really a function of the implementation of law (getting nominations for listings, etc) rather than the statutory design, the imbalanced approach to fungi does little but contribute to the perception that fungi are more often a problem to be managed than an essential part of the ecosystem that warrants specific conservation and restoration attention.[445]

The analysis has revealed not only a certain neglect of fungi by Australian environmental law, but also a certain dysfunction — the laws that exclude fungi are among the only laws that have been used to date to list fungus species for protection. Only one of the three jurisdictions considered in this chapter which provide a clear legal basis for listing fungi for protection, NSW, actually has any fungi listed; whereas the two jurisdictions that were argued not to have such a clear legal basis, Victoria and Tasmania, both have fungi listed. Of course, it is preferable that fungi known to be threatened or otherwise in need of protection be listed under Australian environmental law; but it is also preferable that there be a clear legal basis to do so.

It must be acknowledged that the current inclusion of fungi in environmental legislation — as variable, neglectful, and dysfunctional as it might be — does have significant consequences for their conservation and restoration. Whether as an artificial extension of 'plants' or as an implied component of 'biodiversity', fungi are afforded real conservation and restoration opportunities by existing environmental legislation. Perhaps the most significant of these is the opportunity to be listed as threatened species or ecological communities, or in some other category of protection recognised by law, in most jurisdictions. Despite this protection mechanism being underutilised for fungi to date, it is of critical importance given most of the requirements and prohibitions of Australian environmental legislation — such as protections of criminal law and requirements to make strategies to reduce the extinction risk of the species or

[443] Pouliot, *The Allure of Fungi* (n 3) 241.

[444] See Appendix One Figure 2 for the threat listings that directly implicate fungi.

[445] Pouliot characterises the imbalance more forcefully as 'negligence and misunderstanding … deeply embedded within government thinking and legislation', correlating it with the 'th[e] ignorance and confusion about fungi [that] exist[s] within the public realm': Pouliot, *The Allure of Fungi* (n 3) 242.

community — only apply to listed entities.[446] The implied inclusion of fungi across most Australian environmental legislation is also significant, particularly as it means that fungi can be included in the management of protected areas. Each of these findings is significant and should be acknowledged — yet it should also be acknowledged that these findings have only been arrived at through varyingly elaborate exercises in statutory interpretation. No statute simply says that it applies in relation to fungi. Despite being so important to the flourishing of terrestrial life on Earth, fungi seem to have been treated like an afterthought — if they have been thought about at all.

It is appropriate to conclude this analysis by reflecting on some of the assertions made in the literature about the inclusion of fungi by Australian environmental law. The assertions include the following:

> Fungi are tacitly included in most environmental legislation, although rarely explicitly mentioned. A major shortcoming of this approach is the underlying assumption that protection of fauna and flora also provides adequate protection of fungi.[447]
>
> Under Victoria's *Flora and Fauna Guarantee Act 1998* (FFG) [sic] and the equivalent legislation from most other Australian states and territories, fungi are considered to be plants. They therefore fall under the same assumptions that are used to protect plants.[448]

This chapter has mostly substantiated these assertions.

It is true that fungi are included only impliedly in the majority of environmental legislation. But there is also a significant minority of legislation in which they are expressly included. The express inclusion is only to include fungi within the statutory meaning of 'plants'. Certainly, this manner of inclusion is inadequate, not only because it is not scientifically correct but because, as has been shown in the analysis, such definitions can be displaced. But it does have merit. By defining fungi as including plants, fungi are read into the substantive enactment each time plants are referred to — that is to say, when 'plant' appears, it is read as though it says 'plant or fungus'.[449] Thus, the inclusion of fungi only in a definition is not just a minor technical detail. It has

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[446] It should be noted that there are many other legal consequences that apply only to listed threatened entities, including obligations relating to environmental impact assessment and biodiversity offsetting for development, that are beyond the scope of this thesis to discuss.

[447] Pouliot and May, 'The Third "F"' (n 3) 42, citing Peter K Buchanan and Tom W May, 'Conservation of New Zealand and Australian Fungi' (2003) 41(3) *New Zealand Journal of Botany* 407.

[448] Pouliot, *The Allure of Fungi* (n 3) 240.

[449] See *Kelly* (n 421) 253 [103] (McHugh J).

significant legal consequences. It means that, subject to any contrary intentions in particular cases, where a statute does provide protections for plants, it also provides the same protections for fungi. Of course, whether those protections are adequate for fungi (or plants for that matter), or whether that manner of including fungi has had the extra-legal effect of fungi being conserved in practice as plants despite their unique requirements, is beyond the scope of this thesis to consider.

It is also true that the majority of jurisdictions that expressly include fungi do so by defining them as plants. But that is not the case with the *FFG Act*. Unlike the ACT, Commonwealth, and NSW, Victoria does not define flora as including funga expressly, but rather only includes as flora other living things that are 'generally classified' as flora. The *FFG Act* seems to have been interpreted by some as including funga — as made abundantly clear by the fact that there are listings of funga in Victoria — but to this author there does not seem to be a sound basis for that interpretation.

The analysis in this chapter has shown a clear need for law reform to ensure that fungi are properly recognised by, and integrated into, Australian environmental law. The question of how best to do so is considered in Chapter Five. But it should first be asked whether the current inclusion of fungi in Australian environmental law, such as there is, has had any significant practical consequences for their conservation or restoration. It is to this question that the next chapter turns.

Fungi-focused management signage at Lane Cove Bushland Park, Lane Cove

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CHAPTER FOUR

FUNGI IN ENVIRONMENTAL LITIGATION AND CONSERVATION PRACTICE

I INTRODUCTION

The previous chapter analysed the inclusion of fungi in Australia's environmental legislation. It argued that fungi are included in the design of most environmental laws, either expressly through references to fungi or impliedly through the use of more general environmental concepts that include fungi by their defined or ordinary meanings.

This chapter turns from matters of statutory design to matters of implementation. 'Implementation' is taken broadly to mean all the various ways in which environmental law is given effect. The purpose of this chapter is to consider whether the express or implied inclusion of fungi in Australian environmental laws, such as there is, has had any significance consequences for fungus conservation or restoration in practice.[450]

The argument in this chapter is approached by way of two case studies. The first case study is an analysis of Australian court and tribunal decisions with respect to fungi. It is argued that the current manner of including fungi in environmental law has resulted in no significant consequences for fungus conservation or restoration in litigation. This is because there have been no cases within the scope of 'environmental' law, as defined in Chapter One, in which the needs of fungi have arisen centrally in a dispute. The second and third case studies are, respectively, analyses of conservation strategies for the *Hygrocybeae* community of LCBP in Sydney, NSW, an ecological community listed as critically endangered under the *BC Act*, as well as its individually listed threatened member species; and content analyses of public reserve and private protected area management plans. It is argued that listing fungi as threatened species or threatened ecological communities has had significant consequences for their conservation through the allocation of management resources, but merely mentioning or impliedly

[450] The 'significant consequences' discussed in this chapter are distinguishable from the significant consequences that arise from the text of the legislation itself — for example, the significant consequence that including fungi expressly or impliedly means that they are eligible to be listed as threatened species or ecological communities. Those consequences were discussed in Chapter Three.

including fungi in protected area legislation seems to have had few consequences in protected area management planning. It is suggested that a requirement to actually conserve or restore fungi needs to attend their express or implied inclusion in legislation if there is to be any real assurance that fungi will be actively managed for in practice.

II FUNGI IN COURT AND TRIBUNAL DECISIONS

A *Analysis*

Given fungi are expressly or impliedly included in the operative provisions of many Australian environmental statutes, the question arises whether that inclusion has resulted in any litigation in which the needs of fungi in a conservation or restoration context have been raised as a real issue in the proceeding.

While there are no doubt many decisions which have had the practical effect of conserving or restoring fungi without their being mentioned — indeed, fungi are probably not thought of at all in most environmental litigation — the surer guide to an answer is the presence of fungi in court and tribunal decisions (ie, express references to fungi in the text).

The author has undertaken an analysis of the presence of fungi in Australian court and tribunal decisions publicly available online. The search was carried out on the Westlaw Australia online legal research database (with other databases accessed where Westlaw did not have the full text), limited to cases within Westlaw's 'Key Number' classification of 'environment and planning' that included any of the following terms:

- 'fung!' (ie, 'fungus' and its cognates).
- 'lichen'.
- 'mould'.
- 'mushroom'.
- 'mycelium'.
- 'mycorrhiza'.
- 'mycota'.
- 'saprophyte'.
- 'toadstool'.
- 'truffle'.

B *Results and Discussion*

At the time of writing, there is not a single Australian court or tribunal decision within the scope of 'environmental' law as defined in Chapter One in any of the jurisdictions considered in this thesis in which the conservation or restoration of fungi has been expressly discussed as a real issue in the proceeding.[451]

Why might it be this be the case? Putting to one side the possibility of a flawed search methodology,[452] there seem to be at least six contributing factors:

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[451] The case which comes the closest is *Orica* (n 282), noted in Chapter Three, in which Preston CJ in the NSWLEC considered the removal of lichens on rocks to be part of the environmental harm caused by the commission of an offence of damaging vegetation under s 156A(1)(b) of the *NPW Act*: [75]. This was relevant to consider as part of the objective seriousness of the offence, and thus the appropriate sentence to be imposed by the Court. However, beyond this single reference to lichen removal, fungi were not otherwise considered in the case. So, it seems overly generous to characterise this as a case in which the needs of fungi were a 'real issue' in the proceeding.

Even when 'environmental' law is understood in a much broader sense — for example, in connection with related areas beyond the scope of this thesis like planning law — there are very few cases in which fungi are expressly mentioned. One of the most notable of these cases which directly intersects with the subject-matter of this thesis is *Sandy Outlook Pty Ltd v Ku-ring-gai Council* [2024] NSWLEC 1111. This was a merits appeal against a refusal of a development application for residential subdivision and associated vegetation removal and other works. The development application triggered biodiversity assessment and offsetting requirements under the *BC Act*. One of the 'biodiversity values' that would be affected by the proposed development was *Hygrocybe austropratensis*, a listed endangered fungus under sch 1 pt 2 div 2 of the *BC Act* (and one of the member species of the *Hygrocybeae* community of LCBP discussed in this chapter). The biodiversity development assessment report that supported the development application included an expert report prepared specifically in relation to the threatened fungus. The Court ultimately granted consent to the development application subject to conditions. The conditions included numerous measures to protect the habitat of the fungus, including temporary fencing during the works; a permanent 'fungi protection fence' and conservation signage to be maintained in perpetuity; annual fungus surveys of the whole of the land; and the retirement of one 'species credit' for *Hygrocybe austropratensis* under the NSW Biodiversity Offsets Scheme (or alternatively an equivalent payment into the Biodiversity Conservation Fund maintained under the *BC Act*). This appears to be the only Australian court or tribunal decision with respect to the environmental impacts of development in which the needs of fungi have been directly and expressly provided for, and also the only such decision in which biodiversity offsetting requirements were imposed in respect of fungi. Still, it remains beyond the scope of 'environmental law' as defined for the purposes of this thesis and is therefore not discussed any further.

[452] For example, it is possible that Westlaw does not have a record of all of the relevant cases or that its 'Key Number' system does not accurately capture all environmental litigation in its 'environment and planning' category.

A known absence from Westlaw (and most databases) is local court decisions. There is at least one case discussed in the scientific literature in which a local court prosecution was reportedly successful against a developer on the basis of a then-preliminary determination to list the *Hygrocybeae* community of fungi in LCBP as endangered: see Ray Kearney, 'Citizen Science in Mycology' (2013) 10 *PAN: Philosophy, Activism, Nature* 87, 90. Unfortunately, it has not been possible for the author to obtain further details about this case.

1. *Limitations of the decision-maker*. This is not so much about how many individual judicial officers and tribunal members understand fungi — although that may also be relevant — but the nature of their roles. A court 'often only has an enabling function'; it cannot devise principles and rule on issues 'without appropriate advocates, experts, clients and matters coming before it'.[453] Thus, a court cannot make a finding about the needs of fungi (or the consequences of its inclusion or otherwise under a particular environmental law) without the issue being raised and argued based on evidence.
2. *Limitations of the advocates*. Advocates are essential to identifying the real issues in dispute in a proceeding and deciding whether and how they will be argued. If an advocate is unaware of the relevance of fungi to a matter and is not alerted to it by their client or the evidence, then it seems highly improbable that fungus-related issues will ever be raised. Even if the advocate is alerted to the relevance of fungi, they may choose not to raise fungus-related issues as a strategic decision. After all, there are finite resources in litigation; there may simply be other priorities or better prospects elsewhere.[454]
3. *Limitations of the evidence.* The unavailability of evidence at the level of detail required successfully to argue a fungus-related issue in a proceeding may be a significant barrier. As discussed in Chapter Two, there is little knowledge about most fungus species, and it is only held by a small number of experts. This could make raising a fungus-related issue a poor strategic decision in litigation, even if it has merit.
4. *Limitations of the parties*. Even if an advocate identifies an issue of fungus conservation and the evidence is available, the advocate ultimately takes their instructions from the party for whom they act. A party may simply not have the resources to engage a professional mycologist or ecologist to give evidence about a fungus conservation matter — or even to litigate the issue in the first place — particularly where the prospects of success are relatively low. The proposition may

[453] Jeff Smith and Sue Higginson, '"Please Come In": Access to Justice and the Development of Jurisprudence in the Land and Environment Court of New South Wales' in Elizabeth C Fisher and Brian J Preston (eds), *An Environmental Court in Action: Function, Doctrine and Process* (Hart Publishing, 2022) 253, 265.

[454] Fungus conservation or restoration is unlikely to be the only issue in a proceeding, even if it is (or should) be a real one. There may be numerous other biodiversity-related issues, which themselves may be only one set of a greater number of broader environmental issues; and then the environmental issues may be only one set of an even greater number of total issues in the case. There may simply be not enough time to gather and put on evidence about fungi. Perhaps the advocate may not feel as confident cross-examining the other side about fungal matters as they do about other environmental matters. These are just examples, but they are the sorts of factors may persuade an advocate to deprioritise fungus-related issues in a proceeding.

seem particularly unattractive to a client if they are in one of the many legislative contexts in which fungi are not even mentioned in the laws they are arguing about.

5. *Limitations of the matter*. It may be that some environmental matters simply do not give rise to issues of fungus conservation or restoration. However, given the ubiquity of fungi in the environment, the critical ecosystem functions they perform, and the nature of the threats to them, this seem unlikely to be the limiting factor in most cases.
6. *Limitations of Australian legal institutions and legal culture*. A court can only legitimately go so far when making decisions. A court has two competences: constitutional competence, being 'the proper role of a particular court in the government and governance of the polity'; and institutional competence, being the inherent limitations of adjudication as a means of decision-making.[455] The decisions made by courts will always be a function of those competences. For example, a court will rarely set aside administrative decisions for the sole reason that the court considers them to be irrational, but will more readily set them aside if the decision-maker did not follow proper process.[456] This is also a reflection of 'the pervasive influence of the legal culture of formalism and legality in Australia': the sharp demarcation between reviewing the legality of a decision as opposed to its merits.[457] The institutional and cultural context makes it more difficult for persons to challenge decisions made that might exclude or disbenefit fungi — it is probably not enough in most cases simply to say that an otherwise good decision is bad because the decision-maker did not consider the needs of fungi.

Despite these limitations, there is no doubt that a court or tribunal could, in an appropriate case, competently adjudicate issues relating to fungus conservation and restoration. Courts and tribunals have experience dealing with issues relating to little-known taxa. This is particularly the case for the NSWLEC, a specialist environmental court which has competently dealt with complex legal issues raised by the presence of biota in limestone caves.[458] Courts and tribunals have also shown that they are aware of some of the conservation values of fungi. For example, in a matter not at all about fungi, the Chief Judge of the NSWLEC referred to the existence of the two listed threatened ecological communities of fungi in NSW and identified their unique

[455] Preston (n 13) 9–10.
[456] Ibid.
[457] Ibid 10.
[458] See *Newcastle and Hunter Valley Speleological Society Inc v Upper Hunter Shire Council* (2010) 210 LGERA 126, 156–159 [153]–[177].

vulnerabilities as locally occurring ecological communities.[459] Thus, it seems that if a public interest or test case involving the conservation or restoration of fungi were ever run in a court or tribunal — particularly in a court like the NSWLEC — then there would be no doubt that the issue could competently be dealt with. Of course, it remains to be seen whether any case under Australian environmental law raising concerns about the needs of fungi will ever be filed.

III Fungi in Conservation Strategies and Management Plans

A *The Critically Endangered Ecological Community of* Hygrocybeae *Fungi*

The *Hygrocybeae* community of fungi living in the LCBP is one of only two ecological communities of fungi listed for protection under Australian environmental law.[460] Nine of its members are separately listed as threatened species.[461] This makes the management of the ecological community (together with its threatened members) a useful case to study for understanding whether listing fungi under law results, or at least can result, in significant consequences for their conservation or restoration in practice.

1 *About the* Hygrocybeae *Community*

The LCBP is public land vested in, and under the control of, the Lane Cove Council ('Council'), the local government body constituted for the Lane Cove area in NSW under the *Local Government Act 1993* (NSW) ('*LG Act*'). The LCBP was proclaimed a wildlife refuge under the *NPW Act* in 1979,[462] but is now taken to be an area the subject of a 'wildlife refuge agreement' under the *BC Act*.[463] The ecological community of *Hygrocybeae* fungi living in the LCBP was listed as threatened under the *Threatened Species Conservation Act 1995* (NSW) some 20 years after the wildlife refuge

[459] Ibid 147 [95].

[460] See Chapter Three and Appendix One. The endangered *Xanthoparmelia* lichen community of Mount Canobolas, NSW, is the other threatened ecological community. It too has received some conservation attention recently: see Alison Pouliot, *Underground Lovers: Encounters with Fungi* (NewSouth Books, 2023) 212–216 ('*Underground Lovers*'); Richard W Medd and Colin C Bower, 'Biodiversity and Endemism Within the Mount Canobolas Volcanic Complex' (2019) 141 *Proceedings of the Linnean Society of New South Wales* S45. The management plan for the public reserve protecting habitat of this ecological community is discussed in Part III(B)(2) below.

[461] See Chapter Three Part II(B)(1) and Appendix One.

[462] Governor (NSW), 'National Parks and Wildlife Act, 1974.—Proclamation' in New South Wales, *Government Gazette*, No 140, 12 October 1979, 5115.

[463] See *BC (S&T) Reg* (n 249) cl 18(1)(b).

proclamation, first as endangered in 2000 and then as critically endangered in 2014,[464] after nominations submitted by two citizen scientists with the support of a taxonomic mycologist.[465] A further overlay of environmental heritage was applied to the LCBP through the RNE in 2000,[466] but, as noted in Chapter Two, that overlay no longer has any legal effect.

The *Hygrocybeae* community is made up of 30 listed macrofungi, including 28 in the *Hygrocybe* genus, as well as an unknown number of other species.[467] The area of occupancy and extent of occurrence of the ecological community are estimated to be just 4 km^2 (400 ha).[468] The LCBP itself is only 0.098 km^2 (9.8 ha).[469]

The *Hygrocybeae* community is threatened by several processes. This includes two KTPs listed under the *BC Act*: loss and degradation of native plant and animal habitat due to invasion by escaped garden plants; and invasion by and establishment of exotic vines and scramblers.[470] The *Hygrocybeae* fungi are also threatened by nutrient run-off from adjacent urban areas and impacts from human visitation, such as trampling of habitat. The uplisting of the community to 'critically endangered' seems to be primarily a result of the effects of pollution of the tributary of Gore Creek, which runs through LCBP. The tributary is reportedly contaminated with animal wastes, garden fertiliser, petroleum-derived residues from nearby road surfaces, and sewage overflow. Contamination by chemicals such as diesel oil vapour has resulted in fungus sporing bodies exhibiting 'rosecomb', a mutation which affects the formation and functioning of their spore-bearing gills (and therefore their ability to reproduce).[471] The community's risk of extinction in the immediate future is 'extremely high'.[472]

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[464] Chairperson, Scientific Committee, 'Threatened Species Conservation Act 1995 No 101 – Notice of Final Determination and Amendment of Schedule 1 to Act' in New South Wales, *Government Gazette*, No 32, 3 March 2000, 1586 ('*Hygrocybeae* EEC Determination'); Chairperson, Scientific Committee, 'Notice of Final Determination Under the Threatened Species Conservation Act 1995' in New South Wales, *Government Gazette*, No 22, 21 February 2014, 695 ('*Hygrocybeae* CEEC Determination').
[465] NSW Department of Environment and Climate Change, 'Best Practice Guidelines' (n 110) 2.
[466] 'Lane Cove Bushland Park, River Rd, Osborne Park, NSW, Australia' (n 177).
[467] *Hygrocybeae* CEEC Determination (n 464) 696–697 [2]–[3].
[468] Ibid 697 [6].
[469] Lane Cove Council, 'Plan of Management for Bushland in Lane Cove' (Management Plan, 5 February 2007) 49 <http://ecouncil.lanecove.nsw.gov.au/trim/DocumentLink.asp?RecId=2124/07>.
[470] *Hygrocybeae* CEEC Determination (n 464) 697 [7].
[471] Ibid, citing P B Flegg, 'Response of the Sporophores of the Cultivated Mushroom (*Agaricus bisporus*) to Volatile Substances' (1983) 21(4) *Scientia Horticulturae* 301.
[472] *Hygrocybeae* CEEC Determination (n 464) 698 [8].

2 *Management by the Lane Cove Council*

The Council has three key documents that relate to the management of the *Hygrocybeae* community.

(a) Plan of Management for Bushland in Lane Cove

The first document is the Council's plan of management for bushland in Lane Cove.[473] This is the Council's principal management document for all bushland in its local government area.

The aim of the plan is '[t]o protect and conserve bushland in Lane Cove for all its intrinsic, natural, cultural, and aesthetic values, together with its value as a local recreational, educational and scientific resource'.[474] The *Hygrocybeae* community is expressly included in the plan, described as being part of Lane Cove's bushland and as having habitat, natural heritage, and scientific values.[475]

The plan of management includes the general management policies and strategies for bushland in Lane Cove.[476] These include bushland management objectives under s 36J of the *LG Act*, which expressly includes an objective to protect fungi (albeit as 'flora and fauna').[477] The general policies and strategies do not mention fungi beyond the *LG Act* objective, other than to note potential conflicts between maintaining the heritage value of the *Hygrocybeae* community and maintaining the recreational value of the LCBP (ie, maintaining creekline walking tracks).[478]

In addition to the general management policies and strategies, each bushland area referred to in the plan of management has its own one-page plan. The plan for the LCBP gives significant detail as to fungus conservation by identifying the following matters:

- The existence of the *Hygrocybeae* community.
- The *Hygrocybeae* community's heritage value.
- Threats and conservation problems, including creek bank erosion, the dearth of information on fungus conservation, sewer overflows, trampling, and visitation impacts from cyclists and companion animals.

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[473] Lane Cove Council (n 469).
[474] Ibid 1 [1.1].
[475] Ibid 5 [2.2.5], [2.2.6], 7 [2.3.2].
[476] Ibid 10–37.
[477] Ibid 10. See *Local Government Act 1993* (NSW) s 36J(a) ('*LG Act*').
[478] Lane Cove Council (n 469) 10, 19, 22.

- Area-specific objectives for the LCBP, including protecting fungal habitat from disturbance and increasing community participation in management.
- The need for information about fungal ecology to help understand the specific conservation requirements for *Hygrocybeae* fungi.[479]

The plan of management identifies one species of the *Hygrocybeae* community as being recorded in the adjacent Osborne Park bushland area and native garden and identifies fungi research as an opportunity for a future grant application.[480]

(b) Best Practice Guidelines for the Hygrocybeae *Community of LCBP*

The second management document of the Council is a set of best practice guidelines for conserving the *Hygrocybeae* community of LCBP.[481] These guidelines are intended not only to set out how these particular *Hygrocybeae* fungi are to be managed, but also to provide 'theoretical and practical guidance' for persons engaged in fungus conservation elsewhere.[482] The guidelines set out of the following management practices:

- Regenerating native bushland. Management focuses on maintaining native ground covers to preserve fungal habitat. Weeding is a particular focus. Methods that minimise collateral damage such as cut-and-paint and removal by hand are used. Particular care is taken in moss-covered creekbanks and areas where *Hygrocybeae* fungi are known to produce sporing bodies, as well as during the fungi season. The cleaning of tools and clothing is recommended for biosecurity.[483]
- Avoiding fire as a bush regeneration technique in *Hygrocybeae* areas unless it is necessary for the life cycle of other species in those areas. Controlled thinning is the recommended alternative.[484]
- Maintaining existing vegetation structures.[485]
- Leaving fallen timber unless there is a pressing need to remove it.[486]

[479] Ibid 49.
[480] Ibid 72.
[481] NSW Department of Environment and Climate Change, 'Best Practice Guidelines' (n 110).
[482] Ibid 1. Noting that these guidelines are over 15 years old at the time of writing, they may well no longer reflect current practice.
[483] Ibid 8–12.
[484] Ibid 7–8.
[485] Ibid 11.
[486] Ibid.

- Building, improving, and maintaining fauna habitat. Fauna feed on fungi and aid with spore dispersal. This goes as far as leaving rubbish like old car bodies, pipes, tiles, and tin pieces in situ as temporary habitat while bushland regenerates.[487]
- Closing all non-essential tracks in the LCBP and educating the community not to trample *Hygrocybeae* habitat.[488]
- Managing stormwater run-off from adjacent private properties through community education and the Council's stormwater control plan.[489]
- Controlling the edge effects of adjacent development by way of a development control plan made by the Council under planning law.[490]
- Recording sightings of fungi with photographs.[491]

The guidelines also recommend monitoring changes to the fungi before, during, and after regeneration works to allow the effectiveness of management practices to be assessed.[492]

(c) Community Guidelines

The third management document of the Council is a set of community guidelines, which is ancillary to the best practice guidelines.[493] These guidelines are intended for 'neighbours and visitors' of the LCBP.[494] They give a plain English description of the *Hygrocybeae* fungi to the community and recommend the following actions be taken to help with fungus conservation:

- Stay on walking tracks.
- Keep dogs on leads.
- Weed the garden.
- Keep stormwater out of the bush.
- Do not dump rubbish.
- Do not cut down or plant trees in bushland.
- Join a bushcare group.

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[487] Ibid 12–14.
[488] Ibid 15–16.
[489] Ibid 14–15.
[490] Ibid 7.
[491] Ibid 8.
[492] Ibid 16.
[493] NSW Department of Environment and Climate Change, 'Protecting and Restoring the Fungi Community of Lane Cove Bushland Park' (Brochure, September 2008) <http://ecouncil.lanecove.nsw.gov.au/trim/DocumentLink.asp?RecId=8150/11> ('Community Guidelines').
[494] See, eg, ibid 11.

- Join the Sydney Fungal Studies Group Inc.[495]

3 *Management by the NSW Government*

Although the Council is the owner and primary manager of the LCBP, the NSW Government has a role to play in the conservation of the *Hygrocybeae* community given it is listed as critically endangered under state legislation.

(a) Saving Our Species Program

As noted in Chapter Three, under the *BC Act*, the Environment Agency Head is required to establish a BCP consisting of strategies for every listed threatened species and ecological community.[496] The current program is known as 'Saving our Species' ('SoS').[497] The overarching objective of the SoS is, consistently with the statutory objectives,[498] '[t]o maximise the number of threatened species and ecological communities that are secure in the wild in NSW for 100 years'.[499] For site-managed entities such as the *Hygrocybeae* community, the objective of management is to '[m]aintain a 95% probability of having a viable population in the wild in 100 years (i.e. secure), and ensure that the species' status under the *BC Act* does not decline'.[500] Management under the SoS makes the following assumptions:

- Sufficient investment will result in adequate and cost-effective action implementation.
- Implementing management actions will result in threats being adequately controlled.
- Controlling all known threats will result in improved local population/ecosystem viability.
- Viability populations/ecosystems at all priority management sites will result in the threatened entity being on track to be secure in NSW for 100 years. This includes the additional assumption that the selection of management sites is comprehensive and adequate to secure the threatened entity in the long term.[501]

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[495] Ibid.

[496] *BC Act* (n 232) pt 4 div 6.

[497] See NSW Department of Climate Change, Energy, the Environment and Water, 'Biodiversity Conservation Program', *Environment and Heritage* (Web Page, 14 August 2024) <https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/programs-legislation-and-framework/biodiversity-conservation-program>.

[498] Cf *BC Act* (n 232) s 4.35(2).

[499] NSW Office of Environment and Heritage, 'Saving Our Species Monitoring, Evaluation and Reporting Guidelines for Conservation Projects' (Guidelines, August 2018) 1 <https://www.environment.nsw.gov.au/sites/default/files/saving-our-species-monitoring-evaluation-guide-180412.pdf>.

[500] Ibid 3.

[501] Ibid 2.

The *Hygrocybeae* community has a management strategy under the SoS.[502] The strategy identifies nine threats to the community, an objective in relation to each threat, and management actions to be taken in response. The management actions are intended to be adapted over time in response to results from monitoring the community.[503]

(b) Reports of Management Actions

The NSW Government publishes annual 'report cards' under the SoS. These report cards outline the management actions that were actually taken for a threatened species or ecological community in the reporting year and their results. While there are no report cards published for the *Hygrocybeae* community as a single entity, there are report cards for the nine listed member species, which are said to be managed together as a 'multi-species fungi project'.[504] It can be assumed that the management of these species represents the management of the *Hygrocybeae* community as a whole.

At the time of writing, the most recently published report cards were for the 2022–2023 reporting year.[505] The complete analysis is in Appendix Two. In summary, for all species:

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[502] Saving Our Species, 'Help Save the Hygrocybeae Community of Lane Cove Bushland Park in the Sydney Basin Bioregion' (Conservation Strategy, undated) <https://savingourspecies.environment.nsw.gov.au/project/1033>.

[503] Ibid 2. See further NSW Office of Environment and Heritage (n 499).

[504] See NSW Department of Planning, Industry and Environment, 'Multi-species Fungi Project', *Saving Our Species 5 Year Summary Reports* (Report, October 2021) <https://www.environment.nsw.gov.au/sites/default/files/2024-12/saving-our-species-projects-2016-21-multi-species-fungi-hygrophoraceae-210448.pdf>.

[505] NSW Government, '*Camarophyllopsis kearneyi* 2022–2023 Annual Report Card' (SoS Report Card, 29 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23061>; NSW Government, '*Hygrocybe aurantipes* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23114>; NSW Government, '*Hygrocybe collucera* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23116>; NSW Government, '*Hygrocybe griseoramosa* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23117>; NSW Government, '*Hygrocybe lanecovensis* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23118>; NSW Government, '*Hygrocybe rubronivea* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23120>; NSW Government, '*Hygrocybe reesiae* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23119>; NSW Government, '*Hygrocybe austropratensis* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23115>; NSW Government, '*Hygrocybe anomala* var *ianthinomarginata* 2022–2023 Annual Report Card' (SoS Report Card, 30 July 2024) <https://nswdpe.intersearch.com.au/nswdpejspui/handle/1/23113>.

- Population status is inferred to be 'on track' based on threat management, which is 'on track'. The population trend is unknown.
- Bush regeneration and weed control was implemented.
- A total of $8,316 was expended in management at LCBP.

The management outcomes were identical for each fungus species, reflecting their management as a 'multi-species' project.

4 *Discussion*

The listing of the *Hygrocybeae* community as critically endangered under the *BC Act*, together with the separate listings of nine of its members as endangered or vulnerable, has had significant consequences for the conservation of these fungi. The listings have resulted in the investment of management resources such as time, attention, energy, and money into fungus conservation, most notably through the design and implementation of management plans and strategies, as well as ongoing monitoring. The most recent management data suggest that these *Hygrocybeae* fungi appear to be on track to becoming secure in NSW for the next 100 years. This is a positive conservation outcome as, presumably, these resources would not have been allocated if they had not been listed under environmental law. This demonstrates the usefulness of listing species and ecological communities under environmental law, at least in jurisdictions like NSW where listing triggers a legal requirement to allocate resources (at the bare minimum through management planning) to the listed entity's conservation. It also shows the conscientiousness of government agencies working in conservation (again, at least in jurisdictions like NSW): although there may not be an express legal obligation to implement a strategy for a listed entity under the *BC Act* once the strategy is made and included under the SoS, there is clearly a motivation on the part of responsible agencies to do what they can, with limited resources and no doubt many other competing demands, to ensure the listed entity at least receives some attention.

There are, however, a few concerns that arise from the management documents just analysed which cast doubt on whether the *Hygrocybeae* will continue to be secure.

First, the Council — the owner of LCBP — is relying on significantly outdated management documents. This is problematic because the Council is the primary manager of the *Hygrocybeae* community. The context of management has changed significantly since 2007 and 2008, when the documents were adopted. For example, the

legal context has changed: the threat status of the *Hygrocybeae* community has upgraded from endangered to critically endangered, increasing the urgency with which this community should be conserved. The biophysical context has also changed, both in terms of the current condition of the site after 15 years of restoration and a rapid increase in global heating. Changes such as these are significant for management, yet the relevant documents have not been updated.

Second, current management focuses on weed clearing and bush regeneration. But there are mixed opinions as to whether this is conserving and restoring the existing *Hygrocybeae* community or instead creating a different ecological community of fungi. In 2015, the Council commissioned commercial bush regenerators to clear an invasive woody vine that was threatening the *Hygrocybeae* habitat, which resulted in greater fungus species richness and 20 new colonies of fungus species being observed by citizen scientists.[506] But in 2022, mycologists reported that the regenerated areas did not in fact recover their fungal diversity, but instead had different fungus species types and abundance, including fungal 'weeds'.[507] Further study seems warranted to confirm whether the current bush regeneration works are in fact conserving the listed *Hygrocybeae* community as much as they are thought to be, and if not, whether management needs to be adapted.

The final issue is the level of protection afforded to the LCBP itself. While the LCBP is a wildlife refuge, it does not enjoy the status — and legal protections — of a protected area.[508] Given the LCBP hosts the only known population of a critically endangered ecological community, steps should be taken to grant it a more permanent and secure form of area-based protection.

B *Management of Public Reserves*

It was argued in Chapter Three that fungi are included in protected area legislation mostly by implication. Although this may suffice for the inclusion of fungi as a matter

[506] Ray Kearney and Elma Kearney, 'Conservation of Fungi in Lane Cove Bushland Park' (2015) 24(3) *Australasian Plant Conservation* 10.

[507] Vanessa McPherson and Michael Gillings, 'Fungi of the Lane Cove Valley: Diversity, Distribution and DNA', *STEP* (Web Page, 4 November 2022) <https://step.org.au/index.php/step-matters-193/item/566-fungi-of-the-lane-cove-valley-diversity-distribution-and-dna>.

[508] This is confirmed by the most recent Collaborative Australian Protected Areas Database ('CAPAD') data for NSW, which do not identify the LCBP (or any wildlife refuge) as part of the NRS: 'Terrestrial CAPAD 2022 NSW Summary' (n 250).

of law, as a matter of practice it is only effective in any real sense if it demonstrably leads to fungus conservation and restoration outcomes (or at least planning for those outcomes). Within the confines of a desktop review, protected area management plans are the best indication of whether this is occurring. It is useful, therefore, to consider a number of protected area management plans across the Australian jurisdictions and ascertain whether fungi are actually being cared for.

1 *Pouliot's Analysis of Public Reserve Management Plans*

In her recent PhD thesis, Pouliot carried out a content analysis of 40 public reserve management plans from across Australia (including jurisdictions not within the scope of the present thesis) made between 1987 and 2013.[509] Pouliot sought to ascertain 'how language for fungi is used in Australian biodiversity conservation and to compare the relative representation of fauna, flora and fungi'.[510] Her search terms were:

- animal, fauna, wildlife, vertebrate, mammal, bird, fish, amphibian, reptile, insect;
- flora, plant, vegetation, vascular, tree, grass, shrub, fern, flower, moss;
- fung*, mushroom, lichen, mycota, saprophyte, mycorrhiza, mycelium, toadstool, mould, truffle.[511]

Pouliot found just 104 references to funga across all of the management plans, compared to 7,080 references to fauna and 7,429 references to flora. On average, each plan had approximately 3 references to funga for every 177 references to fauna and 186 references to flora. Considering one management plan in further detail, Pouliot found an additional 56 references to flora and 106 references to fauna outside the above search terms (eg, species names) but no additional references to funga.[512] In terms of how fungi were referred to, Pouliot found no plan had 'a developed notion of what fungi are, why they are significant, why they require explicit attention or why they might be worth conserving'.[513] Most of the references to fungi were to pathogens, and within that category *Phytophthora cinnamomi* was the most mentioned — yet, as has been noted many times now, that organism is not even a fungus.[514] Overall, 'almost all

[509] Pouliot, 'A Thousand Days in the Forest' (n 3) app 6.
[510] Ibid 137.
[511] Ibid app 6.
[512] Ibid app 7.
[513] Ibid 137.
[514] Ibid 137 n 314.

[management plans] showed misunderstanding of fungi, gross under-representation and insufficient terminology to describe them'.[515]

2 *New Analysis of Public Reserve Management Plans*

Pouliot's analysis is highly useful and relevant to the question being asked by this thesis; but it is slightly dated. More than ten years have now passed since the making of the last management plan that Pouliot considered.

To ascertain whether there has been any change in the inclusion of fungi in protected area management planning since Pouliot's analysis, this author has, in a manner similar to Pouliot, carried out a content analysis of a further eight public reserve management plans (some of them covering a great number of individual protected areas) made since 2013 in the jurisdictions the subject of this thesis.[516] The full results are in Figures 1–3 of Appendix Three.

In summary, across the eight management plans analysed by this author, there were 40 references to funga, compared to 1,641 references to fauna and 2,417 references to flora. On average, each plan had approximately 5 references to funga for every 205

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[515] Ibid 137.

[516] See Commonwealth Director of National Parks, 'Australian National Botanic Gardens Management Plan 2022' (Management Plan, 2022) <https://www.anbg.gov.au/gardens/about/management/manplan/anbg_management-plan-2022.pdf>; NSW National Parks and Wildlife Service, 'Blue Mountains National Park and Kanangra-Boyd National Park Plan of Management' (Management Plan, 26 August 2024) <https://www.environment.nsw.gov.au/sites/default/files/blue-mountains-np-kanangra-boyd-np-plan-of-management-240234.pdf>; NSW National Parks & Wildlife Service, 'Mount Canobolas State Conservation Area Plan of Management' (Management Plan, 9 September 2019) <https://www.environment.nsw.gov.au/sites/default/files/mount-canobolas-state-conservation-area-plan-of-management-190498.pdf>; Parks Victoria, 'Greater Alpine National Parks Management Plan' (Management Plan, August 2016) <https://www.parks.vic.gov.au/-/media/project/pv/main/parks/documents/management-plans/greater-alpine-national-park-management-plan.pdf>; Parks Victoria, 'River Red Gum Parks Management Plan' (Management Plan, July 2018) <https://www.parks.vic.gov.au/-/media/project/pv/main/parks/documents/management-plans/river-red-gum-parks-management-plan.pdf>; Tasmanian Department of Primary Industries, Parks, Water and Environment, 'Narawntapu National Park, Hawley Nature Reserve Management Plan 2016' (Management Plan, 21 December 2016) <https://parks.tas.gov.au/Documents/Narawntapu_NP_Management_Plan_2016.pdf>; Tasmanian Department of Primary Industries, Parks, Water and Environment, 'Tasmanian Wilderness World Heritage Area (TWWHA) Management Plan 2016' (Management Plan, 2016) <https://nre.tas.gov.au/Documents/TWWHA_Management_Plan_2016.pdf>; ACT Environment, Planning and Sustainable Development Directorate, 'Canberra Nature Park Reserve Management Plan 2021' (Management Plan, 2021) <https://www.act.gov.au/__data/assets/pdf_file/0006/2547501/canberra-nature-park-reserve-management-plan-2021.pdf>.

references to fauna and 302 references to flora — double the number found by Pouliot, but still small in absolute terms. When this author analysed one management plan in more detail — a plan chosen deliberately for the likelihood of its including fungus-related terms[517] — an additional 4 references to funga (or 9 if references to phytophthora are included), 18 references to fauna, and 35 references to flora were found.[518]

In terms of how fungi were referred to, this author's findings are largely the same as Pouliot's, with the key exception that there are some management plans that actually do have a developed notion of fungi — or at least a recognition that they warrant specific conservation attention. This was clearest (and to be expected) in the plan of management for the Mount Canobolas State Conservation Area in NSW, which recognises the biodiversity value of the listed endangered ecological community of *Xanthoparmelia* lichens inhabiting the area (albeit misdescribing them as 'plants') and including specific management actions to protect them.[519] It is also clear in the Commonwealth's management plan for the Australian National Botanic Gardens, which includes priorities for scientific research into fungi and further developing representation of macrofungi and lichens in the Australian National Herbarium.[520] Other management plans in the ACT and Victoria, covering well over 100 individual public reserves, also cite research and monitoring priorities relating to fungi.[521] However, despite there being more developed notions of fungi, these notions remain so few and far between, especially relative to those of plants and animals, that it is fair to say that fungi remain virtually absent from public reserve management planning.[522]

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[517] NSW National Parks & Wildlife Service, 'Mount Canobolas State Conservation Area Plan of Management' (n 516). This management plan relates to a public reserve that protects habitat of the *Xanthoparmelia* lichen community listed as endangered under the *BC Act*: see n 460.

[518] See Appendix Three Figure 4.

[519] See NSW National Parks & Wildlife Service, 'Mount Canobolas State Conservation Area Plan of Management' (n 516) 2, 7, 11, 16, 20, 22.

[520] Commonwealth Director of National Parks (n 516) 36, 49.

[521] ACT Environment, Planning and Sustainable Development Directorate (n 516) 123, 126; Parks Victoria, 'River Red Gum Parks Management Plan' (n 516) 162.

[522] One argument that has not been addressed in this analysis is whether it is possible to construe the references to 'plants' in management plans as being references to fungi also. This argument has not been addressed because, whether or not it is valid as a matter of interpretation or legal reasoning, it is questionably relevant to the issue of effective inclusion in practice. A nice legal opinion on interpretation probably does not have much bearing on how park managers, rangers, and like officials interpret management plans day-to-day in practice. This is why the analysis has been carried out based on the

3 *The Legal Consequences of Practical Inclusion*

The foregoing analysis has considered whether the implied inclusion of fungi in protected area legislation has resulted in any significant consequences for fungi in practice. The principal measure has been the presence of fungi in management plans. But it is worth pausing briefly to consider whether, even if a public reserve management plan were to provide expressly for fungus conservation or restoration, the person responsible for implementing that plan could be compelled under the protected area legislation to implement those provisions.[523] That is to say, could the fungus-related provisions in a management plan be enforced?

A recent NSW Court of Appeal decision, *Neilson v Secretary, Department of Planning and Environment* ('*Neilson*'),[524] suggests that they could not. The majority of the Court in *Neilson* found that, in NSW, the duty to carry out and give effect to a public reserve management plan is a duty to implement the management plan as a whole — not to implement every 'policy and action' under the plan.[525] Thus, it seems that even if fungi were expressly included and required to be conserved in a management plan, the performance of the requirement could not be compelled by court order.[526] This throws into doubt the legal utility of expressly requiring fungus conservation and restoration in management planning, at least insofar as the legislation remains general about implementation requirements.[527]

C *Management of Private Protected Areas*

Chapter Three considered the legislation governing TFN, Victoria's chief private land conservation organisation. It was argued that fungi are impliedly included in the TFN's governing legislation and, in particular, are permitted to be conserved and restored in the organisation's exercise of its functions. This chapter turns to the TFN's *Statewide*

express references only: these are the surest guide to the fungus conservation and restoration actions actually being carried out in protected areas under law.

[523] There are requirements to implement public reserve management plans in each of the protected area statutes considered in this thesis except Victoria's: see *EPBC Act* (n 191) s 362; *NPW Act* (n 262) s 81(1); *NPRM Act* (n 365) s 30(1)(a); ACT *NC Act* (n 380) s 188.

[524] *Neilson* (n 272).

[525] Ibid 126–130 [45]–[53] (Payne JA, Ward P agreeing).

[526] The similar language used in the other Australian protected area legislation means that *Neilson* would likely be persuasive in other jurisdictions as well, should the issue ever arise.

[527] Of course, legal enforceability is only one consideration. It can be assumed for the present purposes that if a management plan expressly includes fungi, then the government agencies responsible for implementing the plan will use their best endeavours in the circumstances to do so.

Conservation Plan 2021–2030 ('SCP') — a key document for all of the private protected areas that the TFN manages — to ascertain whether that implied inclusion has resulted in any consequences for fungus conservation or restoration in practice.

1 *Trust for Nature (Victoria)*

The SCP is a management plan that sets out the TFN's current objectives, goals, and targets for private land conservation.[528] Unlike the public reserve management plans considered earlier in this chapter, the SCP applies to the TFN's activities across the whole of Victoria rather than to particular sites.[529]

The overarching objective of the SCP is 'to achieve an additional 100,000 ha of permanently protected habitat on private land by 2030, through direct or enabled protection'.[530] Under that overarching objective sit six further objectives, ranging from increasing protection of ecosystems and species at a landscape scale to increasing habitat for 'priority' species and enhancing landscape restoration and connectivity. There is considerable detail as to how each of these objectives will be achieved, including the provision of goals and targets for each objective.

Despite its sophistication, the SCP does not mention fungi once in any of its objectives, goals, or targets. It seems that the implied inclusion of fungi in the TFN's governing statute has not resulted in fungi actually being included (at least in any express way) in the TFN's chief management plan. Indeed, a close analysis suggests that the TFN's conservation practice may be focused on the needs of plants and animals. For example:

1. A goal of the SCP is to increase the extent of 'focal' landscapes.[531] However, the datasets used by the TFN to identify 'focal' landscapes were about native vegetation and fauna habitats. Fungal habitats do not appear to have been considered.[532]
2. Another goal of the SCP is to increase the extent of climate change refuges. The vulnerability of an ecosystem to climate change, and the identification of refuges, is

[528] See Trust for Nature, 'Statewide Conservation Plan 2021–2030' (Conservation Plan, March 2022) 3 <https://trustfornature.org.au/wp-content/uploads/2025/02/Statewide-Conservation-Plan_mar23.pdf>.
[529] It is unknown whether the TFN has site-based management plans to complement its SCP. If it does, then they are not publicly available online. The TFN does publish brochures for each of its protected areas, but these do not contain any great detail as to management: 'Reserves', *Trust for Nature* (Web Page, 2024) <https://trustfornature.org.au/reserves/>.
[530] Trust for Nature (n 528) 15.
[531] Ibid 16–21.
[532] Ibid 16–17, app 1.

determined by reference to ecological vegetation classes ('EVCs').[533] EVCs appear to be designed around flora, not funga.[534]

3. The objective of the SCP to increase habitat protection for 'priority' species is expressly limited to 'threatened flora and fauna'.[535] Even putting to one side the legal concerns about the lawfulness of the existing funga listings in Victoria, there are so few funga listed that it is unlikely that they will be paid any attention under this objective.

The TFN acknowledges that its conservation planning is focused particularly on 'vegetation': '[p]rotecting native vegetation is considered a cornerstone of biodiversity conservation and has been the basis of conservation planning in Australia and internationally for more than 30 years'.[536] That may well be justifiable. But without any measures in the plan for fungi — or at least to check whether the proposed measures are apt for fungi — it cannot be said that fungi are effectively included, from a practical perspective, in the SCP.

IV CONCLUSION

This chapter has considered whether the inclusion of fungi in Australian environmental law, such as was found in Chapter Three, has had any significant consequences for their conservation or restoration in practice. The question was considered by way of case studies of Australian court and tribunal decisions, conservation strategies for listed threatened fungi in NSW, and the management plans of public reserves and private protected areas across Australia.

In the analysis of court and tribunal decisions, it was argued that the inclusion of fungi has had no significant consequences for their conservation or restoration through litigation, at least within the scope of 'environmental' law as understood in this thesis. This is because there is not a single decision in environmental litigation in which the conservation or restoration of fungi has been a real issue in the proceeding. Some arguments, methodological and substantive, were made as to why this might be the case. But it was also argued that should an appropriate case come up, there is no reason

[533] Ibid 31.
[534] See 'Bioregions and EVC Benchmarks', *Victorian Department of Energy, Environment and Climate Action* (Web Page, 20 November 2024) <https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks>.
[535] Trust for Nature (n 528) 45.
[536] Ibid 22 (citations omitted).

to expect that a court or tribunal would not be able to respond accurately and effectively to mycological concerns in the proceeding.

In the analysis of conservation strategies and management plans, it was argued that the express inclusion of fungi in the *BC Act*, together with the legal requirement to actually conserve them once listed, has led to significant practical consequences for fungus conservation; but the mere implications that appear in protected area legislation have not resulted in such significant consequences. The case study of the *Hygrocybeae* fungi showed that listings under environmental law can result in significant allocations of management resources to fungus conservation. This demonstrably results in positive management outcomes for those fungi, even if there are improvements that could be made to management (of which several were identified in this chapter). Meanwhile, in the protected area context, very few management plans made under law showed any sophisticated understanding of the importance of fungi, including their significant ecological functions or why they otherwise warrant specific conservation or restoration attention — let alone what should be done in practice to ensure that they are conserved or restored effectively. The case studies showed that implied inclusions are unreliable; express legal requirements to manage protected areas for fungi are necessary if there is to be more assurance that fungi will be actively conserved or restored in practice.

So, what can be done to include fungi more effectively in Australian environmental law? It is to this final question that this thesis now turns.

Jelly fungus (*Dacrymyces* sp) at Central Railway Station, Sydney

CHAPTER FIVE

A REFORM AGENDA FOR FUNGUS CONSERVATION AND RESTORATION

I INTRODUCTION

This chapter turns to the last issue considered in this thesis: how Australian environmental law might be reformed to include fungi more effectively. It is argued that three types of reform are required. First, there must be recognition. Fungi should be recognised expressly and correctly in environmental laws. Second, there must be integration. Once fungi are duly recognised, they should be expressly and substantively included in the operative and other relevant provisions of environmental laws (at least where those laws refer to particular taxa). Third, there must be innovation. Innovation comes in two forms: the making of new laws for the benefit of biodiversity generally; and the making of new laws for the particular benefit of fungi. Some potential barriers to these reforms are then considered. The chapter concludes by arguing that, by working practically but thinking imaginatively, advocates might influence the development of Australian environmental law, shifting it from a neglectful and dysfunctional approach towards fungi to one that more actively, directly, and expressly cares for them. It is argued that such reforms are required if there is to be any reasonable confidence that Australia's fungal diversity might be effectively protected under law.

II REFORM AGENDA

Based on the analysis in the foregoing chapters, it is argued that three types of reforms are required to include fungi more effectively in Australian environmental law:

1. *Recognition*: defining fungi expressly and correctly and including them in the basic concepts used in environmental laws.
2. *Integration*: expressly and substantively including fungi in the provisions of environmental laws.
3. *Innovation*: developing new environmental laws to improve the inclusion of fungi.

Recognition and integration are two essential steps that must be taken to address the problems identified in this thesis about the inclusion of fungi in existing laws. But it is

through innovation that the most significant gains for fungus conservation and restoration might be realised.

A *Recognition*

One of the most basic problems with Australian environmental law is the universal misdescription and nondescription of fungi.

The first step towards addressing this problem is to recognise fungi. Recognising fungi is most appropriately done by expressly and correctly identifying fungi in laws, including in the definitions of basic concepts used in those laws, wherever other taxa are also expressly recognised.[537] Recognition is justified on legal grounds, because definitions of fungi as 'plants' are liable to be displaced; on scientific grounds, because fungi have not been classified as plants for more than half a century; on justice grounds because, as Pouliot puts it, fungi 'deserve to be correctly recognised' for their own sake;[538] and on public interest grounds, because it would make environmental legislation clearer, simpler, and more accessible to the public. Expressly and correctly recognising fungi would also align Australian environmental law with international best practice about the proper inclusion of fungi in law.[539]

1 *Defining Taxa*

Chapter Three showed that a significant number of environmental statutes have provisions that are defined by, or apply to, particular taxa. For these statutes, the effective inclusion of fungi requires that fungi be defined expressly and correctly.

For example, it was argued that the *FFG Act* does not effectively include funga. The first step to remedying this defect is to insert into the Act a definition of 'funga' such as the following:

[537] Some exceptions will need to be made in particular cases, such as the statutory lists of threatened plants and animals (which for obvious reasons should only be about those taxa).

[538] '[I]n the same way most people would probably prefer not to be confused with cacti or sea slugs': Pouliot, *The Allure of Fungi* (n 3) 240.

[539] Cf 'IUCN SSC Acceptance of Fauna Flora Funga', *IUCN* (Statement, 2021) <https://www.iucn.org/sites/default/files/2022-12/statement-3f.pdf>; 'The Initiative', *Fauna Flora Funga* (Web Page, 2024) <https://faunaflorafunga.org/the-initiative/>. See also Tom W May et al, 'Recognition of the Discipline of Conservation Mycology' (2019) 33(3) *Conservation Biology* 733, 735.

> ***funga*** means any fungus-life which is indigenous to Victoria whether lichenised or non-lichenised and in any stage of biological development and includes any other living thing generally classified as funga;

A definition such as this would correctly and expressly recognise funga as being different from flora and fauna and provide a reference point for the subsequent integration of funga into that statute. Similar definitions should be included in all other environmental statutes that refer to particular taxa.

2 *Defining Other Basic Concepts*

It is also important to include fungi expressly in the definitions of the basic concepts relied upon by environmental laws.

Chapter Three showed that many environmental statutes use general concepts such as 'biodiversity', 'ecosystems', and 'native vegetation'. These concepts are sometimes defined by reference to organisms generally, and at other times by reference to particular taxa.

Where these concepts are defined by reference to particular taxa, fungi should also be included in those definitions. For example, Chapter Three discussed how the ACT *NC Act* defined the concept of 'ecosystem' by reference to plants, animals, and micro-organisms. This is inapt for fungi because fungi are neither plants nor animals, nor are they all micro-organisms. A simple remedy to this defect is to insert 'fungi' into the definition. For example, it could be redrafted as follows:

> ***ecosystem*** means a dynamic complex of animal, fungus, micro-organism, and plant communities and their non-living environment interacting as a functional unit.

In some legislative contexts, more drafting will be required than simply inserting 'fungi' in a convenient location. For example, Chapter Three argued that the definition of 'native vegetation' in the ACT *NC Act* is ineffective to include fungi, despite that definition referring to 'plants' and 'plants' being defined to include fungi. This was because the definition of 'native vegetation' in that Act relies on botanical categories that do not properly accommodate fungi. This definition requires a more elaborate amendment to make it clear that native vegetation includes the fungi that associate with, or inhabit the same areas as, the plants referred to in that definition. For example, the definition could be redrafted as follows:

> ***native vegetation***, for an area, means any of the following kinds of vegetation indigenous to the area:
>
> (a) trees;
> (b) understorey plants;
> (c) groundcover consisting of any kind of grass or herbaceous vegetation;
> (d) plants occurring in a wetland or stream in the area,
>
> and includes fungi that associate with, or inhabit the same areas as, any of those kinds of vegetation.

To be clear, the recommendation here is not to insert fungi in every provision of every environmental statute. Where a concept is used by a statute and that concept is not defined by reference to particular taxa, it is unnecessary to amend the definition because fungi are already included by implication. For example, if the definition refers to 'living organisms from all sources', then it already includes all life, including all fungi. This approach has its own problems (for which solutions are proposed later in this chapter), but the inclusion of fungi as a matter of law is not one of them. Amending these definitions to recognise fungi separately from 'living organisms' would only create confusion and not, legally, improve upon the existing inclusion of fungi in that concept used in the statute.

B *Integration*

Once fungi are expressly and correctly recognised in environmental laws, it is essential that references to fungi be integrated into the operative and other relevant provisions of those laws.

There are two priorities for integration: first, removing the current unclarity in certain statutes as to whether fungi are eligible to be listed as threatened species or ecological communities, including by validating retrospectively the existing listings under those statutes; and second, ensuring that the general integration of fungi in the operative and other relevant provisions of laws is effective.

1 *Clarifying Listings*

One of the most significant problems identified in Chapter Three was the apparent lack of a legal basis under the *FFG Act* and the *TSP Act* for funga to be listed as threatened. Yet, in both jurisdictions, there have been funga so listed.

The priority for integrating funga into these existing Acts is to amend the operative provisions about listing threatened entities to ensure they expressly refer to funga. Consequential amendments to related provisions, such as the requirement in Tasmania for there to be a threatened species strategy, should also be made to ensure the integration of funga is full and effective.

While integrating funga into these provisions will clarify the validity of future listings of funga, they do not deal with the legal validity of the current listings. To address this problem, a retrospective provision should be inserted to preserve the legal validity of those listings. The validation provision should also deem that those listings be of funga, rather than 'flora', from the time that the provisions integrating funga into those Acts commence.

2 *Effective Integration Generally*

Effective integration of fungi requires amendments to be made not only to the basic concepts used in environmental laws, nor just the provisions relating to listing entities or protection, but to every operative and other relevant provision that refers to particular taxa. These amendments are particularly necessary for laws that currently operate by including fungi as 'plants' (of which there are several).

In most cases, integration will be effective simply by referring to fungi wherever plants are referred to. An illustrative example of where amendments might be made is the *FFG Act*. For this statute, in addition to integrating funga in, for example, the operative provisions relating to listing taxa and communities, it would be appropriate also to amend the name of the Act to reflect the addition of funga — ie, to name it the '*Fauna, Flora, and Funga Guarantee Act 1988* (Vic)'. It would also be appropriate to amend the objective in s 4(a), being the 'guarantee' after which the Act is named. For example, it could be redrafted as follows:

> **4 Objectives of this Act**
>
> The objectives of this Act are—
>
> (a) to guarantee that all taxa of Victoria's fauna, flora, and funga, other than taxa specified in the Excluded List, can persist and improve in the wild and retain their capacity to adapt to environmental change; …

In other contexts, the proper integration of fungi requires more than simply adding 'and fungi' (or equivalent) to the relevant provisions. The unique ecology of fungi needs to

be considered in particular cases. For example, in the provisions instituting scientific committees responsible for advising on and, in some cases, determining nominations for listing, it is appropriate that there be a requirement for the committee to include mycological expertise. Another example is the 'picking plants' offence in s 2.2 of the *BC Act*, which relies on a definition of 'pick' that includes 'remove from the ground'. Not all fungi — indeed, not all plants — live in 'the ground'. To ensure the most effective inclusion of fungi in this offence, the definition of 'pick' in this respect should be amended to include also the removal of the fungus (or plant) from its 'host' or 'substrate'. This would accommodate the habitat requirements of fungi (and plants) that do not live in the ground.

For management, one of the key ways to support integrating fungi into existing conservation and restoration practices would be to test those practices scientifically to ascertain whether they actually benefit fungi. For example, if a protected area is managed for 'biodiversity' generally, and in practice that involves managing each of the different native plant assemblages in the area, then the effective inclusion of fungi requires at a minimum that those management practices be tested to ensure that they are actually conserving (or, where necessary,[540] restoring) fungal diversity. This approach, if fully integrated into existing management and resourced sufficiently, could significantly improve the state of Australian fungus conservation and restoration.[541] This type of integration probably does not even require law reform, although the law should be willing to intervene if managers prove unwilling to change their practices.

C *Innovation*

Recognition and integration will have significant consequences for fungus conservation and restoration. They will address the essential problems identified in this thesis about the inclusion of fungi in Australian environmental law.

However, it is through innovations in law that the inclusion of fungi has the potential to be far more effective.

[540] Noting that restoration should only be carried out if there is some evidence that an ecological function that is supposed to be performed by fungi is not being performed. If biodiversity and ecological processes are intact, conservation is sufficient: Interview with Sapphire McMullan-Fisher (n 101).
[541] Interview with Tom May (n 98).

Two types of innovations are argued for in this chapter: creating new laws for biodiversity generally that also benefit fungi; and creating new laws for the particular benefit of fungi.

1 *New Laws for the Benefit of Biodiversity Generally*

The first category of innovations is the creation of new laws for the benefit of biodiversity generally that also benefit fungi. These include reforms to address key environmental problems; require conservation strategies for all listed entities; require management to change if a listed entity's status changes; diversify listing categories; and protect unlisted biodiversity.

(a) Address Key Environmental Problems

Perhaps the most consequential of the reforms that could be made to Australian environmental laws are reforms that directly address the root causes of the key environmental problems that threaten all biota, including fungi. These problems were tabulated in Chapter Two and include wicked problems like climate change and habitat loss. They have been the subject of much expert analysis, and many recommendations have been made.[542] It suffices to say for the present purposes that many of these recommendations, if followed, would likely have significant beneficial consequences for fungi. This is likely to be the case even if the authors of the expert analyses did not turn their minds to fungi when making their recommendations. However, to the extent law reform is required to address the key environmental problems, those reforms should ensure that fungi are expressly recognised and integrated in the manner argued for in

[542] For recent analyses specific to the biodiversity and protected area management contexts, see, eg, Wentworth Group of Concerned Scientists, 'Blueprint to Repair Australia's Landscapes: National Case for a 30-Year Investment in a Healthy, Productive & Resilient Australia' (Synthesis Report, July 2024) <https://wentworthgroup.org/wp-content/uploads/2024/07/Blueprint-to-Repair-Australias-Landscapes-Part-I-Synthesis-Report-Accessible.pdf>; Australian Committee for IUCN Inc, 'Priority Actions to Meet Australia's Commitments to the Kunming-Montreal Global Biodiversity Framework' (Report, 2023) <https://www.aciucn.org.au/_files/ugd/f443f7_c1ae8ddc208a424b9daa7ea316b415e1.pdf>; James Fitzsimons et al, 'Protecting Australia's Nature: Pathways to Protecting 30 Per Cent of Land by 2030' (Report, 2023) <https://www.natureaustralia.org.au/content/dam/tnc/nature/en/photos/australia/Report3030_FINAL_web.pdf>. For slightly older legal analyses, see, eg, EDO NSW and Humane Society International Australia, 'Next Generation Biodiversity Laws – Best Practice Elements for a New Commonwealth Environment Act' (Report, 2018) <https://www.edo.org.au/wp-content/uploads/2019/11/HSI_EDO_Next_Generation_Report_SEARCHABLE.pdf>; Australian Panel of Experts on Environmental Law, 'Terrestrial Biodiversity Conservation and Natural Resource Management' (Technical Paper No 3, August 2017) <https://www.edo.org.au/wp-content/uploads/2022/06/APEEL-Technical-Papers-1-8-Compilation.pdf>.

Part II(A)–(B) above. For example, if biodiversity targets are adopted in environmental statutes, then it is critical for fungi that they be considered and expressly referred to wherever other taxa are also referred to in those targets.[543] Similarly, if legislative action is taken to abate KTPs, then this action should be cognisant of the unique biology, ecology, and conservation needs of fungi. Recognising and integrating fungi in ways such as these when addressing key environmental problems is an essential step to ensuring that they are effectively included in environmental law.

(b) Require Conservation Strategies for All Listed Entities

Chapter Three showed some of the different approaches taken by Australian jurisdictions to the management obligations that should following the listing of an entity. For example, in NSW, a strategy is required to be made for every threatened entity within two years of its being listed, but no strategy is required to be made for a KTP. In the ACT, it is mandatory to make an action plan for a KTP, but discretion is conferred on the Minister to decide in a particular case not to have an action plan for a threatened native species. Both NSW and the ACT require monitoring and review of strategies and action plans respectively, but only the ACT expressly requires action plans to be implemented.

Environmental law across Australia would be significantly strengthened and simplified, including with respect to listed fungi, if management requirements for listed entities were set at a consistent, high standard. The law should require a strategy (however named) to be made within a reasonable period following the listing of any threatened (and potentially any otherwise protected) species or ecological community and any KTP. It should also expressly require those strategies to be implemented, monitored, reviewed, and periodically remade to ensure they remain current. For reasonableness, a head of regulation-making power could be included to exempt the application of these requirements in particular cases; but such a head of power should only be used sparingly. Additionally, if in addressing key environmental problems biodiversity targets are included in environmental legislation, then management planning should also be required to contribute to the meeting of those targets. This reform would significantly improve the effectiveness of environmental law for all listed

[543] Cf Yun Cao, Gang Wu, and Dandan Yu, 'Include Macrofungi in Biodiversity Targets' (2021) 372(6547) *Science* 1160; Susana C Gonçalves et al, 'Include All Fungi in Biodiversity Goals' (2021) 373(6553) *Science* 403.

entities, including listed fungi, as it would ensure that strong management consequences follow every listing decision in every jurisdiction across Australia.

(c) Require Management to Change With Listing Status

A further reform for the benefit of biodiversity generally is to require management by private landholders to be reviewed and, where appropriate, modified following a change to the category under which an entity is listed (for example, if an entity is uplisted from endangered to critically endangered).

Under existing environmental laws, it is already arguably the case that any statutory obligations imposed on governments with respect to management planning must be performed anew if an entity's listing status is changed.[544] This affects how the listed entity is managed by state government agencies. However, it does not directly affect the management planning of third parties, such as local councils and private landholders, who may also manage the entity or its habitat on their own land. This was identified as a problem in Chapter Four, which showed that the Council's plans for managing the community of *Hygrocybeae* fungi in LCBP did not change when that community's status was uplisted from 'endangered' to 'critically endangered'.

To address this problem, the law should require persons responsible for managing land to conserve or restore a listed entity to review any management plans and practices in relation to the entity following a change to its listing status and, if appropriate, modify those plans and practices. The particulars of this reform will require some further consideration — for example, mechanisms will need to be in place to notify landholders directly of changes to listing status, and consideration may need to be given to limiting the requirement to the more sophisticated landholders (eg, local councils and the larger not-for-profit organisations managing private protected areas) given the likely increase in management costs. But regardless of how it is ultimately designed, this reform would significantly improve the effectiveness of including listed entities (including fungi) under environmental law as it would ensure their management across land tenures keeps pace with their extinction threat as recognised by the law.

[544] This follows if it is accepted that the amendment or transfer of a listing, or the omission and insertion of an entity in a statutory list, is, legally, a new listing under that statute.

(d) Diversify Listing Categories

Chapter Three identified the significant potential for fungus conservation and restoration of having categories of protection other than extinction threat available under environmental law. For example, in the ACT, it is possible to list a native species as 'restricted trade', 'rare', or 'data deficient'. These more diverse categories recognise that there is value in legally protecting an entity in certain cases even if it is not threatened with extinction.[545]

Adopting the ACT's additional categories of protection across all Australian jurisdictions would significantly improve the potential to include fungi effectively under environmental law. The potential significance of this reform for fungi is particularly high given many Australian fungi are little-known. As a precaution, they may warrant legal protection until they become better known.

Of course, adopting the additional categories under law is just the first step. Further consideration will be required as to the legal consequences that should follow from listing entities in these categories. For example, it was identified in Chapter Three that, in the ACT, there are distinct criminal offences that apply in respect of these 'protected' native species compared to threatened native species. Consideration should be given as to whether this is an appropriate approach, or if more specific consequences should attach to each category of listing (or, indeed, if listing in some categories should have no legal consequence other than status recognition[546]).

[545] For example, it is well documented that both rare and little-known species can contribute significantly to maintaining overall ecosystem function, as well as provide food and medicine to humans: see, eg, Curtis H Flather and Carolyn Hull Sieg, 'Species Rarity: Definition, Causes and Classification' in Martin G Raphael and Randy Molina (eds), *Conservation of Rare or Little-known Species: Biological, Social, and Economic Considerations* (Island Press, 2007) 40, 41–44; Randy Molina and Bruce G Marcot, 'Definitions and Attributes of Little-known Species' in Martin G Raphael and Randy Molina (eds), *Conservation of Rare or Little-known Species: Biological, Social, and Economic Considerations* (Island Press, 2007) 67, 84–85.

[546] This would make these listings 'performative' in the sense described in Emma Lees and Ole W Pedersen, 'Performative Environmental Law' (2025) 88(1) *Modern Law Review* 124. Performativity is 'not necessarily a bad thing', particularly if it leads to more public 'buy-in' to new ideas and commitments in environmental law (eg, that fungi and other entities might be worth protecting even if they are not threatened with extinction), so long as it does not become a façade to hide inaction: see ibid 153.

(e) Protect Unlisted Biodiversity

Most biodiversity-related laws in Australia prioritise the conservation of entities threatened with extinction over other entities. While paying attention to threatened entities is warranted, this prioritisation means relatively little attention is paid by biodiversity-related laws to the rest of biodiversity. Given so few fungi are listed in Australia, this means that the vast majority of fungi, being unlisted, are being paid very little (if any) specific conservation or restoration attention under biodiversity laws (and even under protected area laws that ostensibly include these fungi, as was shown in Chapter Four).

One way to include more biodiversity (including more fungi) effectively under these laws is to confer greater protections on unlisted entities. For example, there is an opportunity to criminalise under environmental law acts that harm biodiversity in general, whether or not the particular entity harmed is listed as threatened. A model for this can be found in ACT, which, as discussed in Chapter Three, includes offences for taking or selling certain native plants (including fungi) and damaging or harvesting certain fallen native timber (which is an important fungal habitat). Such offences, if adopted across the Australian jurisdictions, would significantly improve the inclusion of biodiversity under environmental law generally and be of particular benefit to fungi given most fungi are unknown to science, let alone listed under law for protection.

2 *New Laws for the Particular Benefit of Fungi*

The second category of innovations for the more effective inclusion of fungi comprises reforms for the particular benefit of fungi, whether or not they significantly benefit other biodiversity. These reforms include requiring the development of a national strategy for fungus conservation and restoration; legislating a scientific discovery program; establishing taxon-specific targets for listings and protected areas; allowing the listing of lookalike species across Australian jurisdictions; presuming nativeness of fungi in environmental offences; and requiring fungus conservation and restoration measures in protected area management plans.

(a) Require the Development of a National Strategy for Fungus Conservation and Restoration

One of the most significant innovations for the particular benefit of fungi would be the development of a national strategy for fungus conservation and restoration. Given the

lack of success in asking governments to make such a strategy to date,[547] it would be preferable for a requirement to develop this strategy to be legislated. Ideally, this would be at the federal level (eg, in the *EPBC Act*), and require endorsement by the state and territory Environment Ministers so that it can cover the whole of Australia.[548]

Developing such a strategy would serve multiple purposes. For example:

1. It would provide an opportunity for conservation mycologists, governments, and other interested persons to come together and discuss the strategic priorities for fungus conservation and restoration in Australia. These strategic priorities could then provide legitimacy to further legislative reforms.
2. It would coordinate efforts across jurisdictions to advance fungus conservation and restoration not just in law, but potentially in policy and practice as well.
3. It would allow government agencies to consider how existing laws can be implemented with respect to fungi, including for example in environmental law enforcement and management.

The strategy should follow international best practice as to its content. This best practice need not be recited here.[549] It suffices for the present purposes to note that, insofar as supporting the effective inclusion of fungi in law is concerned, one of the greatest priorities for the strategy is to establish the legitimacy of fungus conservation and restoration as a government action. Setting out authoritatively the diverse values of the Australian funga and why it warrants specific attention in an official document like a national strategy could be critical to convincing decision-makers, as well as the broader Australian public, of the importance of fungus conservation and restoration. This type of awareness-raising has been described as 'the key objective in fungal conservation

[547] In the Commonwealth jurisdiction, there have been at least two calls for strategic fungus conservation that have been refused. The first was in a conservation overview about fungi, along with other little-known taxa, for the Commonwealth in 1997: May, 'Fungi' (n 3); Stevens (n 3). The second was in a Question on Notice from a Senator to the Commonwealth Environment Minister in 2014: Parliament of Australia, 'Senate Questions on Notice' (5 February 2013) <https://www.aph.gov.au/Parliamentary_Business/Chamber_documents/Senate_chamber_documents/qon>. Indeed, in May's experience, there has been no proactive government action for fungus conservation or restoration since the commissioning of the 1997 conservation overview, besides indirect support for fungal taxonomy via the Australian Biological Resources Study: Interview with Tom May (n 98).

[548] If a requirement to develop a fungus-specific strategy were to be legislated, then it would make sense for legislation to require other taxon-specific strategies (eg, for plants and animals) as well. But the merits of strategies for those taxa are beyond the scope of this thesis to discuss.

[549] See 'The Micheli Guide to Fungal Conservation', *International Society for Fungal Conservation* (Web Page, 2021) <http://www.fungal-conservation.org/micheli.htm>. Cf Fungi Foundation, 'Home', *Fungal Conservation Tracker* (Web Page, 2025) <https://fungalconservationtracker.ffungi.org>.

today'.[550] Having greater public and decision-maker support will only facilitate the adoption and implementation of reforms to include fungi more effectively in Australian environmental law.

(b) Legislate a Scientific Discovery Program

One of the greatest problems associated with including fungi effectively in environmental law is that they are extremely little-known. This creates problems because many operative provisions rely on being able to identify organisms. For example, it would be impossible to tell whether an organism is native to an area — and therefore list it for protection or prosecute an offence in respect of it — if its identity is unknown. The great diversity in fungi, together with their being so little known, means that many fungus species are likely to go extinct before they are even discovered.[551]

Environmental law can play a role in radically improving scientific knowledge and understanding of the Australian funga by requiring the establishment and implementation of a government-funded scientific discovery program.[552] An example of how legislation could do this is drafted below:[553]

> **Division 6A Scientific Discovery Program**
>
> **4.37A Establishment of Scientific Discovery Program**
>
> (1) The Environment Agency Head must establish a Scientific Discovery Program.
>
> (2) The Scientific Discovery Program's objectives are—
>
> (a) to make measurable progress towards describing every species of animal, fungus, and plant native to New South Wales by 2050,
>
> (b) to assess the extinction risk of every described species.
>
> **4.37B Content of Scientific Discovery Program**
>
> (1) The Scientific Discovery Program must consist of the following—

[550] Niskanen et al (n 25) 165.

[551] See, eg, Lofgren and Stajich (n 26) R1316 (citations omitted).

[552] Cf Deloitte Access Economics, 'Cost Benefit Analysis of a Mission to Discover and Document Australia's Species' (Report, October 2020) <https://www.taxonomyaustralia.org.au/_files/ugd/173494_dc15204b663a4896b691315a94bb0961.pdf >.

[553] This drafting uses the provisions in Division 6 of Part 4 of the *BC Act* (n 232), which relate to the BCP (ie, SoS), as a model.

(a) a strategy to achieve the objectives in section 4.37A, including targets and timeframes,

(b) a framework to guide the setting of priorities for implementing the strategy,

(c) a process for monitoring and reporting on the overall outcomes and effectiveness of the strategy and the Program.

(2) The Environment Agency Head may amend or replace the strategy or any other component of the Scientific Discovery Program at any time.

Note—

Part 9 requires public consultation in relation to the strategy under this section.

4.37C Implementation of Scientific Discovery Program

The Environment Agency Head must take reasonable steps to achieve the objectives of the Scientific Discovery Program, including by implementing the strategy in section 4.37B(1)(a).

4.37D Review of Scientific Discovery Program

(1) The Environment Agency Head is to review the outcomes and effectiveness of the Scientific Discovery Program every 5 years after the establishment of the Program.

(2) The Environment Agency Head is to prepare a report of the review and publish the report on a government website maintained by the Agency Head.

Such a program should be legislated to increase its authority and ensure, by making it more difficult to abolish, that successive governments are bound to implement the program during its lifetime.

A scientific discovery program would be revolutionary for the inclusion of fungi in Australian environmental law. Having a deeper understanding of Australian fungal diversity would allow more appropriate listings to be determined and management plans for protected areas to be more sophisticated in their approach to fungus conservation and restoration. Indeed, having this knowledge would likely enhance the effectiveness of every innovation recommended in this chapter.

(c) Establish Taxon-specific Targets for Listings and Protected Areas

Once fungi are duly recognised and integrated in existing environmental laws, a simple innovation for the better inclusion of fungi would be to use the provisions of those laws to the greatest practicable extent for the benefit of fungi.

In law, this innovation could be implemented by enacting, and requiring the implementation of, targets:

1. to assess the extinction risk of animals, fungi, and plants (complementing the scientific discovery program just argued for);
2. to establish protected areas for listed taxa; and
3. to establish protected areas for animal, fungal, and plant diversity generally.

This reform as it relates to fungi could be designed and implemented as follows.

(i) Targets for Listing Fungi for Protection

Ensuring fungi are eligible to be listed under law for protection is just the first step to their effective inclusion. The next step is to ensure there are fungi actually so listed.[554] This is important because, as has already been noted, many provisions of environmental law are only enlivened once a species or ecological community is listed as threatened.

[554] There is detailed discussion in the mycological literature about the feasibility of listing fungi. Historically, they have been perceived as difficult to list, but this is increasingly no longer the case: see especially Rebecca Yahr et al, 'Red Listing Lichenized Fungi: Best Practices and Future Prospects' (2024) 56(6) *Lichenologist* 345; Mueller et al, 'What Do the First 597 Global Fungal Red List Assessments Tell Us About the Threat Status of Fungi?' (n 122); Anders Dahlberg and Gregory M Mueller, 'Applying IUCN Red-listing Criteria for Assessing and Reporting on the Conservation Status of Fungal Species' (2011) 4(2) *Fungal Ecology* 147.

There is a broader debate about whether listing is appropriate as a conservation strategy for fungi. Proponents suggest that listing duly recognises of the threat status of an entity, directs research priorities, facilitates funding (from both government grants and philanthropy), and informs conservation planning and resource allocation: see, eg, Arnolds (n 100) 255–257; Interview with Sapphire McMullan-Fisher (n 101). Others criticise listing for creating 'an economy of death' and being 'effectively wish lists' that lack legal standing or a management or protection guarantee: see the discussion in Pouliot, *The Allure of Fungi* (n 3) 246. The criticisms identified by Pouliot are not supported by this thesis, which has shown that listing fungi results in significant legal and other consequences, including the actual allocation of management resources towards their conservation. Others still recognise listing processes as important, but consider more attention should be paid to conserving intact biodiversity and ecological processes at a larger scale: Interview with Tom May (n 98).

Given so much of environmental law prioritises listed entities over unlisted entities, it seems imprudent to this author not to use the listing process maximally for fungal gains.

There is a particular need to establish legal targets for the listing of fungi given so few fungi are listed relative to their estimated diversity. The content and implementation of these targets should be informed by two considerations.

The first consideration is to ensure that nominations for listing are encouraged. This could be achieved by using the 'conservation theme' provisions in environmental legislation to determine that the conservation theme for a particular year will be fungi. Advance notice of this theme should be given to allow enough time for mycologists to gather the necessary data to support nominations of fungi for listing. Ideally, government funding would be allocated to assist with these nominations.

The second consideration is to decide which listings of fungi should be prioritised. Given that funding for threatened species recovery is already lacking (as discussed in Part III(B) below), a target to list every threatened fungus species is unlikely to be viable. Instead, a more focused approach should be taken. There are many ways this could be done. One way is to focus on the fungal diversity hotspots around Australia and attempt to list them for protection as ecological communities and, where appropriate, to list their members for protection as individual species.[555] Another way is to approach listings of species (not just fungi) as 'holobionts' — ie, ensure the key symbionts that associate with a listed organism are also listed for protection.[556] Another way still is to prioritise the most charismatic of the threatened fungi, such as brightly coloured mushroom-forming species, for the first nominations, as these fungi have an 'aesthetic advantage' that draw attention to them and may assist with them with being listed.[557] Whatever approach is taken, having taxon-specific listing targets legislated and implemented would significantly improve the inclusion of fungi under Australian environmental law.

(ii) Targets to Establish Protected Areas for All Listed Fungi

A measure to complement targets to list fungi for protection would be to legislate targets to ensure that all listed fungi (ideally all listed entities), to the greatest extent practicable, have their habitats formally protected as part of the NRS.

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[555] This reflects the way the *Hygrocybeae* fungi were listed in NSW: Buchanan and May (n 447) 418–419.

[556] May et al, 'Recognition of the Discipline of Conservation Mycology' (n 539) 735.

[557] This factor may have contributed to the success of the *Hygrocybeae* listing in NSW: Pouliot, *Underground Lovers* (n 460) 166.

This would address one of the problems identified in Chapter Four, which is that not all listed fungi have their habitats formally protected. The example was given that the critically endangered *Hygrocybeae* community in NSW, while protected in a 'wildlife refuge', does not have its habitat in the LCBP protected by any formal protected area (with attendant management obligations) recognised as part of the NRS.

Adopting this reform would include fungi more effectively under environmental law by ensuring that listed fungi enjoy the benefits of having their habitats conserved and restored in protected areas, including with the attendant obligations of management.

(iii)Targets to Establish Protected Areas for Fungal Diversity Generally

A further set of targets should be legislated and implemented to establish new protected areas to conserve and, where necessary, restore fungal diversity more generally. This innovation takes the targets for listed entities one step further by seeking to protect fungal diversity regardless of whether it is recognised as having particular conservation value in a list maintained under law.

Part II(E) of Chapter Two referred to a number of studies that support the proposition that the Australian funga may not be well represented in the NRS, with both global and local studies suggesting that many fungal diversity hotspots occur outside existing protected areas. This means there is a pressing need for specific targets to conserve and, where necessary, restore hotspots of fungal diversity in the NRS.

This reform should be approached in two ways: first, by designing and implementing targets to establish new protected areas to conserve known hotspots, and restore known degraded areas, of fungal diversity; and second, by designing and implementing targets to protect connections between, and buffers around, these new and existing areas to the greatest extent practicable.[558] Further studies should be carried out to inform these targets and their implementation, although a Sydney-based study suggests that conservation networks comprising habitat nodes of at least 3.5–5 ha with several areas

[558] In the latter regard, it is worth noting that most countries, including Australia, do not have a structurally connected protected area network: Michelle Ward et al, 'Just Ten Percent of the Global Terrestrial Protected Area Network Is Structurally Connected via Intact Land' (2020) 11(1) *Nature Communications* 4563:1–10. Re-establishing these connections is important for fungus conservation and restoration: Pouliot, *Underground Lovers* (n 460) 243; Interview with Sapphire McMullan-Fisher (n 101).

of at least 100 ha, functionally connected by corridors of proportionate sizes, are required.[559]

(d) Allow the Listing of Lookalikes

A smaller scale reform for the particular benefit of fungi, but one of potentially great significance, is to ensure all environmental laws allow lookalikes to be listed as threatened or otherwise protected species.

Chapter Three discussed how the environmental laws of the Commonwealth and ACT allow 'similar' species to be listed as threatened in addition to a species that is actually threatened with extinction if, among other things, the species are so similar that it is difficult to differentiate them. The ability to list lookalikes has untapped potential. Currently, there are no listings of fungi that make use of these provisions, so they are yet to be tested. However, macrofungi can be visually similar; the distinguishing features between species can be subtle or even microscopic, making identification difficult.[560] Listing lookalikes may have numerous benefits. An obvious one is deterrence of criminal behaviour: if all fungi that have particular visual characteristics enjoy strict protections under environmental law, then this may deter people who might have otherwise harmed the fungus (eg, by picking it for consumption or deliberately harming it). The ability to list lookalike fungi could therefore significantly improve the effectiveness of their inclusion under environmental law.

(e) Presume Nativeness of Fungi in Environmental Offences

In addition to the problems with identifying fungi described in this chapter, there is also the complexity, noted in Part II(D) of Chapter Two, of identifying whether a fungus is native to an area. This complexity creates significant problems in the context of enforcing environmental crimes with respect to fungi: if nativeness is an element of the offence but is difficult or impossible to prove, then the prospects of a successful prosecution may be reduced to near-zero.

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[559] See Ian N Drinnan, 'The Search for Fragmentation Thresholds in a Southern Sydney Suburb' (2005) 124(3) *Biological Conservation* 339.

[560] See, eg, Tom May, 'Use of Target Species in Citizen Science Fungi Recording Schemes' (2021) 5 *Biodiversity Information Science and Standards* e73960:1–3, 1. Even for experts, distinguishing fungi based on morphology alone is difficult; only a minority of fungi can be identified confidently in this way. For example, McMullan-Fisher described in an interview with this author how a *Russulales* fungus being studied in Australia, originally thought to be one distinctive, recognisable species, has ultimately proved to be six separate species after further scientific study: Interview with Sapphire McMullan-Fisher (n 101).

The nativeness problem can be remedied by reforming environmental legislation to allow the regulations made under that legislation to authorise conclusive presumptions to be made that particular taxa are native to the relevant jurisdiction for the purposes of that legislation. This could be done by adopting a relevant classification in an official database that is publicly accessible.[561] Having the ability to prescribe a way for conclusively presuming that an identified fungus is native to Australia would address the nativeness problem, making environmental crimes committed against fungi less difficult to prosecute. This would improve the effectiveness of including fungi in environmental criminal laws.

(f) Require Fungus Conservation and Restoration Measures in Protected Area Management Plans

It was argued in Chapter Four that the implied inclusion of fungi in protected area legislation has had few significant consequences for fungus conservation or restoration in practice as far as management planning is concerned.

An innovation to ensure the more effective inclusion of fungi in protected area management — particularly if the relevant legislation continues to rely on general concepts such as 'biodiversity' that are not defined by reference to particular taxa[562] — is to require that fungi be addressed expressly in protected area management planning. For example, for public reserves, content requirements should be inserted into legislation to require management plans for each reserve to specify conservation and, where necessary, restoration measures for the animals, fungi, and plants that inhabit the reserve.[563] In the case of statutory trusts for private land conservation, such as the TFN, the trusts' objects and functions should be amended to recognise and integrate fungi in the manner argued for earlier in this chapter.

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[561] This is the approach taken to deeming plants as 'native' for the purposes of defining 'native vegetation' under the *LLS Act* (n 421): see s 60B(2) and *Local Land Services Regulation 2014* (NSW) cl 106.

[562] See Part II(A)(2) above.

[563] This measure would not address the further problem identified in Chapter Four Part III(B)(3) that the implementation of such measures, even where the statute requires it, may not be enforced by a court. To address this further problem, protected area legislation would need to be amended to expressly require that each of the measures specified in the management plan must be implemented. However, this reform would have ramifications far beyond fungus conservation and restoration and may disincentivise ambition in protected area management planning.

Like many of the reforms recommended in this chapter, this one requires further particularisation before it is fit to be adopted. For example, an issue that is likely to arise is conflicting management priorities. Currently, there are routine management activities carried out for the benefit of other taxa that are known to be detrimental to fungi.[564] Once fungi are more effectively included in management planning, the opposite may become the case: activities for the benefit of fungi may be carried out, but these activities may be detrimental to other biota. There is also a lack of information at the level of detail required for managers about measures that are appropriate for different kinds of fungi, particularly in the restoration context.[565] The needs of decomposers, for example, are likely to be very different from those of lichens or mycorrhizal fungi. But no matter how they are particularised, these reforms would significantly improve the effectiveness of the inclusion of fungi in protected area laws as they would address one of the key issues identified in this thesis: namely, that implied inclusion is an unreliable way, particularly from a practical perspective, to achieve fungus conservation or restoration outcomes.

III BARRIERS

For environmental law to 'work', it needs both good design and effective implementation.[566] The reform agenda just proposed has focused primarily on matters of design. However, in their implementation, a significant number of the proposed reforms — particularly the more ambitious of the suggested innovations — are likely to encounter barriers. Some of the biggest barriers are identified in this part. Overcoming the barriers may be critical to the success of many of the reforms recommended in this chapter.

A *Opposition to the 'Three Fs'*

An initial barrier to including fungi more effectively may be political and other opposition to the concept of the 'three Fs' — fauna, flora, and funga.

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[564] See, eg, Royal Botanic Gardens Kew (n 18) 74.

[565] However, steps are being taken to address this information gap: see 'Working With Fungi', *Fungi4Land* (Web Page, 2024) <https://fungi4land.com/working-with-fungi/>.

[566] See, eg, Neil Gunningham, 'Enforcing Environmental Regulation' (2011) 23(2) *Journal of Environmental Law* 169, 170.

One source of opposition may be environmental advocates. The chief criticism of the 'three F' approach from this perspective is that all life should be included more effectively in law — not just two or three 'Fs'. After all, it is the interactions between all organisms that make ecosystems function, not just the interactions between animals, fungi, and plants.[567] While such criticism would have merit, it would misunderstand the proposal. The proposal is not to refocus all environmental law from biodiversity in general to fauna, flora, and funga in particular. It is to attempt to enlarge the laws that currently focus on plants and animals to include also fungi — thus meaning at least the macroscopic kingdoms of life are being properly included environmental law.[568] While this approach may be inadequate for conserving or restoring the full diversity of microscopic life, it is at least one increment better than simply focusing on plants and animals. It would certainly be better for the fungi.

Another source of opposition might be those who suggest that, as a matter of political or resourcing priority, it is enough for environmental law to focus only on plants and animals. But this criticism would misunderstand the existing scope of environmental laws. As shown in Chapter Three, most environmental laws already include fungi — indeed, many already include all aspects of biodiversity. If this criticism were taken to its fullest extent, then most environmental laws would need to be amended to expressly exclude all taxa except plants and animals. This would be a retrograde step, completing ignoring the diverse values of fungi described in Chapter Two or why fungi warrant specific attention.

B *Lack of Funding*

The next barrier to the reforms recommended in this chapter would likely be funding.

All reform proposals need some form of funding for their implementation. No economic analysis has been carried out by this author to estimate how much it might cost to implement any of the reforms argued for in this chapter.[569] But there is some existing understanding in the literature of the costs of certain reforms to deal with the key environmental problems, as well as implementing a scientific discovery program.

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[567] McMullan-Fisher (n 48); Interview with Sapphire McMullan-Fisher (n 101).

[568] See especially 'The Initiative' (n 539).

[569] Presumably, recognition and integration would cost relatively little. The greatest expense would likely be the time spent by public servants advising on and preparing amendments to the relevant laws. But the innovations could cost far more.

For example, the cost of discovering and documenting all remaining taxa in Australia was estimated in 2020 to be $824 million (in total) over 25 years.[570] In 2022, it was estimated that $2 billion per year for 30 years would be required to restore 99.8% of Australia's degraded terrestrial ecosystems to 30% vegetation coverage.[571] In 2023, leading scientists recommended that $5 billion (not including ongoing management costs) be spent on expanding on the NRS.[572] And most recently, in 2024, the cost of comprehensively recovering Australia's nationally listed threatened terrestrial and freshwater species was summed to an estimated $583 billion per year for 30 years — approximately 25% of Australia's Gross Domestic Product in 2022.[573]

These funding requests are not small. Government spending on biodiversity conservation does not come close to these amounts.[574] Asking for even more money to be spent specifically to conserve and restore the diversity of fungi — a mostly unknown kingdom of life — would likely be fraught with difficulty. Yet, there are ways for this money to be found. Possibilities include reallocating money currently spent on subsidies harmful to biodiversity in Australia[575] and imposing new requirements on

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[570] Deloitte Access Economics (n 552).

[571] Bonnie Mappin et al, 'The Costs and Benefits of Restoring a Continent's Terrestrial Ecosystems' (2022) 59(2) *Journal of Applied Ecology* 408. Cf Wentworth Group of Concerned Scientists (n 542), which recommended $7.3 billion per year over 30 years for a broader environmental restoration program.

[572] Fitzsimons et al (n 542).

[573] April E Reside et al, 'The Cost of Recovering Australia's Threatened Species' (2025) 9 *Nature Ecology & Evolution* 425.

[574] See, eg, Brendan A Wintle et al, 'Spending to Save: What Will It Cost to Halt Australia's Extinction Crisis?' (2019) 12(6) *Conservation Letters* e12682:1–7; 'Insights From Our Budget Washup Webinar', *Biodiversity Council* (Web Page, 29 May 2024) <https://biodiversitycouncil.org.au/news/insights-from-our-budget-washup-webinar-1>.

The most recent federal Budget includes $250 million to expand the NRS: Commonwealth of Australia, 'Portfolio Budget Statements 2025–26: Climate Change, Energy, the Environment and Water Portfolio' (Budget Related Paper No 1.3, 2025) 17 <https://www.dcceew.gov.au/sites/default/files/documents/dcceew-2025-26-pbs.pdf>. But this a small fraction of the $5 billion recommended and has not been viewed optimistically by experts: see, eg, 'What's in the 2025–26 Federal Budget for Nature?', *Biodiversity Council* (Web Page, 1 April 2025) <https://biodiversitycouncil.org.au/news/what-s-in-the-2025-26-federal-budget-for-nature>; James Watson, 'A Budget Splash to Conserve 30% of Australia's Lands Will Save Species – If We Choose the Right 30%', *The Conversation* (online, 25 March 2025) <https://theconversation.com/a-budget-splash-to-conserve-30-of-australias-lands-will-save-species-if-we-choose-the-right-30-252918>.

[575] See Biodiversity Council, 'Identifying and Assessing Subsidies Harmful to Biodiversity in Australia' (Report, October 2024) <https://biodiversitycouncil.org.au/admin/uploads/Biodiversity_Harmful_Subsidies_Report_7_Oct_2024_a019b36623.pdf>.

persons who cause or have caused environmental damage to pay reparations for that damage.[576] Money for fungi can be found, if there is the political will to do so.

C *Unclear Social Licence*

Another potential barrier is the unclear social licence in Australia to spend significant amounts of public money on fungus conservation and restoration efforts.

There is clearly a social licence in Australia for government action to address biodiversity problems in general. Indeed, most Australians appear to support more of this action being taken, including through significantly greater government expenditure.[577] The issue for fungi is that it is unclear whether this support is consistent across all taxa or only applies to certain taxa.[578] For example, a recent study suggested that there is a 'strong aversion to extinction' among the Australian public and a willingness to pay for conservation,[579] but the study was only conducted in relation to animals. The results might have been different if the study was conducted in relation to fungi also.

What seems clear is that fungus advocates and governments need to create social acceptability for fungus conservation and restoration — that is, a social licence to take government action, spend public money, and ultimately cause inconvenience to individuals, for the benefit of fungi.[580] It may be that the social licence is not known until fungus conservation and restoration efforts are taken too far. For example, May has recommended taking strong precautions for fungi: treating little-known fungi as rare until it can be proven that they are not, and reserving more land than appears to be

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[576] Marco Grasso and Richard Heede, 'Time to Pay the Piper: Fossil Fuel Companies' Reparations for Climate Damages' (2023) 6(5) *One Earth* 459.

[577] See Biodiversity Council, '2024–2025 Biodiversity Concerns Report: A Survey of Community Attitudes Toward Nature Conservation' (Report, March 2025) <https://biodiversitycouncil.org.au/admin/uploads/2025_Biodiversity_Council_Community_Concerns_Report_ee239c6469.pdf>.

[578] Cf John C Z Woinarski, Stephen T Garnett, and Kerstin K Zander, 'Social Valuation of Biodiversity Relative to Other Types of Assets at Risk in Wildfire' (2024) 38(3) *Conservation Biology* e14230:1–12, an Australian study which found different social valuations of different taxa. Respondents preferred koalas to be prioritised for protection over non-charismatic taxa such as invertebrates and plants. Fungi were not included in the survey, but one can imagine the results that might have been produced if the question was asked.

[579] Kerstin K Zander et al, 'How Public Values for Threatened Species Are Affected by Conservation Strategies' (2022) 319 *Journal of Environmental Management* 115659:1–10.

[580] See John D Peine, 'Social Considerations' in Martin G Raphael and Randy Molina (eds), *Conservation of Rare or Little-known Species: Biological, Social, and Economic Considerations* (Island Press, 2007) 236.

necessary for protected areas to increase the likelihood that fungi will be 'carried along'.[581] But such an approach may be a 'double-edged sword': strong precaution may provide protection against threats with extinction, but potential inaccuracies in judging the actual extinction threat to a fungus species may erode public support for fungus conservation measures in general, proving deleterious in the long term.[582] The need for a social licence is why it is critical for the law to require a national strategy for fungus conservation and restoration that authoritatively and convincingly details the values of fungi, as was recommended in Part II(C)(2)(a) above.

D *Knowledge Gaps*

One of the more technical barriers to including fungi more effectively in Australian environmental law is the vast knowledge gap that exists around Australian fungi. Even if fungi were fully recognised and integrated into existing laws and there were a willingness to innovate for the benefit of fungi in the manner argued for in this chapter, the gaps in scientific understanding about this little-known kingdom of life might thwart the full implementation of the reforms.

For example, in the listing context, it is difficult currently to know whether a fungus that appears threatened is actually underreported and common, and whether a fungus that has numerous scientific collections is actually overreported and threatened with extinction.[583] It is also difficult to prove whether any particular fungus has actually gone extinct.[584] In the protected area management context, measures for fungi may be difficult to design and implement if the managers do not have knowledge, or access to knowledge, about fungus conservation and restoration. Integrating fungi into conservation or restoration planning in this case would risk becoming a box-ticking exercise — something to meet bureaucratic demands rather than a reform that actually results in significant consequences for fungus conservation or restoration.

Ultimately, it must be recognised that there will never be complete or perfect knowledge of fungal diversity. However, it seems clear from the literature, at least to this author, that there is enough knowledge at this point in time to 'make scientifically sound management recommendations and to develop strategies to integrate fungi into

[581] May, 'Fungi' (n 3).
[582] Flather and Sieg (n 545) 54.
[583] See, eg, Bierend (n 185) 65.
[584] Brian M Spooner and Peter Roberts, *Fungi* (Collins, 2005) 515.

conservation programs and resources management activities', and for those programs and activities to be improved incrementally with adaptive management over time.[585] It may be the case that conservation and restoration measures will need to start small and grow as the knowledge base of the Australian funga also grows over time.

E *Time Lags*

Another technical barrier, and the final barrier considered in this chapter, is the time lag problem. The problem is that even if fungi are included under law and significant conservation and restoration work on them begins now, it could take decades before there is enough scientific information to assess the extinction risk — and therefore the conservation priority — of many fungus species.

For example, the IUCN Red List process requires population changes to be measured across generations. For most fungi, this means that population changes have to be measured over a significant period. In some cases, the period is as long as 50 years.[586] This may mean that even if all remaining Australian fungus species are discovered by, say, 2050 (eg, pursuant to the scientific discovery program recommended in Part II(C)(2)(b) above), it could take many more years after that to gather the conservation data necessary for threat assessments of those species.[587]

Like the knowledge gap problem, the time lag problem may best be overcome by recognising the inadequacy for what it is and being willing to act in the face of uncertainty. Mycologists have suggested that there simply may not be enough time to allow comprehensive conservation planning before certain fungus species go extinct.[588] Alternatively, it may be that once there is enough knowledge of these species, there are no opportunities left to create protected areas to conserve them properly.[589] Thus, some amount of precaution and proactiveness will be required; but exactly how far this can

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[585] Randy Molina et al, 'Addressing Uncertainty: How to Conserve and Manage Rare or Little-known Fungi' (2011) 4(2) *Fungal Ecology* 134, 143. McMullan-Fisher reiterated in an interview with the author that conservation and restoration practices should include both measures of action and measures of research: Interview with Sapphire McMullan-Fisher (n 101).

[586] Lynne Boddy, 'Fungi, Ecosystems, and Global Change' in Sarah C Watkinson, Lynne Boddy, and Nicholas P Money (eds), *The Fungi* (Academic Press, 3rd ed, 2016) 361, 392–394.

[587] However, May considers that it would be possible to get the required conservation information in years rather than decades, particularly if governments were willing to employ fungal ecologists and conservation mycologists to assist with the work: Interview with Tom May (n 98).

[588] See, eg, Sapphire J M McMullan-Fisher et al, 'Surrogates for Macrofungi and Mosses in Reservation Planning' (2010) 24(3) *Conservation Biology* 730, 731 (citation omitted).

[589] May, 'Fungi' (n 3) 65.

be taken will need to be tested carefully to ensure that the boundaries of social acceptability with respect to fungus conservation and restoration are not transgressed.

IV WORKING PRACTICALLY, THINKING IMAGINATIVELY

There is an enormous opportunity to include fungi more effectively in Australian environmental law. It does not have to be 'a far-off dream'.[590] As Pouliot argues:

> Australia is possibly better positioned than any country in the world to set a precedent for fungus conservation and biodiversity conservation more generally. Australia has the tremendous advantage of being one of two among the 17 nations considered as megadiverse with a developed and industrialised economy. The combination of Australia's affluence, technological capacity, high level of public scientific literacy, systematically designed protected areas and civil stability offer the prospect of the world's best conservation.[591]

This chapter has proposed a reform agenda to seize this opportunity. It has argued that three types of reforms are required to include fungi more effectively in Australian environmental law: first, the express and correct recognition of fungi as a distinct kingdom of life; second, the proper integration of fungi into the operative and other relevant provisions of laws; and third, innovations in law for the benefit of biodiversity generally and fungi in particular.

Recognising that there are significant barriers to adopting and implementing the reforms argued for in this chapter, it is suggested that fungus advocates approach the task by working practically but thinking imaginatively. Working practically requires that attention be paid to the most essential reforms and, if failures are encountered, accepting that some progress is better than nothing. History suggests, for example, that lobbying for a fungus conservation strategy is unlikely to succeed; but lobbying for the simple recognition and integration of fungi in existing laws may be more palatable while still having significant consequences for fungus conservation and restoration. While working practically in these ways, imaginative thinking requires that fungus advocates maintain a clear idea of what 'effective' inclusion in law looks like and the various ways that might be achieved. Some jurisdictions may welcome the opportunity

[590] Whitney Bauck, 'Saving the World's Fungi Might Save Us, Too', *Atmos* (online, 28 August 2024) <https://atmos.earth/saving-the-worlds-fungi-might-save-us-too/>.
[591] Pouliot, *The Allure of Fungi* (n 3) 241.

to be world-leading in the field of fungus conservation and restoration. Others may be more interested in seeing how to amend and use existing provisions for the maximal benefit of fungi. Others still may sympathise with the cause but only be willing to implement changes to correct any significant errors or omissions in law with respect to fungi. Finally, there may be those who are not yet receptive to the idea of conserving or restoring fungi at all. Being adaptable and willing to embrace a diversity of approaches is part of the imaginative thinking that, in this author's view, will be required for fungus advocates successfully to realise the more effective inclusion of fungi across Australian environmental laws.

Ultimately, Australia only needs to protect the fungal diversity it wants to keep. It is up to law to govern how this will occur. It follows that the effective inclusion of fungi in Australian environmental law is not just desirable, but necessary, if there is to be any reasonable confidence that they might be effective in protecting Australia's fungal diversity. The alternative is at best wishful thinking, and at worst continued neglect and dysfunction. By drawing on the reform agenda argued for in this chapter, and working practically but thinking imaginatively, fungus advocates can help Australia make the transition from neglect and dysfunction to the more effective inclusion of fungi in Australian environmental law.

Mycelium and sporing bodies of the scarlet bracket (*Trametes coccinea*) at Yarramundi Reserve, Agnes Banks

CHAPTER SIX

CONCLUSION

I SUMMARY OF THE FINDINGS AND ARGUMENT

This thesis sought to assess comprehensively and critically, for the first time in legal scholarship, the extent to which fungi are effectively included in Australian environmental law. The effective inclusion of fungi was assessed by way of doctrinal, comparative, empirical, and policy research into two key questions: first, whether fungi are included at all in Australian environmental law; and second, to the extent they are included, whether that inclusion has resulted in any significant consequences for their conservation and restoration.

The first substantive chapter of this thesis, Chapter Two, provided an overview of fungi. It explained what fungi are and described their biology, ecology, evolution, some of their unique complexities, as well as their unique conservation and restoration requirements. The chapter also described the Australian funga, its status, and the most pressing threats. The chapter concluded with an overview of the diverse instrumental, intrinsic, and relational values of fungi and made the argument that fungi warrant specific conservation attention.

Chapter Three turned to the question of whether fungi are included in Australian environmental legislation. The chapter confined itself to the statutes of the Commonwealth, ACT, NSW, Tasmania, and Victoria that deal with terrestrial biodiversity conservation and the management of terrestrial protected areas. It was argued that the inclusion of fungi in legislation is best described as being on a spectrum of neglect. On one end of the spectrum, there are laws that expressly refer to fungi and include them in some way in their operative provisions. On the other end of the spectrum, there are laws that generally exclude fungi. Most laws fall somewhere in between. Although misdescription and nondescription of fungi is universal in Australian environmental law, every statute includes fungi at least impliedly, to some extent — meaning fungi are at least permitted, to some extent, to be conserved or restored under them. Most concerningly, two jurisdictions where there are fungi actually listed as threatened species, Tasmania and Victoria, have biodiversity statutes that apparently do not authorise those listings. There was also one instance, in the ACT,

in which the inclusion of fungi as 'plants' was argued not to be legally effective. Thus, it was argued that there is not only a certain neglect of fungi in law, but also a certain dysfunction. Yet the inclusion of fungi, such as there is, still has significant consequences for their conservation and restoration — the most significant being that fungi may be cared for as part of the management of protected areas across Australia and, in most jurisdictions, can be listed as threatened species or ecological communities. Unfortunately, in reality this significance has been limited as there are only 45 species and 2 ecological communities of fungi currently listed for protection under law. These numbers are very low relative to the estimated diversity of fungi in Australia.

Chapter Four turned to the question of whether this manner of including fungi has resulted in any significant consequences for their conservation or restoration in practice. It was argued in the litigation context that there have been no significant consequences for fungus conservation or restoration because there have been no cases within the scope of 'environmental' law as understood in this thesis in which the needs of fungi have arisen centrally in a proceeding. In the protected area management context, it was argued that the mostly implied inclusion of fungi under the relevant legislation has resulted in very few practical consequences for fungi — few of the public reserve and private protected area management plans considered in this thesis showed a sophisticated understanding of fungi, their values, or why they are worth conserving, let alone how they might actually be conserved or restored in practice. However, in the context of biodiversity conservation, it was shown that the ability to list fungi as threatened can and does have significant consequences for their conservation. This was demonstrated by consideration of the listings of threatened fungi in NSW which, together with the positive legal obligation in that jurisdiction to develop strategies to conserve listed threatened entities, has demonstrably resulted in the allocation of management resources to the conservation of those fungi.

Chapter Five took the findings of this thesis and proposed an agenda for law reform. It argued that three types of reforms are needed to include fungi more effectively in Australian environmental law: first, express recognition of fungi as a distinct kingdom of life and a legitimate subject of legislative attention; second, the full integration of fungi into existing laws; and third, innovations in law for the benefit of biodiversity generally and fungi in particular. It was argued that by working practically but thinking imaginatively, fungus advocates would be well placed to influence the development of

law, shifting it incrementally from a state of dysfunction and neglect to a more active approach to fungus conservation and restoration. It was argued that such reforms are not just desirable, but necessary, if there is to be any reasonable confidence that environmental law might be effective in protecting Australia's fungal diversity.

Thus, the key finding of this thesis, and its central argument, is that fungi are generally neglected by Australian environmental law.

II DIRECTIONS FOR FUTURE RESEARCH

Fungi challenge Australian environmental law. The relatively simple question of whether they are effectively included raises many further, more complicated questions. Does the general neglect of fungi mean that Australian environmental law is 'so severely compromised', from a scientific perspective, 'as to be invalid'?[592] Does it mean that the law is attempting to govern human relationships with a world that does not really exist?[593] How much of 'the environment' is actually covered by 'environmental' law? What other blind spots might there be in environmental law? Is it acceptable for environmental law to have these blind spots? These are the kinds of questions that fungi raise — and they are questions that need answering.

This thesis has taken the first steps into what could be a new, diverse field of inquiry for scholars of environmental law. Legal scholarship would be enriched by exploring this field further. It is appropriate to conclude by noting some of the many directions in which future research might be taken.

A *Fungi in the Environmental Laws of Other Australian Jurisdictions*

This thesis analysed the environmental laws of the Commonwealth, ACT, NSW, Tasmania, and Victoria. A logical next step is to analyse also the environmental laws of the Northern Territory, Queensland, South Australia, and Western Australia. This would allow a fuller appreciation of how fungi are included in environmental laws across all Australian jurisdictions.

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[592] Cf David Minter, 'A Future for Fungi - The Orphans of Rio', *International Society for Fungal Conservation* (Blog Post, 2010) <http://www.fungal-conservation.org/blogs/orphans-of-rio.pdf>.

[593] Cf Giuliana Furci and Merlin Sheldrake, 'No, You Shouldn't Be Afraid of Fungi', *TIME* (online, 19 February 2023) <https://time.com/6256252/fungi-science-the-last-of-us/>.

B *Fungi in Other Areas of Environmental Law*

This thesis defined 'environmental' law to include only those laws that directly concern biodiversity conservation and the management of protected areas. But environmental law includes many more matters, particularly in its intersections with other areas like planning and natural resource management. The inclusion of fungi in these other areas of law would be a worthy subject of future research.

C *Aquatic Fungi in Australian Environmental Law*

This thesis was limited to the environmental laws governing the terrestrial environment. An analysis of the inclusion of fungi in the laws governing the aquatic environment is also warranted.

D *Fungi in Indigenous Protected Areas and Shared Management Reserves*

This thesis considered laws and management plans with respect to public reserves and private protected areas, but not Indigenous Protected Areas or shared management reserves. It would be useful to ascertain the extent to which fungi are included in the governance and management of these types of protected areas.

E *Fungi in International Environmental Law and the Domestic Laws of Foreign Nations*

This thesis excluded discussion of international environmental law. It would be valuable to understand the extent to which fungi are included in multilateral environmental agreements, and if so whether and how such inclusions have been reflected in Australian law.[594]

It would also be valuable to compare foreign domestic environmental laws with Australian environmental law with respect to fungi.[595] There may be much to learn from

[594] Efforts have been made recently to integrate fungi into 'national and international legislation, policies and agreements': see Jonathan Watts, 'Fungi Could Be Given Same Status as Flora and Fauna Under Conservation Plan', *The Guardian* (online, 16 October 2024) <https://www.theguardian.com/environment/2024/oct/16/fungi-status-boost-conservation-cop16-uk-chile-biodiversity-plan>; 'Pledge for Fungal Conservation', *Fungi Foundation* (Draft Pledge, 2024) <https://assets.ffungi.org/FungalConservationPledge2024_EN.pdf>. Unfortunately, these efforts have been unsuccessful to date: see Fungi Foundation (LinkedIn, 13 November 2024) <https://www.linkedin.com/posts/fungi-foundation_cop16-chile-activity-7262101449168359425-Rphe/>.

[595] A starting point for this analysis might be the 'fungal conservation tracker' being developed by the Fungi Foundation: Fungi Foundation, 'Home' (n 549).

a comparative analysis with jurisdictions, such as Chile,[596] that are highly regarded for the ways they have chosen to include fungi in their environmental laws.

F *Empirical Studies*

Empirical research has the potential to reveal deeper insights about fungi under Australian environmental law. For example, research could be carried out to ascertain whether, despite their virtual absence from management plans, fungi are actually adverted to in the conservation and restoration work of field officers responsible for the everyday management of protected areas and how that advertence (or inadvertence) relates to the legal framework for protected area management.

G *Political Science Studies*

This thesis made arguments about the ways Australian environmental law neglects fungi, but it did not make any arguments about why the law has been designed in those ways. Rigorous studies in political science are required to provide a reliable explanation. Such studies would be worthwhile as they would allow the reform suggestions in Chapter Five to be further refined and, perhaps, approached in a way that increases the likelihood of their being adopted.

H *Theoretical Studies*

This thesis analysed and made arguments about the current state of the law and how, practically, it might be reformed for the benefit of fungi. However, the thesis did not touch on the deeper, more theoretical questions that fungi raise about the nature of environmental law. The tendency of fungi to reveal blind spots and challenge the most basic concepts relied upon in environmental law makes them a suitable vehicle for traversing the terrain of legal theory.

I *Fungi and Australian Environmental Policy*

A natural complement to this thesis would be a study of the effective inclusion of fungi in Australian environmental policy — particularly public strategies that decide the long-term directions of environmental laws, policies, programs, and practices in Australia. From a legal perspective, this study could be carried out by way of a doctrinal analysis similar to that which was carried out in Chapter Three. This would offer the opportunity

[596] For example, Chile: see Royal Botanic Gardens Kew (n 18) 77.

to make policy-focused reform suggestions, which would no doubt complement and enhance the law reform suggestions made in Chapter Five.

J *Fungi and Other Social Norms*

The law is just one source of norms that govern human behaviour. Other sources of norms, such as morals, may also influence profoundly how people interact with fungi — perhaps more so than the law. For example, an empirical study could be carried out to ascertain whether Australians feel any moral obligation towards fungi and, if there is one, how it compares to any such obligation felt towards plants and animals.[597] Studies such as this would enrich our understanding of how Australians relate to fungi and help clarify the appropriate role of the law in governing those relationships.

[597] For a sophisticated account of Australians' relationships with fungi, see Pouliot, *The Allure of Fungi* (n 3).

Cordyceps (*Cordyceps* sp) at Waterfall Reserve, Mount Wilson

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Lichens on sandstone at The University of Sydney Quadrangle, Camperdown

APPENDIX ONE

FUNGI LISTED UNDER AUSTRALIAN ENVIRONMENTAL LAW

*Figure 1: Fungi Listed for Protection**

Entity	*Entity Type*	*Threat Status*	*Legislation*
Commonwealth			
Nil.			*Environment Protection and Biodiversity Conservation Act 1999* (Cth).
New South Wales			
Hygrocybeae Community of Lane Cove Bushland Park in the Sydney Basin Bioregion.	Ecological community.	Critically endangered.	*Biodiversity Conservation Act 2016* (NSW).
Mt Canobolas *Xanthoparmelia* Lichen Community.		Endangered.	
Camarophyllopsis kearneyi.	Species.	Endangered.	
Hygrocybe austropratensis.			
Hygrocybe collucera.			
Hygrocybe griseoramosa.			
Hygrocybe lanecovensis.			
Hygrocybe anomala var *ianthinomarginata*.		Vulnerable.	
Hygrocybe aurantipes.			
Hygrocybe reesiae.			
Hygrocybe rubronivea.			
Victoria			
Hypocreopsis amplectens.	Species.	Critically endangered.	*Flora and Fauna Guarantee Act 1988* (Vic).

Usnea acromelana.			
Asterophora mirabilis.		Endangered.	
Chlorovibrissea bicolor.			
Cortinarius canarius.			
Cortinarius cramesinus complex.			
Morchella esculenta.			
Xanthoparmelia suberadicata.			
Tasmania			
Punctelia subflava.	Species.	Endangered (presumed extinct).	*Threatened Species Protection Act 1995* (Tas).
Austroparmelina pallida.		Endangered (extant).	
Bunodophoron notatum.			
Erioderma sorediatum.			
Menegazzia minuta.			
Roccellinastrum neglectum.			
Xanthoparmelia amphixantha.			
Xanthoparmelia molliuscula.			
Xanthoparmelia subloxodella.			
Xanthoparmelia willisii.			
Austromelanelixia piliferella.		Vulnerable.	
Hypotrachyna laevigata.			
Xanthoparmelia jarmaniae.			
Xanthoparmelia mannumensis.			
Austroparmelina whinrayi.		Rare.	

Calycidium cuneatum.			
Calycidium polycarpum.			
Cetraria islandica subsp *antarctica*.			
Hypotrachyna immaculata.			
Parmeliopsis ambigua.			
Parmeliopsis hyperopta.			
Parmotrema crinitum.			
Teloschistes flavicans.			
Xanthoparmelia graniticola.			
Xanthoparmelia microphyllizans.			
Xanthoparmelia oleosa.			
Xanthoparmelia vicaria.			
Xanthoparmelia vicariella.			
Australian Capital Territory			
Nil.			*Nature Conservation Act 2014* (ACT).

***** Although the other jurisdictions are not shown, this figure represents a complete statement of the fungi listed for protection under Australian environmental law: see n 441 and accompanying text.

*Figure 2: Fungi Directly Implicated in Listed Threats**

Entity	*Threat Type*	*Legislation*
Commonwealth		
(Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)).†	Key threatening process.	*Environment Protection and Biodiversity Conservation Act 1999* (Cth).
Infection of amphibians with chytrid fungus resulting in chytridiomycosis.		
New South Wales		
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.	Key threatening process.	*Biodiversity Conservation Act 2016* (NSW).
(Infection of native plants by *Phytophthora cinnamomi*).†		
Introduction and establishment of exotic rust fungi of the order *Pucciniales* pathogenic on plants of the family *Myrtaceae*.		
Victoria		
Infection of amphibians with Chytrid Fungus, resulting in chytridiomycosis.	Potentially threatening process.	*Flora and Fauna Guarantee Act 1988* (Vic).
Human activity which results in artificially elevated or epidemic levels of Myrtle Wilt within *Nothofagus*-dominated Cool Temperate Rainforest.		
(The spread of *Phytophthora cinnamomi* from infected sites into parks and reserves, including roadsides, under the control of a state or local government authority).†		
(Use of *Phytophthora*-infected gravel in construction of roads, bridges, and reservoirs).†		
Tasmania		
N/A.‡		*Threatened Species Protection Act 1995* (Tas).
Australian Capital Territory		
Nil.		*Nature Conservation Act 2014* (ACT).

* This figure should not be taken as a complete statement of the fungi directly implicated as threats under law in Australia. Fungi may be directly implicated in listings in other jurisdictions not considered in this thesis.

† References to phytophthora are indicated in brackets as these organisms are not fungi but are sometimes referred to as such.

‡ There is no provision for the listing of threatening processes in Tasmania.

APPENDIX TWO

ANALYSIS OF SAVING OUR SPECIES REPORT CARDS FOR LISTED THREATENED FUNGUS SPECIES IN NSW, 2022–2023

	Camarophyllopsis kearneyi	Hygrocybe austropratensis	Hygrocybe collucera	Hygrocybe griseoramosa	Hygrocybe lanecovensis	Hygrocybe anomala *var* ianthinomarginata	Hygrocybe aurantipes	Hygrocybe reesiae	Hygrocybe rubronivea
Listing Status	Endangered.					Vulnerable.			
Management Status at LCBP	Threat management is known to be on track. Population status is unknown but inferred to be on track based on threat management. Population trend is unknown.								
Management Stream	Site-managed species.								
*Management Sites**	LCBP.	LCBP; Mount Wilson.	LCBP.			LCBP; Mt Wilson.			
Management Partners at LCBP	Crowdfunding; Environment and Heritage Group; Lane Cove Council; Western Sydney University; Willoughby City Council.								
Planned Management	Undertake bush regeneration and weed control across LCBP with focus on known fungi habitat and avoiding disturbance when fungi are fruiting.								
	Liaise with Sydney Water about stormwater management in LCBP.								

Actions at LCBP	
Number of Planned Management Actions Fully or Partly Implemented at LCBP	1 of 2.†
Annual Threat Targets	Water quality monitored to meet the Lane Cove Council's water quality targets.
	Maintain/reduce weed extent in 9 ha of creekline habitat.
	Habitat disturbance to be maintained at minimal levels.
Threat Status	On track.
Monitoring at LCBP	Two monitoring visits were undertaken by the Environment and Heritage Group. Monitoring metric was presence or absence during surveys. Initial identification based on morphology indicated the presence of six of the nine species. Scientific rigour of the method was high.
Total Expenditure at LCBP	$8,316 ($6,454 cash; $1,862 in kind).‡

* Additional surveys for the listed species were conducted at eight other sites in Sydney and surrounds.

† Liaising with Sydney Water about stormwater management was not implemented because improvement works were not required in this reporting year.

‡ The total expenditure figure reflects the total investment into management at LCBP by each of the management partners, not just the NSW Government. In 2022–2023, the Council contributed the most to management at LCBP, with $5,669 cash and $51 in-kind. It is unclear whether the total expenditure figure represents the total for the site as a whole (ie, all of the listed threatened species) or the total per species, and whether any of this expenditure was for the purposes of the surveys noted in the asterisk above at the other sites in and around Sydney.

APPENDIX THREE

ANALYSIS OF PUBLIC RESERVE MANAGEMENT PLANS, 2013–2024

*Figure 1: Animal-related Terms**

	animal	*fauna*	*wildlife*	*vertebrate*	*mammal*	*bird*	*fish*	*amphibian*	*reptile*	*insect*	**TOTAL**
Commonwealth											
Australian National Botanic Gardens Management Plan 2022	20	8	20	4	0	4	0	0	0	0	**56**
New South Wales											
Blue Mountains National Park and Kanangra-Boyd National Park Plan of Management 2024	33	0	11	1	1	1	2	0	1	0	**50**
Mount Canobolas State Conservation Area Plan of Management 2019	25	0	11	0	0	1	0	0	0	0	**37**
Victoria											
Greater Alpine National Parks Management Plan 2016	45	50	13	6	8	18	51	3	3	0	**197**
River Red Gum Parks Management Plan 2018	37	58	84	8	6	92	159	2	3	1	**450**
Tasmania											

Narawntapu National Park, Hawley Nature Reserve Management Plan 2016	12	31	41	7	4	40	47	12	3	0	**197**
Tasmanian Wilderness World Heritage Area Management Plan 2016	23	29	36	18	3	15	63	1	0	1	**189**
Australian Capital Territory											
Canberra Nature Park Reserve Management Plan 2021	152	32	83	23	12	129	19	0	9	6	**465**
TOTAL											**1,641**

*Figure 2: Fungus-related Terms**

	fung!	*mushroom*	*lichen*	*mycota*	*saprophyte*	*mycorrhiza*	*mycelium*	*toadstool*	*mould*	*truffle*	**TOTAL**
Commonwealth											
Australian National Botanic Gardens Management Plan 2022	9	0	5	0	0	0	0	0	0	0	**14**
New South Wales											
Blue Mountains National Park and Kanangra-Boyd National Park Plan of Management 2024	0	0	0	0	0	0	0	0	0	0	**0**

Mount Canobolas State Conservation Area Plan of Management 2019	0	0	7	0	0	0	0	0	0	0	**7**
Victoria											
Greater Alpine National Parks Management Plan 2016	7	0	0	0	0	0	0	0	0	0	**7**
River Red Gum Parks Management Plan 2018	2	0	0	0	0	0	0	0	0	0	**2**
Tasmania											
Narawntapu National Park, Hawley Nature Reserve Management Plan 2016	2	0	0	0	0	0	0	0	0	0	**2**
Tasmanian Wilderness World Heritage Area Management Plan 2016	5	0	0	0	0	0	0	0	0	0	**5**
Australian Capital Territory											
Canberra Nature Park Reserve Management Plan 2021	2	0	0	0	0	0	0	0	1	0	**3**
TOTAL											**40**

*Figure 3: Plant-related Terms**

	flora	*plant*	*vegetation*	*vascular*	*tree*	*grass*	*shrub*	*fern*	*flower*	*moss*	**TOTAL**
Commonwealth											
Australian National Botanic Gardens Management Plan 2022	55	329	14	4	6	4	1	2	3	1	**419**
New South Wales											
Blue Mountains National Park and Kanangra-Boyd National Park Plan of Management 2024	3	20	5	0	2	0	0	0	0	0	**30**
Mount Canobolas State Conservation Area Plan of Management 2019	0	23	17	0	1	5	1	0	0	0	**47**
Victoria											
Greater Alpine National Parks Management Plan 2016	39	29	64	0	32	21	14	1	2	4	**206**
River Red Gum Parks Management Plan 2018	55	40	53	2	50	46	11	0	4	1	**262**
Tasmania											
Narawntapu National Park, Hawley Nature Reserve Management Plan 2016	56	53	27	1	25	47	4	25	19	6	**263**

Tasmanian Wilderness World Heritage Area Management Plan 2016	27	42	50	2	28	21	0	1	4	5	**180**
Australian Capital Territory											
Canberra Nature Park Reserve Management Plan 2021	7	248	143	0	61	491	39	0	21	0	**1,010**
TOTAL											**2,417**

* Notes applicable to Figures 1–3:

- These figures reflect the number of results generated by the author's PDF reader when each of the terms was searched, adjusted to exclude results that are manifestly erroneous or irrelevant (eg, 'S TREE T' or 'treehouse' being included in the results for 'tree').
- The author did not screen the results for particular usages of terms (eg, usages of 'plant' as a verb rather than a noun; or usages of 'wildlife' in the names of government agencies and documents) as it is unclear whether Pouliot did so.
- Cognates and related words are included in the results (eg, 'flowering' was counted as 'flower'; 'invertebrate' was counted as 'vertebrate'; 'shrubland' was counted as 'shrub'; 'water mould' was counted as 'mould').
- Only one Commonwealth management plan was analysed because the remainder of the Commonwealth's protected areas are either shared management reserves or apply to external territories, both of which are beyond the scope of this thesis. Only one ACT management plan was analysed as there have been no others made for public reserves since 2013.

Figure 4: Detailed Analysis of Mount Canobolas State Conservation Area Plan of Management 2019

Organism	*Number of References*
Animal-related Terms	
Cattle	1
Deer	1
Dog	2
Fox	2
Goat	1
Horse	6
Pig	2
Rabbit	1
Sheep	1
Varied sitella	1
TOTAL	**18**
Fungus-related Terms	
Xanthoparmelia	4
*(*Phytophthora cinnamomi*)* *	(1)*
*(*Phytophthora*)* *	(4)*
TOTAL	**4 (9)***
Plant-related Terms	
Blackberry	5
Canola	1

Gorse	1
Prostanthera	1
Prostanthera gilesii	3
Radiata pine	2
Pine	1
Scotch or English broom	1
Seed	1
Serrated tussock	1
Silver-leaf candlebark	3
St John's wort	1
Snow gum	2
Weed	10
Wheat	1
Willow	1
TOTAL	**35**

* References to phytophthora are indicated in brackets as these organisms are not fungi but are sometimes referred to as such.