



Saving space for the long now: old-growth forests and ancient trees in the Anthropocene

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Abstract: Old-growth forests and ancient trees embody a profound temporal and spatial otherness that stands in stark contrast to the accelerated, unmoored rhythms of Anthropocene human societies. This paper bridges dendrological science, environmental philosophy, and conservation policy to argue that arboreal life constitutes an irreplaceable form of non-human being requiring deliberate, multi-scale protection. It first distinguishes between old-growth forest ecosystems that form complex collective networks perceived culturally as both sacred sanctuary and forbidding wilderness and solitary ancient heritage trees, widely venerated as individual touchstones of deep time embedded often within human landscapes. Drawing on recent physiological research, the paper introduces the framework of dendromorphism: the modular, adaptive, indeterminate growth pattern of trees that escapes programmed senescence, accumulates heritable somatic mutations, and sustains a youthful living envelope over ancient structural biomass. This unique biology produces organisms that integrate centuries of environmental experience within a single permanently rooted existence. Situating the argument within a 4,000-year cultural arc from the Epic of Gilgamesh to the Long Now Foundation, the paper concludes with three actionable conservation strategies: strict old-growth forest preservation, systematic stewardship of ancient heritage trees, and intentional landscape-wide recruitment of successor tree cohorts to sustain arboreal deep time into future millennia.

Key words: dendromorphism; forest conservation; deep time.

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The tree bears its thousand years as one large majestic moment.

Nobel laureate RABINDRANATH TAGORE, 1921

1. INTRODUCTION

In this article, I want to build upon the conference theme that states ancient trees and old-growth forests are “a treasure of life and

culture”. I am not alone among my scientific peers in wholeheartedly agreeing with this claim, so I am going to attempt to bridge the intellectual separation between existing forest and tree research and more cultural and hu-

manistic perspectives on solitary trees and magnificent old-growth forests. Few papers synthesize the shared “long now” temporal ontology with joint conservation and ecological imperatives. This paper constructs perspectives for protection of intact old-growth forests and isolated ancient trees, often embedded in human landscapes, by bridging dendrology, environmental philosophy, and conservation policy.

Old-growth forests and ancient trees appear in the human imagination as places that exist outside of time. They anchor our world to a past that extends far beyond the scope of our daily activities. In many ways, they are the antithesis of modern human life with its constant turnover and instant gratification. Trees endure, persist, fully inhabit and embody their environment, inherently faithful to place. They are patient without being passive. They shape their immediate surroundings through a deeply symbiotic and iterative process, creating ecological and evolutionary potentialities, gradually converting environmental challenges into unanticipated solutions. Additionally, forests often become increasingly stable and self-perpetuating with time with old-growth forests epitomizing sanctuaries of astonishing biodiversity and carbon capture (Luyssaert et al., 2008; Watson et al., 2018). Modern human societies, particularly in the Anthropocene, often have little commitment to place or often ignore the vernacular, indigenous local properties in pursuit of ideas envisioned and borrowed from another place or time. Humans impose, revise, envision new materials and functions. Our societies are volatile, increasingly chaotic and unpredictable, often going through rapid cycles of boom and bust, while space and time become irrelevant. As the impact of the Anthropocene expands and accelerates, we need to intentionally create and protect a space for old-growth forests and ancient trees. Recreating or recovering their

unique contribution to this world will be very difficult except for the simple passage of long periods of time (Piovesan et al., 2022).

A basic truth lies at the center of the perception that old-growth forests and ancient trees reside in “a land that time forgot” because their existence fundamentally relies upon the fact that humans have not disturbed them. Humans cannot fabricate or mine old-growth forests. The resurrection of extinct species, like the woolly mammoth, is increasingly probable given advancing technologies (Turner et al., 2025) but we cannot accelerate the passage of time to create an old-growth forest. Clear-cutting millennial old-growth forests erases irreplaceable ecological and evolutionary properties, analogous to destroying priceless primary cultural artifacts for trivial immediate utilitarian gain, e.g. crushing the Rosetta stone to make concrete.

A distinction can typically be made between old-growth forests and ancient trees. Old-growth forests are dark and intimidating places where people often choose not to go or live because the trees are so dominant that energy, light, water, the sustenance of life is suspended high overhead, embedded in wood, buried in vast living networks of mycelium and roots. In our stories and films, old-growth forests are often forbidden and foreboding places that legends and stories warn us to avoid. In great modern myths, like Tolkien’s *Lord of the Rings*, and countless ancient fairy tales, those unwise enough to venture into old-growth forests often meet great unimaginable dangers. These spaces can be as foreign to modern city-dwelling humans as the bottom of the sea, suffocating, claustrophobic, dangerous. We must recognize the tension between the enormous objective environmental value of these spaces with the common cultural perception.

Here, I first distinguish the ecological properties and cultural perceptions of old-growth

forests from individual ancient heritage trees across global biomes and then introduce the novel framework of “dendromorphism to unpack trees” unique non-anthropogenic temporal biology. The otherness of tree biology is contextualized within humanity’s ancient history of old-growth forest exploitation via *The Epic of Gilgamesh* and the counterbalance of the Long Now philosophy that extends far beyond modern human time frames. Finally, I outline two relatively simple and actionable global conservation strategies tailored to the Anthropocene.

2. OLD-GROWTH FORESTS: EMERGENT COLLECTIVE ECOSYSTEMS

While old-growth forests have been greatly reduced in the last couple of centuries (Lindenmayer et al., 2012), numerous amazing examples remain scattered across the globe’s major biogeographic regions: on the European continent the Białowieża Forest (Poland/Belarus) sustains the European bison and towering oaks and sprawling yews; the Caspian Hyrcanian Forest (Iran) spans a deep green arc of mixed broad-leaved species along the southern coast of the Caspian Sea; in east Asia, the Yakushima forests (Japan) are confined to a mountainous island dominated by cedar trees while the tropical forests of Indochina, shared by numerous countries, persist in a rapidly developing region; everwet tropical forests in Taman Negara (Malaysia) and the “Heart of Borneo” (Indonesia/Malaysia) are dominated by the dipterocarps, which reach their maximum diversity in Southeast Asia; the southern supercontinent of Gondwana has outstanding examples in Daintree Rainforest (Queensland, Australia) and Tarkine (Tasmania); while distinct elements of the African continent are preserved in Kakamega (Kenya) and Reunion

(Madagascar); with the Americas dominated by the vast rainforests of the tropical Amazon shared by numerous South American countries and the Tongass (USA) and Redwood National and State Park (Pacific Northwest, USA) protecting the massive trees of the temperate Pacific Northwest. Each one of these old-growth forests possesses their own unique set of properties and characteristics.

All human societies recognize old-growth forests as an extraordinary and inspiring realm but often with a starkly different presence: they are often seen either as a transcendent, sacred sanctuary of deep time and interconnected life, or an alien, forbidding wilderness that isolates humans from the security of ordered settlement. This contrast in perception depends entirely on relationship and experience. Indigenous communities that practice generational stewardship view old-growth with reverence while more urban cultures oriented toward extractive exploitation frame it as threatening or disposable. The modern world is accelerating the divergence between these viewpoints, particularly as local communities themselves become more endangered and integrated. Fortunately, in the past decade, a number of non-fiction books such as Susan Simard’s *Finding the Mother Tree* and Peter Wohlleben’s *The Hidden Life of Trees*, have generated a wide public appreciation of the value and wonder of old-growth forests.

3. ANCIENT TREES: SOLITARY CULTURAL TOUCHPOINTS FOR NATURE

Ancient trees, on the other hand, often stand alone, at least the trees that we distinguish as individuals and are drawn to as muse and mentor. They can be exposed by human activity, hewn from the original forest from which they grew, or frequently, planted as the

focal point during the founding of an early human settlement or sacred site (Taxel, 2023). These trees are venerated, photographed, decorated, worshipped, personified. We gather around them for community events. We linger beneath them for solace and perspective. They are ambassadors for nature's wisdom and grandeur and patience. Of course, certain trees, even when surrounded by old-growth forest, reach such a level of magnificence that we go on pilgrimages to see them. Their existence is so valuable and important that we hide their locations and even punish those who have the audacity to violate their solitude, like the redwoods of California and bristlecone pines of Utah. Their singular imposing nature provides a very different dimension of insight into the "long now" of tree existence, compared to forests.

Some ancient historical trees bridge cultural memory and ecological time. The Cedars of Lebanon (concentrated in the Kadisha Valley) embody ancient human narratives about longevity, sacredness, and loss. The Fortingall Yew is among Europe's most famous ancient yews, emblematic of resolute persistence and hardiness but their exact age remains shrouded in the mystery of "deep time". The Jōmon Sugi, an ancient Japanese cedar among the oldest and largest trees in the country, stands as a powerful symbol of Japan's natural heritage and conservation efforts. In the USA, General Sherman is a colossal giant sequoia located in Sequoia National Park, near Three Rivers, California. It is considered the largest known living single-stem tree on Earth by volume, symbolizing the extraordinary scale and longevity of the Sierra Nevada's sequoia forests. Gran Abuelo ("Great Grandfather"), also known as Alerce Milenario, is a monumental Patagonian cypress tree (*Fitzroya cupressoides*) in southern Chile's Alerce Costero National Park. Gran Abuelo stands within a remnant

of ancient Valdivian temperate rainforest, a globally rare ecosystem characterized by evergreen broadleaf trees and high rainfall. No list of significant ancient trees would be complete without including Methuselah, the single best manifestation of the long now, a bristlecone pine persisting for millennia in very harsh conditions and often reduced to small strips of living tissue. Many other ancient trees, both famed and anonymous, exist scattered across the landscape, often times inhabiting harsh and limited conditions, clinging to cliff faces or rocky ridges, their stunted growth rates actually one of the keys to their longevity (Larson et al., 1999; Mu et al., 2023).

Sadly, the Major Oak, central to stories of noble Robin Hood and his Merry Band in Sherwood Forest in the UK, appears to have finally succumbed to a number of challenging circumstances, including recent extraordinarily hot and dry summers, decades of trampling by tourists creating compressed soils, and changes in the water table due to nearby coal mining ("Robin Hood's World-Famous Major Oak Is Dead. Here's What Happened to the 1,200-Year-Old Tree" 2026). This passage of this iconic tree is a clear cautionary tale illustrating the loss of an irretrievable being due to the effects of the Anthropocene that existed at the intersection of culture and science.

Ancient trees embody divine knowledge and stand at the gates of heaven in human cultures. In the Abrahamic tradition, the tree of knowledge itself stood at the center of the Garden of Eden and the transgression of eating its fruit was the ultimate downfall of humanity. The Sidrat al-Muntaha in Islamic tradition is a large lote tree (*Ziziphus spina-christi*) that marks the utmost boundary in the seventh heaven, where the knowledge of the angels ends. The Buddhist path to enlightenment was discovered by Gotama beneath a fig tree, whose plasticity and ease of rejuvenation belies

the antiquity of any one stem. A sapling from the original Bodhi Tree was sent to Sri Lanka by Emperor Aśoka in 288 BCE, and planted at Anuradhapura, where it survives today as the Jaya Sri Maha Bodhi, regarded as the oldest living human-planted tree with a known date. Sacred groves and trees exist in many indigenous cultures, across religions around the world, where they serve many functions, including temporal bridges between the past and future, moral witnesses outlasting individual human perspectives, spatial exceptions set apart from everyday use where one is expected to acknowledge the profound, and living cosmologies where ancestral origins maintain a corporeal presence in the world.

As Nobel laureate Tagore expressed, the very essence of tree being requires the integration of countless, almost inconsequential events to obtain their full being and express the range of their emergent powers. In this article, I will explore how and why we should find a place in the modern world for this wholly un-anthropoc way of being.

4. DENDORMORPHISM: MUCH MORE THAN JUST A NON-HUMAN WAY OF EXISTENCE

An ancient tree embodies an intersection of time, both old and youthful, like no other being. With a modular body plan built up through the repetitive and adaptive addition of nodal growth units, each tree has the potential to become a wide range of mature forms, all depending upon the interplay between the current environmental conditions of soil, water, and sun and the past growth of the tree (Pasques & Munné-Bosch, 2023). As the tree ages, its tissue go through a relatively rapid transition, given its lifespan, from living to dead, with much of the senescing material dropping as fallen branches or sloughed off as

bark flakes while internally the wood incrementally reinforces the structural integrity of the tree. Wood dies once it obtains its mature form, performing the function of vascular tissue in a structural state for some years and supported by some living parenchyma threaded through its interstices until finally it often fills in with hardened material designed to resist rot and fungi, becoming simply wood. Many old trees actually begin to decay in their centers, encompassing the entire trajectory of life in one individual, from the emergence of fresh new leaves to the hollow core and cavities which provide refuge to many organisms (Lindenmayer & Laurance, 2017).

It is the constant renewal of tissue that is the hallmark and outstanding feature of tree growth that enables their ability to escape the “programmed senescence” suffered by most animals. Even if a tree is one thousand years old, almost all of the living tissue on the tree standing now is only a few years old at most. The cambium under the bark, leaving behind the porous structure of dead xylem through which water and nutrients are drawn up from the soil to the canopy and pushing out phloem which distributes sugars and hormones and complex metabolites, is undoubtedly youthful and adaptive, responding to the demand from above and below. The leaves, flower, and fruit emerge from meristematic tissue protected in buds to perform their specialized functions only briefly, for a growing season. *Imagine your own health, if your blood vessels were constantly replaced, your muscles and joints never older than a toddler’s!*

This distributed and indeterminate growth above and below ground allows selection to occur at the level of individual leaf buds and root caps and these somatic mutations and epigenetic imprinting can be inherited (Schmitt et al., 2024; Satake et al., 2024). If a branch is receiving plenty of sun and water,

its buds will emerge into thriving leaves, while lower branches with their leaves in the shade can be slowly self-pruned. Below ground, roots bathed in groundwater and nutrients and coated with beneficial mycorrhizae will proliferate and expand while those in dry rocky conditions will wither. Each deleterious somatic mutation that affects growth will be pruned at the bud level as the poorly performing leaves that emerge from it are outcompeted by healthy buds. Beneficial somatic mutations can be inherited, as each branch produces its own individual flowers and fruit. The tree cannot be understood as an “individual” but more as a colony of evolving and competing iterations of itself, each with the full potential to become a forest in its own right.

This distributed growth form also enables the ability to compartmentalize, isolate, and grow over and around any injury or disease that is encountered during the tree’s lifetime (Shigo, 1984). Unlike animals, trees do not repair injured tissue or organs, they simply grow new tissue. This makes sense as it follows from the standard growth plan of a tree. The compartmentalization of disease and infection also allows the tree to maintain its structural integrity while encapsulating the threat.

Senescence, or a decline in performance with age, can only be detected in about half of the trees examined in a large study (Qiu et al., 2021). Trees shift their growth strategy through their life, slowing their extension and addition of wood and height as they mature to focus more on reproduction, but overall little indication of any type of programmed death has been found in trees. Only a marginal decline in fitness was detected in the reproduction of bristlecone pines, given their several millennia of their lifespan (Lanner & Connor, 2001). It is worthwhile to emphasize again that only a small fraction of the biomass of an ancient tree is actually “alive”. Sap-

wood represents only a fraction of total stem volume in mature trees, declining relative to heartwood with age (Zimmermann & Brown, 1974). Second, within sapwood, only a subset of tissues contain living cells with ray and axial parenchyma together typically accounting for on the order of 10–30% of volume, depending on ring structure and growth conditions (Guilley et al., 2002). Third, even within this parenchyma pool, living protoplasts are not uniformly distributed and are lost abruptly during heartwood formation (Spicer & Holbrook, 2007). Combining these terms suggest that the fraction of the entire stem occupied by living cells is reduced to only a few percent. Even further, the metabolically living fraction of each cell (the protoplast) represents only a small proportion of total cell mass! This framing makes explicit that the immense biomass of old oaks is structurally dominated by dead cell walls, while physiological life is confined to a thin, spatially constrained, and dynamically maintained living envelope.

These aspects of individual tree growth also have profound implications for the population and community of trees in a forest. Because of the flexibility and adaptiveness of the mature form of each tree, given its immediate environment, and the lack of any programmed lifespan, the average lifespan of a tree in a population is not correlated with the maximum lifespan (Bialic-Murphy et al., 2024; Kobayashi & Akasaka, 2025). In contrast to most animals, where each life stage (juvenile and developing, mature and reproductive, old and declining) is tied rather strictly to a particular calendar year, the life stage of a tree depends on many factors. Increasing amounts of evidence, both empirical and theoretically, suggest that a small fraction of trees live for a substantially longer period of time than most trees (Cannon et al., 2022). So, while the vast majority of trees will live for only decades, a

small number of trees will live for centuries. These ancient trees, despite being only a very small percentage of the population, create a complex and deeply interwoven demographic structure in the population, affecting the evolutionary dynamics in ways that are poorly understood (Smith et al., 2025). Ecologically, these ancient trees provide an abundance of benefits to the overall ecological community, including the humans that live there.

5. TOWARDS A LONG NOW FOR THE ANTHROPOCENE

The Epic of Gilgamesh is the world's oldest piece of literature, written over 4000 years ago in Mesopotamia (Balogh, 2022). In this tale, the despotic king travels with his friend, Enkidu, to the Cedar Forest to kill the forest guardian, Humbaba, who was appointed by the gods to protect the forest. Ignoring Humbaba's pleas for clemency and appeals to their better nature about the value and beauty of the forests, they kill him and cut down the cedar trees, in particular the tallest to make a great cedar gate for the city of Nippur. They build a raft out of the cedar wood and float down the Euphrates to their city with the spoils, including Humbaba's head. They performed this deforestation of old-growth primarily to make themselves famous, despite dire warnings from the gods about floods and catastrophes. This ancient tale encapsulates the tension between the human perception that natural resources only become valuable when they are converted for our direct use, even if to simply glorify ourselves, and the tangible and intangible values that forests and their like possess above and beyond human utilization. It is a fitting way to mark the beginning of the end for the "long now" of tree being caused by the forces of the Anthropocene.

The Long Now Foundation was established and developed by Stewart Brand, who first created the Whole Earth Catalog that provided tools to ordinary people to live an ecological life in the modern world. The Long Now Foundation promotes viewing humanity's stewardship on a ten thousand year time scale, far beyond any existing time frame for accounting, from economics to ecology (Brand, 2009). An important effort of the foundation is the management of bristlecone pine forests on Mt. Washington in eastern Nevada (USA), including the incorporation of the famously variable growth rates of these pines into human perceptions of time. While these efforts seem rather philosophical and even far-fetched, they provide a powerful and inspiring counterpoint to the acquiescence of management policies to the immediacy of humanity's need for instant gratification. We must work with natural rhythms and patterns, allowing processes to occur at many different rates and scales.

The famous subtitle to the Whole Earth Catalog - "We are as gods and might as well get good at it" - recognizes the great responsibility that we have in the Anthropocene. In Mesopotamian times, humanity could be forgiven the need to prove their dominion over nature and the rather childish impulse to destroy ancient trees to appease their own pride, but in modern times, the broad and profound impact of our actions is very clear. Old-growth forests that once covered vast expanses are now degraded and fragmented, the global climate has warmed and set local weather off on unpredictable trajectories. We need to acknowledge our great power and refuse our animalistic instincts for dominion and consumption but instead go beyond those natural impulses and become like gods, become "super-natural", and have the grace and beneficence to preserve the natural legacy of the Earth so that

future generations, both human and non-human, may benefit from its beauty, resources, services, and power.

Ancient trees provide fundamental guidance to humanity's moral compass. If we lose them, if we cut down old-growth forests everywhere, we not only lose the substantial ecological and evolutionary benefits of these organisms, we become unmoored from the deep past, disconnected from anything that has witnessed the Earth for more than a century or two. We should strive in our acceptance of our terrible modern powers for transformation to learn from the sustainable world building processes evident and emergent in forests. Trees are a powerful role model for our institutions and forests a classic example of resilient and adaptable networks. We must find a way to make space for this dendromorphic means of existence in the world.

Three main strategies are simple and obvious:

1. the strict preservation and sustainable management of old-growth forests (Chiti & Piovesan, 2026). No reason exists, economic or ecologic, for humanity to harvest ancient trees in old-growth forests. Although some level of mitigation might be necessary, as the larger ecological processes are faltering and local weather is changing, simple and complete protection of old-growth forests should be a global mandate.
2. The recognition and monitoring of ancient heritage trees, particularly the stewardship of ancient trees outside of the forest and embedded in anthropogenic landscapes (Piovesan et al., 2022). Tell their stories, mitigate their decline, create legacies around their care. These trees are direct anchors of antiquity for local human communities.
3. The intentional recruitment of the next generation of ancient trees across the entire landscape, from cities to forests, restored or

native, should be incorporated into management plans (Lindenmayer & Laurance, 2017).

We preserve and collect precious artifacts of human history which serve no other purpose except reminding us of our past, inspiring awe and wonder, and teaching us about distant historical cultures. Similar investment and concern should be taken for these trees. The world is changing and the long now of ancient trees is being squeezed increasingly into the margins of the world, as described in 1957 by this passage from Italo Calvino's *The Baron in the Trees* (pg. 306): "Then, the vegetation has changed: no more the holm oaks, the elms, the oaks; now Africa, Australia, the Americas, the Indies extend branches and roots here. The ancient trees have retreated upward: on top of the hills the olives, and in the mountain woods pines and chestnuts; down on the coast it's an Australian red with eucalyptus, elephantine with ficus, enormous and solitary garden plants, and all the rest is palms, with their disheveled tufts, inhospitable desert trees." We should take the time to look down upon the world from among the tree tops as Cosimo does, the "baron in the trees" of the novel, and we will be moved towards a greater sense of community, patience, and wisdom.

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