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FORUM

Beyond the "Illusion of Preservation": Taking Regional Responsibility by Protecting Forests, Increasing Sustainable Wood Production, and Reducing Consumption in New England

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Abstract

As society rightfully recognizes the importance of forests as a natural climate solution and as inextricably linked with protecting biodiversity, there is mounting pressure to eliminate harvesting across many of New England's forests, especially on public lands. There are irreplaceable benefits of forests that are managed passively, with minimal human intervention, but this strategy alone will fail to provide the full suite of benefits we seek from our forests. If we reduce harvesting within the region while maintaining our high levels of consumption, we are merely shifting that wood production elsewhere. We sought to address this "illusion of preservation" by first quantifying the gap between production and consumption. We found that, as a region, New England produces three-quarters of the wood volume it consumes: only 59% of its lumber and 80% of the raw material for paper. Regional growth exceeds removals by a factor of two. More stark are the disparities within the region: southern New England states produce only 7% of the volume of wood consumed therein, despite being 60% forested, whereas Maine produces 70% of the entire region's volume. We set forth a vision for remedying this imbalance by 2060 with three integrated steps: 1) protecting at least 70% of New England in a mosaic of both passively and actively managed forests; 2) expanding ecological forestry to meet our resource needs; and 3) re-orienting towards more durable products, boosting recycling, and reducing consumption. In advancing these steps side-by-side, we can take regional responsibility and permanently safeguard the innumerable values our forests afford us.

Keywords Ecological forestry · Wood consumption · Forest protection

Extended author information available on the last page of the article

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A Timeless Reliance with Global Implications

As they have for thousands of years, the forests of New England—blanketing roughly 80% of the region—support humans and non-humans alike in countless ways. It is therefore heartening to see a growing societal recognition of the importance of forests as the planet warms, as species disappear, and as our connections with nature and with one another fray. We increasingly—and rightfully—look to our forests as a "natural climate solution" to sequester and store carbon, as the backbone of a connected landscape for protecting biodiversity, and as a place for recreation and restoring our individual and collective well-being. At the same time, the forest offers us the opportunity to foster a bioeconomy that can help meet many material needs, especially for housing, more sustainably than by relying on steel, concrete, and plastic. How can these urgent and inescapable social and environmental imperatives best be harmonized in the forests of New England?

That question lies at the heart of ongoing discourse—and, indeed, tension—surrounding calls to eliminate harvesting on substantial areas of New England's forests, especially on state and federal lands (e.g., "Proforestation" (Moomaw et al. 2019); RESTORE: The North Woods; Standing Trees). Forests that are stewarded passively with minimal human intervention—often called wild forests, or "wildlands"—have irreplaceable benefits and yet cover less than 4% of New England today (Foster et al. 2023). We undeniably need more places that are free from active management and are instead left to their own dynamics and development. However, this strategy by itself will fail to provide the full suite of benefits we seek from our forests—here in New England and beyond. If we reduce harvesting within New England while maintaining our high levels of consumption, we are merely shifting that wood production elsewhere, including to regions with greater amounts of intact forest and biodiversity and weaker environmental oversight than exists in much of New England (Pfaff & Walker 2010; Wiedmann & Lenzen 2018). Indeed, due to outsourced cutting in recent years, the US is responsible for habitat loss equating to the geographic ranges of > 30 forest-dwelling animals—moreso than any other nation (Wiebe & Wilcove 2025). Because of this leakage, reduced cutting at home will do little to protect global biodiversity or decrease carbon dioxide in the global atmosphere.

Unless the very real need to create and preserve more forest reserves is matched by the equally real need for sustainable harvesting to address our wood product demands—a balance many groups and land trusts support—that preservation is essentially undermined. It is, in other words, *illusory*. This insight, and the use of that provocative term, first emerged in the 2002 article entitled "*The Illusion of Preservation*" (Berlik et al. 2002). The piece documented the paradox of the state of Massachusetts producing a tiny fraction of the volume of wood consumed therein despite being considerably forested, and the authors argued that the state must simultaneously advance the preservation of intact reserves while *also* conserving additional lands for sustainable wood production.

Two decades later, we sought to revisit that seminal work and extend it to all of New England, which ranges from just under 60% wooded in its southern states to almost 90% wooded in Maine (USFS 2020). Specifically, we asked: *What are the imbalances in consumption and production of wood among and within the six New England states? How might we remedy those imbalances?* We relied on data from the U.S. Department of Agriculture, Forest Service's (Forest Service) Forest Products Laboratory (Howard

& Liang 2019) and Forest Inventory and Analysis (FIA) program (Bechtold & Patterson 2005) for consumption and production, respectively, as well as published rates of wood recovery (Falk & McKeever 2012; Morris 2016), and we necessarily made several adjustments (e.g., scaling consumption by state median incomes) and assumptions (e.g., fuelwood consumption equates to production in each state) to account for data gaps and limitations. (A full accounting of data sources, methods, and assumptions are given in Appendix 1.) We then developed a hopeful and plausible scenario for how we might address those imbalances—in other words, how we might remedy the *Illusion*—while simultaneously addressing urgent climate and biodiversity goals.

A Persistent Imbalance

Today, New England produces the equivalent of about 76% of the wood it consumes: 59% of its lumber and 80% of the raw material (i.e., pulp and mill waste) needed to produce the paper consumed (Fig. 1; Table S1; see Appendix 1 for methods and data sources). Producing three-quarters of the wood product volume consumed could be viewed as encouraging—after all, some parts of New England are quite heavily populated. And yet, the region at large is heavily forested such that one might ask why we are producing *only* three-quarters. Indeed, regional growth exceeds removals by a factor of two. Furthermore, the disparities *within* the region recapitulate that *Illusion*: collectively, the southern New England states of Massachusetts, Connecticut, and Rhode Island produce a mere 7% of the wood consumed therein, despite being roughly 60% forested (a finding similar to the original *Illusion* paper for Massachusetts). Together, Vermont and New Hampshire are at parity with regard to lumber and produce more paper raw material than the states consume, leading to a balance of 117%. Finally, Maine produces substantially more lumber and paper raw material

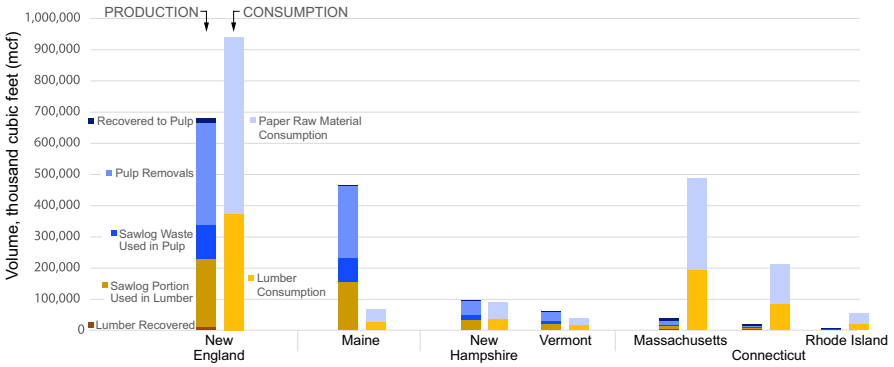


Fig. 1 Wood production and consumption in New England, circa 2020. Present-day wood production numbers are derived from the Forest Service Forest Inventory and Analysis (FIA) program, and consumption numbers are based on income-adjusted national per capita rates. These numbers include lumber and pulp and account for material recovered from waste streams. Fuelwood is not illustrated, as it is assumed that consumption is equal to production. Precise numbers by product class (including fuelwood) are given in Tables S1 and S2 of the Appendix, along with detailed methods

than it consumes: upwards of 325%. In fact, 70% of New England's production comes from Maine, while 70% of the region's consumption occurs in southern New England. For a region that is 80% forested, the region-wide deficit and these within-region disparities are striking, showing that the *Illusion* isn't just a global or national phenomenon but operates *within* the New England region as well.

The national phenomenon is notable, too: the Northeast, Great Lakes states, Iowa and Missouri collectively hold roughly a quarter of the country's forest area yet produced only about 15% of US sawlogs and 13% of its pulpwood in recent years. Meanwhile, the South, with little more than a third of the forest area, supplied over half of the nation's sawlogs and roughly 80% of its pulpwood. The West, no longer the surplus producer it once was, accounted for the remainder (Howard and Liang 2019; Donahue 2024). The imbalance we document within New England is thus a regional expression of a national one—the heavily reforested East now importing a great deal of its wood, much as it imports most of its food, because on the whole it does not cut its forests in proportion to their area or productivity (Donahue 2024).

Taking Regional Responsibility

Can New England remedy this production-consumption imbalance while retaining—even enhancing—other social and ecological benefits of a diverse, healthy forest? We believe this is possible. We are not, of course, opposed to responsible wood markets. But we ought to look more to the trees that surround us to help meet our needs, embracing our necessary reliance on forests rather than hiding it in some other part of the world. Given New England's favorable climate and abundant, productive forests, the region *could* achieve at least a net balance in its ratio of wood consumption to production—with each part of the region contributing in proportion to its productive forest base—instead of displacing the costs and benefits of such production elsewhere.

We identify three key steps, to be taken between now and 2060, to achieve that balance while simultaneously addressing urgent climate and biodiversity goals. These steps include (1) first and foremost, permanently protecting New England's forests from development in a mixture of passively managed reserves and actively managed forests, (2) advancing ecological forest management over a much greater portion of the New England landscape to provide a sustainable supply of wood, and (3) reducing and reorienting consumption while enhancing recycling.

We set forth these steps not as an exact prescription but rather as one vision for safeguarding the ecological, economic, social, and cultural values of New England's forest, while sustainably meeting our wood product needs. We do so with the hope of stimulating more awareness and discussion on this need both within the region and elsewhere in the US where similar production and consumption disparities exist.

STEP 1: PROTECT FOREST. Permanently Protect from Development at Least 70% of New England's Land in Both Passively Managed Reserves and Forest Available for Ecological Forestry

Ensuring that forests remain forests is foundational for addressing the biodiversity and climate crises and for realizing the innumerable benefits we derive from forests, including wood products. However, we are losing forests at a rapid clip in New England: in recent decades, roughly 17,000 acres are permanently converted each year, largely due to residential and commercial sprawl, but also to renewable energy development, especially large solar arrays (Manion et al. 2023; Thompson et al. 2017b). These conversions permanently perforate and fragment the forest, reducing its ecological integrity and connectivity and making it more difficult—even infeasible—to manage holistically (Silver et al. 2015; Kittredge et al. 2017).

To stem this ongoing loss and fragmentation, we need to take two steps: minimize the rate of forest loss and accelerate forest protection from development to meet or surpass the goals set forth by regional initiatives, namely the Wildlands, Woodlands, Farmlands & Communities (WWF&C) collective. Specifically, WWF&C calls for permanently protecting from development at least 70% of New England in forest by 2060, with at least 10% of the region as "wildlands" (currently, they cover only 3.3%; Foster et al. 2023) and 60% as "woodlands" that are available to be actively managed. Here, "wildlands" are passively managed—i.e., with minimal human intervention beyond, for example, trail maintenance, strategic control of invasive species, and traditional practices like foraging—whereas actively managed areas must also be rigorously protected from development but remain available for harvest as through, in this vision, the principles of ecological forestry. Crucially, passive management and active management are not opposing management strategies. They are complementary, and land protection efforts should encompass both.

STEP 2: EXPAND ECOLOGICAL FORESTRY. Increase Acreage in Ecological Forest Management and Reorient Sustainable Production toward Lumber

For New England to balance its ratio of wood consumption to production, we need to increase active forest management and regional lumber production (we will rein in some of our consumption in step 3 below). Indeed, we have forests that are capable of sustainably producing most of what we need but currently do not. Boosting the acreage actively managed under ecological forest management and reorienting production towards lumber can close the gap.

The broad goal of ecological forestry "to sustain healthy, productive forests, replete with native species diversity and a full array of ecosystem services… [a] goal best met by managing forests in ways that bring them closer in structure, function, and composition to healthy, natural forests at all stages of successional development" (Palik & D'Amato 2017). In New England, this means restoring the landscape and forest complexity lost with European settlement such that old-growth and other forests permanently protected as "wild" are an integral part of ecological forestry and may be embedded within actively managed forests.

Under ecological forestry, harvesting wood products is carried out in ways that prioritize the restoration and sustaining of natural forest conditions—large snags and downed wood, a diversity of tree species and sizes, and canopy layers and gaps—rather than, for example, maximizing total yield in the short run. It may not produce as much harvestable wood as rapidly as intensive plantations, short-rotation forestry, or periodic high-grading that removes only the "best" trees. But ecological forestry does produce a steady output of long-lived wood products that are often of high market value, all while enhancing the ecological values of healthy, diverse forests. Certainly, other sustainable forest management approaches could yield the volumes needed to meet our wood product needs—ecological forestry is, after all, on a spectrum (Nyland 2016)—but in this holistic regional vision we emphasize the primacy of ecological processes and conditions. Below, we describe where and how ecological forestry could be applied across types of ownerships to sustainably meet our wood product needs.

STEP 3: REDUCE CONSUMPTION. Reduce Wood and Paper Consumption by 25%, Shift to More Durable Products, and Enhance Wood Product Recycling

As a parallel step, and to determine how much ecologically-sourced wood production is needed to address the *Illusion*, we asked how much we could realistically reduce our consumption. The environmental impact embodied in all we consume—wood or otherwise—is frequently overlooked, and our consumption is only accelerating. While wood products meet real needs and are often environmentally preferable to carbon-intensive alternatives like steel, concrete, and plastic, we can reduce *net* consumption while still tipping the balance towards wood relative to other materials.

Precisely calculating achievable wood consumption reductions is difficult, but we can estimate plausible reductions by looking at the close correlation between population growth and lumber consumption associated with housing starts (Figure S3; Howard & Liang 2019). Even as the population of southern New England, in particular, has expanded in recent years, a sharp decline in growth rates is anticipated, and this slowdown means substantially less lumber will be needed to meet housing demand (EPA, 2018; Howard & Liang 2019; Commonwealth of Massachusetts, 2020). We have extrapolated these projections to arrive at a 25% reduction in lumber consumption by 2060 (Appendix 2). Pulp consumption, on the other hand, follows long trends over time, including a decline of roughly 25% within the first decade of the twenty-first century (Howard & Liang 2019), though declines in newsprint and writing paper have now been counterbalanced by a demand for packaging. If we could renew an annual reduction in paper use of 0.5%−1.0%, a further decline of 25% by 2060 would be feasible (Appendix 2). Notably, this would bring per capita paper consumption—nearly four times the global average—closer to levels in much of Europe (FAO, 2020). That pulpwood could then be reoriented towards more durable products such as wood fiber insulation, thermally-modified siding and decking, and other emerging innovations. (The same holds for fuelwood: while we foresee some continued wood-fueled heating in rural areas, the more we can pivot material away from combustion towards durable products that lock up carbon, the better—a pivot made easier as distributed solar is increasingly viable.)

As for lumber consumption reduction, beyond the anticipated decline in population growth and therefore housing starts, single-family housing offers a prime opportunity: in 1975, the average new single-family house in the Northeast was about 1,600 square feet; now, it's nearly 2,800 square feet (US Census Bureau 2023c). Since families are getting smaller, it's unclear why larger houses are warranted—unless it might be to store all the other stuff we don't actually need. If, instead, the average new house built moving forward was 2,000 square feet, that would represent considerable savings in lumber while addressing the severe deficit in smaller, more affordable homes. Moreover, moving toward clustered development with multifamily buildings—instead of big houses on big lots—allows for more efficient use of materials, energy, and transportation while protecting forests and farmland and counteracting the decline in shared civic spaces.

Sustainably Producing the Wood New England Consumes

How much wood could ecological forestry sustainably produce, and how much acreage would be needed to meet our wood product needs, after accounting for reduced consumption? To answer these questions, we applied a broad, conservative estimate: by 2060, ecologically managed forests in New England could produce an average of 0.4 cords of wood per acre, per year. Many foresters might argue that well-managed New England forests could produce more than 0.4 cords per acre annually. That may well be, but using this conservative rate leaves ample room for levels of retention that protect ecological values and sustain high levels of carbon storage within the forest. We estimated that such production would on average be divided into 60% sawlogs and 40% low-market-value wood (the inverse of what harvests yield today).

Using this harvest rate of 0.4 cords/acre/year, if we devoted about 20 million acres—just under half of New England's land, or 60% of our forest—to ecological forestry, we could meet our needs. More specifically, by 2060, this scenario would yield just under 8 million cords annually, or about 680,000 mcf total (sawtimber and pulpwood volumes combined; Fig. 2). With the requisite investments in milling capacity and workforce to reverse ongoing declines, this would satisfy all of the region's lumber demand and all of its raw materials for paper. Notably, this scenario does not require an overall increase in what we currently harvest. But, by reorienting management toward growing mature trees and higher-grade wood, it would boost lumber production by 25% (Fig. 2). And even though the southern New England states would still be net consumers, they would be closer to producing 20–25% of the volume consumed therein (Fig. 3; Table S2).

Where in New England might that roughly 20 million acres of actively managed forests be located and distributed across the 32 million acres of the three dominant types of forest ownership—family and nonprofit (FFOs, 14 million acres), corporate (12.1 million acres), and public (5.7 million acres)? We have chosen one plausible scenario to illustrate the opportunities and challenges presented by these different ownerships (Table 1). First, we devoted 4 million acres to passive forest management (including the existing 1.3 million acres of "wildlands"), drawing roughly equal areas from family, corporate, and public forests. Then, we designated the remaining 11 million acres of corporate lands, 7 million acres of family forests, and 2 million acres of public forests to ecological forestry to arrive at 20 million acres.

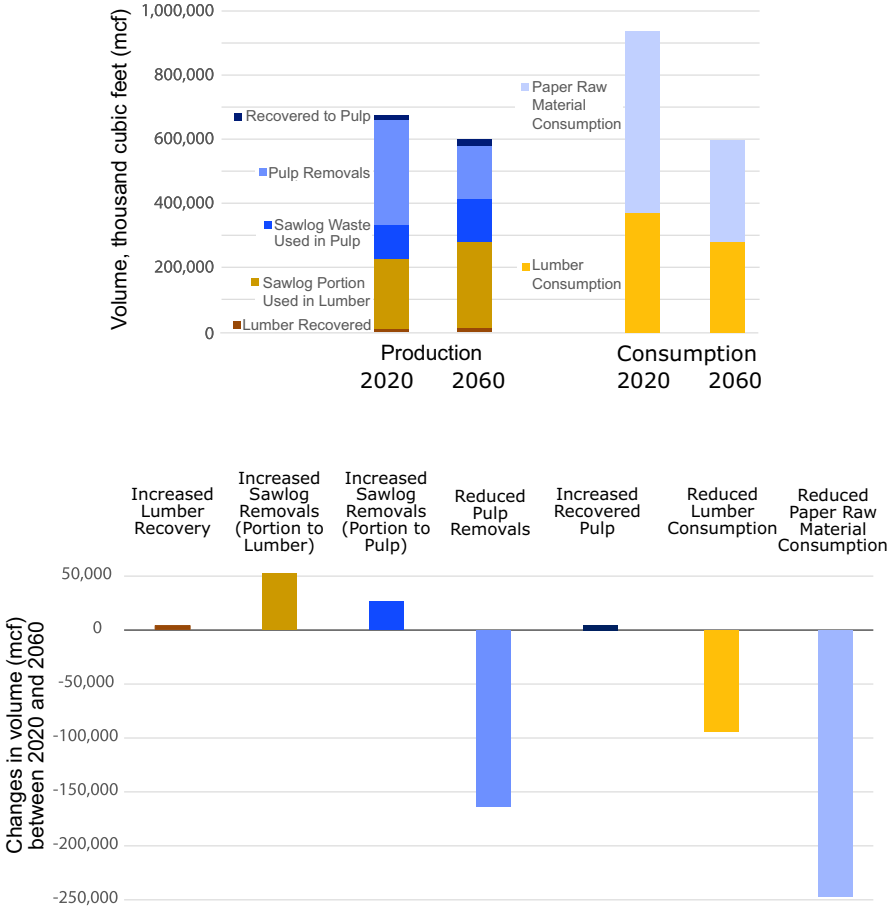


Fig. 2 Differences in production and consumption from 2020 to 2060 and contributing components. For New England as a whole, we are calling for a substantial but achievable reduction in consumption by 2060, as shown in the top panel. Production would modestly decline and, crucially, would be re-oriented towards more durable products. This would enable us to sustainably close the gap between our consumption and production. More specifically, and as illustrated in the bottom panel, closing this gap would require reduced consumption in both lumber and paper products, increased production of sawlogs via ecological forestry (two-thirds of which will go to lumber and one-third to pulp), and a reduction in pulpwood removals. Recovering more lumber and pulp from the waste stream would contribute only a small bit to closing the gap, but striving to reduce what ends up in the landfill is nonetheless a worthy goal. Fuelwood is not illustrated, as it is assumed that consumption is equal to production, even as the 2060 scenario promotes a shift away from combustion of lower-grade material towards more durable uses. A state-level break-down of numbers by product class (including fuelwood) are given in Tables S1 and S2 of the Appendix, along with detailed methods

Managing 20 million acres by ecological forestry would require dramatic changes in the way many forests are currently managed, including strikingly different approaches between the family forests of southern New England and the corporate forests of the north. For example, only about 15% of FFOs have formal forest management plans, and most have recently seen only sporadic, low-intensity harvesting,

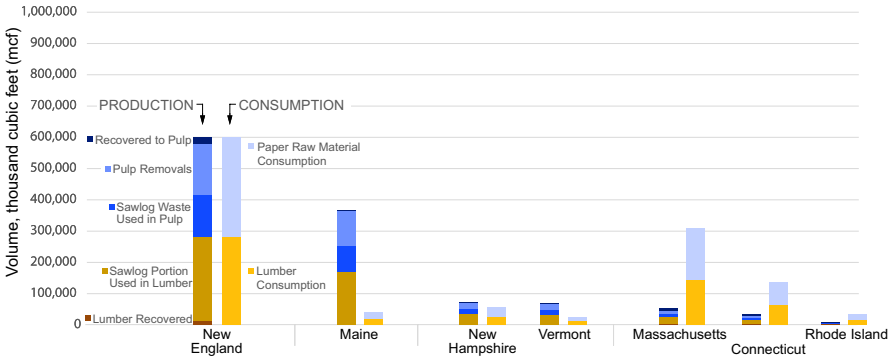


Fig. 3 Wood production and consumption in New England, circa 2060. Production and consumption estimates for 2060 reflect a reduction of lumber and paper consumption relative to today's levels, enhanced rates of recycling and recovery, and a re-orientation of production towards more durable products. Fuelwood is not illustrated, as it is assumed that consumption is equal to production, even as this scenario promotes a shift away from combustion of lower-grade material towards more durable uses. A break-down of numbers by product class (including fuelwood) are given in Tables S1 and S2 of the Appendix, along with detailed methods

or none at all (Butler et al. 2021). This means moving beyond the *Illusion* will require convincing families to engage in management decision-making at unprecedented levels (Sass et al. 2023); the appeal of ecological forestry, which may resonate with families increasingly motivated by amenity values, may help that cultural shift (Rickenbach and Kittredge 2009; Denaroso et al. 2025). It will also require substantial investment in the milling infrastructure and workforce now largely missing from many parts of southern New England.

By contrast, many corporate forests have been heavily cut for decades to maximize wood output and financial returns, increasingly on shorter time horizons as forest product companies have given way to institutional investors (Sass et al. 2021). This has led to a reduction in silvicultural treatments used to boost growth and quality such that many forests lack large trees and trees older than 50 years (Giffen et al. 2022; Granstrom et al. 2022). To restore the productive capacity of these homogenized, young forests, they need to see greater investments in pre-commercial thinning and silvicultural systems that retain more mature trees and promote multiaged forests (Kenefic et al. 2014). However, such a shift towards ecological forestry may be complicated on corporate lands where high returns on investment prevail, suggesting that long-term applications of ecological forestry will require either greater consumer willingness to pay premiums for wood products, some form of ecosystem services payments or cost-share programs, or changes in ownership.

Finally, only a fraction of actively managed areas on public lands is treated each year such that the volume of wood harvested from public lands—especially federal—remains minimal (Thompson et al. 2017a; Oswalt et al. 2019). Per the most recent FIA inventory, roughly 700 mcf was harvested from the 750,000-acre White Mountain National Forest and 1,500 mcf from the 416,000-acre Green Mountain and Finger Lakes National Forests (which includes 16,000 acres in New York), which is well under 1% of what was harvested from the

Table 1 Passively managed "wildlands" and actively managed "woodlands" in New England, circa 2020 and 2060. At 1.3 million acres today, wild reserves cover less than 4% of the New England landscape. Following the Wildlands, Woodlands, Farmlands, and Communities (WWF&C) vision, we call for designating at least four million acres (10% of the total landscape) as passively managed "wildlands" by 2060 as well as rigorously protecting from development "woodlands", which remain available for active management. Devoting 20 million acres of the latter to productive ecological forestry could, at an average rate of 0.4 cords per acre per year, enable us to meet our wood product needs. Another 7.6 million acres would still be available—some might be returned to the region's tribes, some might go to even more wild reserves, some might go to agroforestry, and so on. Data for 2020 are from Butler et al. (2021) and Foster et al. (2023), with forest defined per the USDA Forest Inventory and Analysis definition of having at least 10% canopy cover of live trees and being at least 1 acre in size, which includes, but is not limited to, timberland. Some forest, even as it may remain *available* for active management in this vision, may be so parcelized or fragmented (e.g., as in rural residential areas) that active management is infeasible. Still, there is sufficient forested acreage across the region for EFM to meet wood product demands

	2020 (million acres)		2060 (million acres)		
	Passive managed	Available for active management	Passively managed	Harvested by ecological forestry	Additional available for active management
FFO etc	0.30	13.40	1.00	6.99	5.72
Corporate	-	12.20	1.00	10.98	0.22
Public	1.00	4.70	2.05	2.01	1.64
TOTAL	**1.30**	**30.30**	**4.05**	**19.97**	**7.58**

region at large (Forest Service 2026). Despite these low volumes and typically robust planning processes and oversight, recent public debate over public forest management has led to further harvest reductions and hesitance among policymakers. (It is important to note that ongoing executive actions, including the Trump Administration E.O. 14,225 mandating a 25% increase in federal timber production and efforts to restructure implementation of the National Environmental Policy Act, may alter these dynamics.) This means that, in many ways, we may be undermining some of the region's best examples of sustainable, multi-objective forest stewardship while doubling down on industrial production elsewhere—the very conundrum that motivated revisiting the *Illusion of Preservation*. And it's a conundrum that ecological forestry on 2 million acres of our public lands may help us to navigate.

To recap, in this example we envision at least 4 million acres set aside as passively managed, with ecological forestry practiced on 11 million acres (90%) of corporate lands, 7 million acres (50%) of family forests, and 2 million acres (35%) of public forests (Table 1). This still leaves ample "extra" acreage, which affords flexibility in how these lands are distributed to achieve our sustainable wood production target. For example, we might elect to devote even more lands to passively managed wild reserves or to longer rotations while aiming for more than 0.4 cords/acre/year in concentrated areas elsewhere, not unlike the triad model first discussed for New England's spruce-fir forests (Seymour and Hunter 1992).

Prioritizing our Forests

In short, the forest acreage is available whereby, with good management, New England could largely meet more of its own wood needs while more squarely addressing the looming crises of biodiversity loss and climate change. However, achieving anything like this by 2060 will require a radical reordering of priorities around how we value and manage our forests and, crucially, enduring public and private investments in local forest-based economies. Indeed, shuttered mills, aging and shrinking workforces, declining and volatile markets (especially for low-grade material), and the shift in northern New England ownerships to large investment companies, among other economic dynamics, are not only hurdles to reconciling our production-consumption gap, but they also continue to erode the vitality of historically timber-dependent communities. The gap between our consumption and our production is a consequence of the market-driven global economy, enormously high rates of consumption, and a society increasingly out of touch with the sources of the products we consume—dynamics that hold well beyond New England. Further, we do not have a holistic, region-wide system in place to encourage superlative forest stewardship oriented around the common good. On the contrary, we have an entrenched system that rewards either piecemeal development or heavy cutting that maximizes short-term economic returns on industrial lands. Our incentive programs have failed to engage a substantial segment of family forest owners in long-term active forest management. At the same time, an increasingly pervasive attitude

holds that no forest management is the most environmentally sound approach one can take. We wholeheartedly agree that passive management is an ecologically sound approach and, indeed, is a foundational aspect of ecological forestry. However, the dynamics of ongoing forest loss and degradation on the one hand, and pressures to curtail all harvesting on the other, are only exacerbating ethical and ecological costs in a world where natural resource consumption is simply a fact of life.

Collectively, the steps we set forth above represent a coherent, aspirational vision for safeguarding the ecological, economic, and social values of New England's forest while sustainably meeting our resource needs—remedying the *Illusion*. Our intention is to be illustrative, not prescriptive. There are certainly other ways in which we could collectively and creatively envision a sustainable, vibrant future for our forest and communities, with the benefits we derive from the land widely and equitably shared—both in New England and beyond. Determining how, precisely, we achieve such a future is the next challenge we must confront. Our forests have long blessed us with resilience and countless other gifts; it is time we reciprocate by caring for them with real rather than illusory values.

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Authors Contributions Caitlin Littlefield: conceptualization, methodology, formal analysis, data curation, writing – original draft. Paul Catanzaro: conceptualization, methodology, writing – original draft, writing – review. Anthony D'Amato: conceptualization, methodology, writing – original draft, writing – review. Brian Donahue: methodology, formal analysis, writing – original draft, writing – review. David Foster: methodology, writing – review. Brian Hall: visualization, writing – review. Kenneth Laustsen: data curation, writing – review.

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Data Availability All data were summarized from existing, publicly available citations or databases. Spreadsheets documenting calculations can be made available as Supplementary Information.

Declarations

Competing interests We have no competing interests directly or indirectly related to this submitted work. We adapted the manuscript from an outreach report released in 2024, but it has not otherwise been published nor is it being considered for publication elsewhere.

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