1. First and Last Name

Mark Ashton, Mark Bradford, Bradford Gentry, Thomas Graedel, Timothy Gregoire, Sara Kuebbing, Xuhui Lee, Robert Mendelsohn, Joseph Orefice, Alan Organschi, Pete Raymond, Barbara Reck, Jim Saiers, Karen Seto, Gerald Torres, Yuan Yao.

2. Email Address

Joseph.orefice@yale.edu

3. **Affiliation (Drop down menu)**

4. **Job Title and Organization**

Ashton: Senior Associate Dean of The Forest School at the Yale School of the Environment (YSE) and Morris K. Jesup Professor of Silviculture and Forest Ecology
Bradford: Professor of Soils and Ecosystem Ecology, YSE
Gentry: Senior Associate Dean of Professional Practice; Frederick K. Weyerhaeuser Professor in the Practice of Forest Resources Management and Policy; Co-Director, Yale Center for Business and the Environment, YSE
Graedel: Professor of Industrial Ecology (retired), YSE
Gregoire: J.P. Weyerhaeuser Professor of Forest Management, YSE
Kuebbing: Director of Research, Yale Applied Science Synthesis Program, YSE and Yale Center for Natural Carbon Capture
Lee: Sara Shallenberger Brown Professor of Meteorology, YSE
Mendelsohn: Edwin Weyerhaeuser Davis Professor of Forest Policy; Professor of Economics, YSE
Orefice: Lecturer; Director of Forest & Agricultural Operations, Yale Forests, YSE
Organschi: Senior Critic; Director of the Building Lab, Yale School of Architecture
Raymond: Senior Associate Dean of Research & Director of Doctoral Studies; Professor of Ecosystem Ecology, YSE
Reck: Senior Research Scientist, Center for Industrial Ecology, YSE and Director Material Systems, Bauhaus Earth.
Saiers: Clifton R. Musser Professor of Hydrology, YSE
Seto: Frederick C. Hixon Professor of Geography and Urbanization Science, Director of the Hixon Center for Urban Sustainability, YSE
Torres: Professor of Environmental Justice and Professor of Law, Yale Law School and Professor of Environmental Justice, YSE
Yao: Assistant Professor of Industrial Ecology and Sustainable Systems, YSE

5. **Area(s) of Agreement? Please comment on sections of the report with which you especially agree.**

In general, we find that we are in strong agreement with the Committee in the following recommendations:

1) General Recommendation #1 (page 26): Agencies should strategically apply management approaches and prioritize forest management using a “landscape scale approach”. We agree that there should be no blanket management policy (for example, ‘touch nothing’, ‘cut everything’) prescribed for state forest lands. No one forest is the same, thus management options should never be uniform across all forests. We agree that some state lands should be

placed in reserve for their ecological or cultural value, while other state lands may be well-suited to remain working forests. But this has already been done. The Massachusetts 2020 Forest Action Plan estimates that approximately 40,000 acres (7.6%) of state-managed forest are currently set-aside from timber harvest. If the state reconsiders the wildlife habitat goals determining the proportion of state lands in various habitats (early successional, young forest, etc.), this assessment should be open and transparent, based on the best available ecological and wildlife science, and explicitly consider trade-offs among meeting biodiversity goals, carbon goals, or socioeconomic goals that could occur with habitat goal adjustments.

2) General Recommendation #4 (page 26): We agree that forest management should use silvicultural prescriptions that emulate natural disturbance regimes historically associated with the local site and forest community (1-8). We note here (and describe in more detail below), that this type of management is NOT LIKELY TO OCCUR on privately-owned forest land in the state without policy interventions (9).
3) General Recommendations #5 & #6 (pages 26-27): Commonwealth land managers and agency leadership must be empowered to make considered decisions, informed by public input, that involve tradeoffs and seek to achieve multiple goals. Forest should never be managed solely for carbon, but for multiple benefits including biodiversity protection, timber and non-timber resources, and cultural values. There will sometimes be synergies in management decisions that meet multiple goals; there also will be conflicts and tradeoffs at other times. Decisions should also be revisited periodically, and state agencies should have the flexibility to change management approaches as society's values or the science of forest management change. This point emphasizes the importance of Recommendation #1, above, that management decisions should be made for both the forest under management consideration and that forest's placement in the larger forest landscape. Landscape planning and prioritizing certain goals in certain areas is the only way to meet the multiple different objectives Massachusetts has for its forest.
4) Keep Forests as Forests: The report notes that most forest acreage AND carbon loss in Massachusetts is from conversion of forestlands to non-forested lands. Forest harvest has a 75% smaller footprint than forest conversion, and unlike forest conversion for human settlement or agriculture, harvested forests remain forests (just ones with initially fewer and younger trees) that re-sequester carbon over time.

Area(s) of Disagreement? Please comment on sections of the report with which you especially disagree.

We understand there was disagreement among authors of the report. We agree with and emphasize the following important points raised by some committee members:

1. **Avoid binary classification of management.** The report regularly pits active forest management against no management, as if the options for such a choice are binary. Figure 6 attempts to address the spectrum of management, and we applaud the efforts of the authors to describe the continuum of management actions between "active" and "passive". However, we feel that even trying to create a continuous scale for management actions suggests an inherent ranking among approaches. Figure 6 suggests that certain silvicultural systems, such as group selection or shelterwood, are more "active" than other silviculture systems like annual firewood harvesting. Should an even-aged regeneration system which includes timber harvesting once every 100 years be considered more "active" than annual firewood harvesting or selections systems which dictate logging on 10-20 year cutting cycles? We question whether these

distinctions are accurately describing "activity"? We caution any policy attempts to distill forest management decisions to a single axis for simplicity, and emphasize again (as with general recommendation #1, in areas of agreement), that management decisions must instead be place-based, site-specific, and capture the desires and needs of the communities living within and around the forests, as well as broader environmental and socioeconomic contexts. We suggest that forest management approaches instead be framed as options to meet certain objectives, such as resource needs and forest resilience goals.

2. **"Active Management" is a dynamic and flexible way to protect and care for forests in a changing climate.** "Active" management can happen in many forms and timeframes (10). Restricting any tree cutting from sites removes future tools that may be needed to ensure forests meet the needs of society – including growing long-lived big trees. "Passive" forest management (doing nothing) allows forests to develop on trajectories that may or may not result in long-term carbon storage. There is research which suggests that actively managed forests in New England, using specific silvicultural techniques to manage for multiple age classes, can result in healthier long-lived trees and greater long-term carbon sequestration and benefit other forest ecosystem services by generating more resilient forests (11).
3. **Multiple-objective forest management is needed.** We caution the state not to ignore other forest management objectives for the sake of carbon storage. Forests provide critical resources for the people of Massachusetts and periodic forest management is compatible or necessary to meet other objectives like promoting recreation, biodiversity, air and water pollution reduction, climate resilience, and generating forest products.
4. **Forest management can increase forest resilience to climate change and other forest stressors like pests and pathogens.** There should be no question that forest management, with the proper objectives and implementation, can increase resilience. Ecosystem resilience increases with different age classes, species diversity, and structural aspects of forests. Active forest management is the only tool we have to create this type of resilience. Relying on natural disturbance to create resilience is not certain. Like all natural systems, natural disturbances will result in uneven changes in forest ecosystems through time at whatever pace, location, and scale that "nature" decides. Change in Massachusetts' forests is occurring regardless of active management or not. Invasive pests, anthropogenic-induced climate change, and forest fragmentation due to development are new and increasing stressors on our forests. And the fact that these forests are already legacies of the most significant human impact on them to date– colonial land clearance – makes them homogenous in age and structure and predisposed to invasive insects, disease, and climate disturbance. Active management enables forest stewards to balance these adverse effects on forest ecosystems by periodically nudging the forest in a more resilient direction. Active forest management is the method we have to ensure that our forests under pressure will be resilient to ongoing and future disturbances. Active forest management can promote the forests we want and need for the future for biodiversity, timber production, carbon storage, water provision, and many more desirable services of forest lands.
5. **Mature forest can be managed forests**. We agree that mature forests are important, but mature forests can result from "active" forest management. In other words, "passive management" is not the only route to fostering "mature forests". The 'mature' forests of pre-colonial America were regularly "actively" managed by indigenous peoples before colonists forcibly removed indigenous communities from the forests they stewarded. Another example are the oak forests of the Spessart region of Germany, where oaks are grown on 200-300 year rotations with an intentional structured canopy and understory. Closer to home, a recent publication from researchers at the University of Vermont demonstrated using field measurements and modeling exercises that some forms of "active" management can increase

structural complexity and carbon stocks relative to other forms of "active" management or passive no harvest (12). These are just a few examples of how tailored "active" silvicultural prescriptions that are forest- and site-specific can enhance desirable features within mature forests. Importantly, these forests management actions make forests better able to withstand and recover from disturbances in ways that passive management will often fail to achieve. *The climate crisis needs forest managers to be innovative, not inactive.*

6. **Early successional habitat should be of concern.** The report recommends reducing the amount of early successional habitat while increasing the amount of mature forests. Early successional habitat, and associated rare species, will be significantly reduced when active forest management for such habitat is limited. While natural disturbances, like hurricanes, will create early successional habitat over time, these disturbances are rare enough that early successional species may disappear before another major disturbance event creates more early-successional habitat. This is especially concerning because connectivity of habitats in southern New England are limited by human development. The Commonwealth should pay particular attention to the fact that deliberate, early successional habitats are often the fastest forest lands to recover after major disturbances like hurricanes. If they are not present on the landscape, recovery of the Commonwealth's forests will be slowed.
7. **Local Wood Production can promote more sustainable forest management in Massachusetts and deter detrimental forests practices outside the Commonwealth:** Massachusetts can control and enhance the type of wood it uses and produces when that wood is grown in its own forests. Relying on Massachusetts wood demand to be sourced from other regions results in the state having no control over the type and quality of forest management its wood is sourced from. This type of "not-in-my-backyard" wood sourcing approach could lead to the Commonwealth's exploitation of resources from more ecologically sensitive places, such as primary tropical forests, in the world. There is historical precedence for this type of exploitation. When Boston depleted its firewood resources in the 18th century, the city's demand for wood led to deforestation of coastal islands in other parts of New England. If Massachusetts wants to use wood products and address climate change, then sourcing wood locally empowers the Commonwealth to meet both objectives with the most accurate carbon accounting possible. We note that other Commonwealth climate planning documents recognize the importance of considering wood product sourcing regions. Strategy L4 of the "Massachusetts Clean Energy and Climate Plan for 2025 and 2030" is to "incentivize long-lived, durable wood products" and the report text highlights that sourcing from Massachusetts is better than sourcing from other regions with higher ecological impacts or less regulations on harvesting. In short, Massachusetts has the capacity to shape its environmental impact when it manages its own forests, acknowledging its role as a global participant in the stewardship of forest lands.
8. **Wood products can produce climate benefits**. Carbon stored in wood products is an important part of the climate conversation around managed forests. States like Massachusetts should be incentivizing management which supports the production of long-lived forest products and renewable energy such as firewood. There is also evidence that the use of wood products as substitutes for steel and cement in construction is a much more efficient solution to climate mitigation than business as usual.

1) **The "best" approach to managing forest for carbon and climate mitigation will be site-specific.** There is no scientific consensus that a single type of forest management action is the "best" for carbon storage and climate mitigation. This is, in part, because we are creating models and projections of an unknown future. There is growing evidence, however, that forest management can lead to carbon benefits, but these benefits may accrue over different time-scales or within different carbon pools (10-13). And, all forest carbon projection models—for both passive and

actively managed forests—are built off a series of assumptions of future climate, disturbance, social, and economic conditions. An adaptable and flexible forest management policy for the Commonwealth would likely involve setting benchmarks and guardrails for forest managers to follow when determining forest management plans. The Commonwealth has a robust long-term dataset of forests conditions on their state lands and a deep bench of experts in forestry, forest ecology, forest management, and forest modeling with the state Department of Conservation & Recreation. We think that the best management decisions will only be made considering the current forest conditions, the desired forest outcomes, and using transparent data-driven models and forecasts for state-owned forest lands.

9. **We still have more to learn about soil carbon stocks.** We cannot quantify the relative effect of forest management practices on soil carbon stocks. We strongly agree with the Committee that soils are an important (and often overlooked) carbon pool in forest ecosystems, and that the Commonwealth should enforce (on public and private lands) best management practices in forests that reduce soil disturbances and promote organic buildup (downed woody debris, leaf litter, etc.) in soils. However, these recommendations are not based on extensive high-quality, empirical data that demonstrates the magnitude of effect of forest management practices on soil carbon stocks. That data does not exist. However, some data does exist and suggests that timber harvesting on New England soils has minimal impact below 10-cm soil depth and the top soil layers recover nutrients and carbon relatively quickly post harvest (14-15). However, more prescriptive management recommendations for protecting or building soil carbon stocks cannot be evaluated at this time without additional scientific studies.

6. State Consideration: Please offer your comment for our consideration as we develop the state's response to these guidelines and their implementation by agencies.

We applaud the authors of the report for their transparency regarding where the expert committee members were in strong agreement or disagreement over recommendations. In general, we hope that the Commonwealth will interpret the Committee's level of agreement on topics as an assessment of "confidence" in a particular finding. For topics that Committee members found unanimous agreement, the state may interpret that a diverse group of scientists have "high confidence" that a policy or practice will be a net benefit. For topics that Committee members found strong disagreement, the state should interpret that to reflect "low confidence" among scientists that a policy will be a net benefit. We encourage the state to prioritize Committee recommendations with high agreement and to spend more time evaluating the impacts of recommendations that stirred strong disagreement. Some of this disagreement appeared to stem from ideological differences in wildland protection, or differences in a 'preservationist' oriented philosophy that seeks to limit human extraction from nature versus a 'conservationist' oriented philosophy that seeks to sustainably utilize natural resources. This is an old debate, but more recent sustainable development pathways repeatedly advocate for the latter. A conservationist approach to land protection and management may be especially relevant for the state's forest lands given the thousands of years of human management that shaped the current forests of today, and an opportunity to reset forest trajectories that are still recovering from the massive impacts of deforestation by European colonists.

We also note that the state should consider external factors outside the scope of the Committee's purview for this report. This is especially true for areas where there was strong disagreement among Committee members. The Committee considered a wide range of topics regarding the management of state-owned forest resources. However, as the Commonwealth applies the Committee's findings to

state-wide policy, we note that the impact of any decisions on how the state manages its forests will also affect the 83% of Massachusetts forest lands that are not owned or managed by the state.

An important consideration of any future policy should evaluate the "activity shifting leakage" impact of state harvest bans. The state may opt to stop harvesting wood on state-owned forest land. That does not necessarily stop harvesting activity in Massachusetts' forests. It is well-demonstrated (especially in national and international carbon markets) that preventing one forest from harvest likely shifts harvesting activities to another forest (16-17). We encourage Massachusetts to estimate how much activity shifting leakage has occurred over the past few years when harvesting activities were halted on state-owned lands. Did production for mills in the region decline, or did wood products continue to flow into mills? Where does Massachusetts acquire its wood products? What is the carbon impact if a much higher proportion wood was imported rather than produced within the state?

The Commonwealth's total carbon footprint may remain the same with strict bans on forest harvesting if privately-owned forests in the state or forests in the region (or even globally) are harvested instead. If consumption of wood remains the same in the Commonwealth, there is potential that the carbon footprint of the state may increase given additional transportation costs, as well as lost economic opportunity for the state. If forest harvesting on private land increases, we are concerned that those operations will have less oversight regarding 'sustainability' and adherence to many of the best management practices highlighted by the Committee. Particularly concerning is that prior research has shown that exploitative forest harvest practices are quite common in the region on private forest lands (9). If reduction in state-forest harvests leads to increases in private-forest harvests, it is likely that the private harvests are doing more harm to the Commonwealth's forest relative to state-sponsored harvests overseen by state forest professionals with expertise and knowledge in implementation of best forest management practices. This harm may be accentuated if the Commonwealth chooses to limit its forest management expertise by banning management on state forest lands, whereas a positive and collaborative relationship between state and private forest management seems likely if the Commonwealth focuses on supporting effective management.

7. **Additional Comments**

References Cited in Responses:

1) Kelty, M.J. and D'Amato, A.W., 2006. Historical perspective on diameter-limit cutting in northeastern forests. In *In: Kenefic, Laura S.; Nyland, Ralph D. eds. Proceedings of the conference on diameter-limit cutting in northeastern forests; 2005 May 23-24; Amherst, MA. Gen. Tech. Rep. NE-342. Newtown Square, PA: US Department of Agriculture, Forest Service, Northeastern Research Station: 3-15.* (Vol. 342).
2) Curtze, A.C., Muth, A.B., Larkin, J.L. and Leites, L.P., 2022. Seeing past the green: Structure, composition, and biomass differences in high graded and silviculture-managed forests of similar stand density. *Forest Ecology and Management*, *526*, p.120598.
3) Nyland, R.D., 1992. Exploitation and greed in eastern hardwood forests. *Journal of Forestry*, *90*(1), pp.33-37.
4) Ward JS. Crop tree release increases growth of mature red oak sawtimber. Northern Journal of Applied Forestry. 2002 Dec 1;19(4):149-54.
5) Ward, J.S., 1992. Response of woody regeneration to thinning mature upland oak stands in Connecticut, USA. *Forest Ecology and Management*, *49*(3-4), pp.219-231.

6) Ward, J., Worthley, T., Smallidge, P. and Bennett, K., 2006. Northeastern forest regeneration handbook: a guide for forest owners, harvesting practitioners, and public officials.
7) Ward, J.S., 2009. Intensity of precommercial crop tree release increases diameter growth and survival of upland oaks. *Canadian Journal of Forest Research*, *39*(1), pp.118-130.
8) Ward, J.S. and Worthley, T.E., 2004. *Forest regeneration handbook: a guide for forest owners, harvesting practitioners, and public officials*. US Forest, Northeast Area, State and Private Forestry.
9) Belair EP and MJ Ducey. 2018. Patterns of forest harvesting in New England and New York: using FIA data to evaluate silvicultural outcomes. Journal of Forestry: 116:273-282.
10) Ontl TA, MK Janowiak, CW Swanston, J Daley, S Handler, M Cornett, S Hagenbuch, C Handrick, L Mccarthy, N Patch. 2020. Forest management for carbon sequestration and climate adaptation. Journal of Forestry 118:86-101.
11) Kern CC, LS KEnefic, C Kuehne, AR Weiskittel, SJ Kaschmitter, AW D'Amato, DC Dey, JM Kabrick, and BJ Palik. 2021. Relative influence of stand and site factors on aboveground live-tree carbon sequestration and mortality in managed and unmanaged forests. Forest Ecology and Management 493:119266.
12) Ford SE and WS Keeton. 2017. Enhanced carbon storage through management for old-growth characteristics in northern hardwood-conifer forests. Ecosphere 8:e01721.
13) Giffen RA, CM Ryan, EP Belair, MA Pounch, S Brown. 2022. Storing more carbon by improving forest management in the Acadian forest of New England, USA. *Forests* 13:2021.
14) Carpenter, R., Ward, E.B., Wikle, J., Duguid, M.C., Bradford, M.A. and Ashton, M.S., 2021. Soil nutrient recovery after shelterwood timber harvesting in a temperate oak hardwood forest: Insights using a twenty-five-year chronosequence. *Forest Ecology and Management*, *499*, p.119604.
15) Warren, K.L. and Ashton, M.S., 2014. Change in soil and forest floor carbon after shelterwood harvests in a New England Oak-Hardwood Forest, USA. *International Journal of Forestry Research*, *2014*.
16) Pan W, M Kim, Z Ning, H Yang. 2020. Carbon leakage in energy/forest sectors and climate policy implications using meta-analysis. Forest Policy and Economics 115:102161.
17) Pan C, A Shrestha, JL Innes, G Zhou, N Li, J Li, Y He, C Sheng, J Niles, G Wang. 2022. Key challenges and approaches to addressing barriers in forest carbon offset projects. Journal of Forestry Research 33:1109-1122.
18) Nepal P, PJ Ince, KE Skog, SJ Chang. 2013. Forest carbon benefits, costs and leakage effects of carbon reserve scenarios in the United States. Journal of Forest Economics 19:286-306.