Association for Fire Ecology Position Paper
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The Role of Fire in Managing Long-Term Carbon Stores: Key Challenges

Executive Summary

The United States Government has recently called for inventory and monitoring of carbon stocks and emissions in federal agencies and on federally-managed public lands. The Association for Fire Ecology (AFE), an organization dedicated to understanding the nature and role of fire in natural and managed ecosystems, strongly suggests that these inventory and monitoring efforts account for the role of fire in ecosystems function. Specifically, AFE maintains that:

1) Fire is a fundamental component of the Earth's natural carbon cycle, with a functional role that pre-dates human existence. A majority of terrestrial Earth ecosystems are adapted to include a significant role for fire. For those ecosystems, full, immediate suppression of wildfires as a means of reducing greenhouse gas (GHG) emissions may not yield long term emissions reductions compared to landscapes where fire is maintained and re-established in its native and/or functional role.
2) In addition to its place in the natural carbon cycle, by definition, wildfire is wild and uncontrolled. The Environmental Protection Agency (EPA) in 2007 erroneously designated wildfires as managed anthropogenic emission sources, equivalent to GHG emissions from burning fossil fuels. This designation should be rectified. Anthropogenic sources of carbon, such as fossil-fuel GHG emissions, can be reduced via modification of human activities, but emissions from fires of appropriate scale and severity should not be reduced.
3) If they exist at all, only rudimentary, first order estimates exist for quantifying the long versus short term emissions tradeoffs under the land management policies currently implemented by various federal and state lands management agencies. An unprecedented expansion of research is required to more fully understand carbon storage and emission trade-offs associated with managed versus wildfire regimes on the landscape.
4) Prescribed burning is a controlled reduced-risk management tool used to reduce or mitigate undesirable ecological and socio-economic impacts of wildfires. Carbon emissions from prescribed burning are typically much lower than those stemming from wildfires for the same landscape. Prescribed burning emissions should be considered for categorical exclusion from future legislation and regulation curbing annual GHG emissions. Emissions from managed wildfires that produce ecosystem benefits should also be excluded from annual GHG emission inventories.

The Role of Fire in Managing Long-Term Carbon Stores: Key Challenges

The last decade has brought increased concern over the Earth's changing climate and shifting carbon balance, and in response, has seen development of nascent carbon markets that quantify, value, and trade carbon. With the passage of the Energy Independence and Security Act of 2007, the US Secretaries of the Interior and Agriculture were charged with completing a national assessment of carbon emissions from US ecosystems. The assessment must identify adaptation and mitigation strategies for carbon management that will lead to reduced emissions and enhanced sequestration on terrestrial landscapes. This task is consistent with other global efforts.

In response, the Secretary of the Interior established the *Climate Change Response Council* and the *DOI Carbon Storage Project* under the leadership of the U.S. Geological Survey, while the US Forest Service has incorporated similar actions into its *Global Change Research Strategy 2009-2019.* The President subsequently signed an Executive Order on Federal Leadership in Environmental, Energy, and Economic Performance on October 5, 2009, setting a 90-day deadline for the development of emissions inventory and reduction strategies.

Fires—whether natural, intentional, or accidental—add to global greenhouse gas (GHG) emissions and are among the most widely studied contributors of carbon dioxide and methane. Currently, some advocates suggest that enhanced wildfire prevention and suppression is an important mitigation strategy to reduce wildfire-related carbon emissions. However, decades of scholarly fire research indicate that fire plays a key ecological role in most global ecosystems, and should be considered a vital and essential process in evolving carbon accounting systems. The ecological role of fire is variable from place to place and as the climate shifts. Thus, a unilateral approach to preventing or suppressing fire in order to maximize carbon sequestration would destabilize systems that require fire and also increase carbon losses caused by fires in the long term.

Strategically incorporating ecological knowledge of fire into carbon management and climatic change initiatives is essential to reducing atmospheric carbon levels. We describe several concerns below where a clear understanding of an ecosystems' fire ecology is requisite to developing effective policy.

1. The fallacy of wildfire suppression and prevention. Even the most moderate climatic change scenarios predict increasing wildfire impacts. While a policy of enhanced fire suppression and prevention appears to be a logical response to these predictions, it is ill-advised as a stand-alone policy for several reasons:

i.) Fire-prone ecosystems have evolved to withstand varying levels of fire impacts and are comprised of species and processes that are fire-adapted. Withholding fire destabilizes fire-adapted communities and ecosystems.

ii.) Wildfire suppression and prevention in many fire-prone ecosystems only delay the inevitable return of wildfire. Decades of excluding frequent, low-to-moderate severity fires (e.g., in southwestern pine forests, dry mixed conifer, etc.) only increase the severity (and GHG emissions potential) of undesirable impacts when fire ultimately returns. In ecosystems evolved with high-severity fire, stand-replacing wildfires are required to re-initiate successional processes that maintain ecosystem diversity. Only ecosystems dominated by un-natural, human-ignited wildfires benefit from extensive suppression and prevention efforts (e.g., Mediterranean chaparral). This is a hard lesson learned from 20th century fire management.

iii.) Forest soils and their biota store significant amounts of carbon and other nutrients both in soil and in surface debris. High intensity wildfires following fire exclusion in some forested ecosystems can impair the carbon storage capacity for decades to centuries. In contrast, low intensity fires can maintain and enhance carbon-sequestering soil ecosystems while charring some of the surface debris and delaying its decay and availability as fuel in subsequent fires.

iv.) The largest opportunity for sequestering carbon in lower elevation, temperate zone forests lies in growing large trees. Infrequent wildfires not only kill large trees but also consume great quantities of fuels. In many forest ecosystems, frequent low intensity fires will tend to maintain forests composed of more large trees with lower surface and ladder fuel levels. In many cases, *more* rather than less fire may be the key to reducing long-term carbon emissions and increasing carbon storage in these ecosystems. The use of prescribed fire can also aid in accomplishing this objective.

2. Balancing carbon storage and habitat. Prior to European settlement and management, forests throughout the US were burned by fires of varying frequency, severity, season, and extent. The result was an exceptionally diverse floral and faunal landscape at a multitude of spatiotemporal scales. The prospect of using fire to increase both the quantity and predictability of stored carbon in ecosystems with naturally short fire return intervals is a double-edged sword. On the one hand, vast forests composed of well-spaced large, fire-tolerant trees and little understory vegetation and surface fuels may be highly suited to carbon storage and reduced emissions from wildfires. On the other hand, these conditions have historical analogues in only a few areas and therefore may provide a highly uncertain future for some native species. The same is true for ecosystem conditions that would result were we able to completely exclude fire from this point on. The answer lies somewhere in between these two extremes. The task ahead is to balance carbon storage and loss with maintaining ecosystem diversity and resilience. Additional research and knowledge can sharpen this point.

3. Favoring long vs. short-term carbon storage. Various forms of vegetation management and prescribed burning have been recommended for public lands that are susceptible to stand-replacing wildfires, especially in ecosystems that once burned frequently under low-moderate intensity fire regimes. These treatments promote removing small trees and ladder fuels, while burning surface fuels. Clearly much research and development is needed to fully understand the distributed effects of these treatments to terrestrial and aquatic ecosystems, including the life-history of carbon stored in wood products that are removed from some forests. However, research to-date suggests that carefully designed and executed treatments with planned subsequent recurring prescribed burning in ecosystems evolved with naturally low-severity fire will decrease the risk of high-severity wildfire while maintaining a developing fire-tolerant forest. In the short-term, removal of numerous small stems may be somewhat controversial because treatments initially reduce carbon storage, although carbon stock changes are generally small. However, empirical observations and simulations attest that the long-term effect in treated stands is to increase the amount of carbon stored in larger fire-tolerant trees and resilient soils. They also reduce the risk of subsequently losing these carbon stocks to wildfire.

4. Prescribed vs. wildfires. The use of prescribed burning can be highly contentious due to its short-term contributions to atmospheric carbon. However, recent science shows that prescribed fires, while burning within pre-planned prescription parameters, produce one-third to one-half of the total smoke emissions associated with wildfires, and in some cases, even less. Furthermore, since treated stands vastly reduce tree mortality when wildfire returns, carbon stocks can be maintained more reliably, with less risk of loss to stand-replacing fire. In addition, the fine particulate emissions that are hazardous to human health are much reduced in prescribed versus wildfires. Prescribed burning is not a complete panacea for controlling emissions of atmospheric carbon from wildfires, however, and many issues remain unresolved, including:

i.) Long and short term ecological effects of wildfire versus prescribed fire to better understand when and where prescribed burning should be preferred to wildfire.

ii.) Long and short-term carbon and regional air quality trade-offs associated with wildfire and prescribed fire.

iii.) Developing large-scale vegetation management approaches that enable fire managers to manage the variability, severity, and extent of wildfires in ways that favor resilient and resistant ecosystems, increased large tree retention in some forests, and reduced carbon emissions.

Recommendations

Based on decades of research and centuries of fire history, we submit that fire, sustainably applied and managed to limit high severity and overall size on landscapes, can be a powerful tool for (1) minimizing landscape GHG emissions, (2) increasing ecosystem resilience, and (3) decreasing overall risk of catastrophic vaporization of carbon stocks that occurs during type conversion. The policy implications of this knowledge are as follows:

1) *Conduct an independent and critical evaluation of how managed and wildfires are considered in national carbon policy, and in future carbon accounting.* Such an evaluation should include input by skilled fire ecologists, fire physical scientists, economists, and fire managers, from all representative regions of the US.
2) *Recognize the dynamic nature of ecosystems as carbon markets develop.* Terrestrial ecosystems are highly dynamic, with widely varying vegetation conditions and associated carbon storage potential. Because the current carbon cap and trade system is designed for industrial and infrastructure emissions and storage, summarizing losses and gains annually and with narrow variance, it represents a virtually static system. Such a system has limited utility to ecological systems, where single and overlapping change events (e.g., deforestation or reforestation events) have immediate and long-term effects that can span centuries. To be meaningful and accurate, carbon accounting horizons should occur across decadal and longer time scales, and across broad spatial scales that quantify carbon at the regional or landscape level as opposed to individual sites or forest stands.
3) *Exempt prescribed burning from annual carbon budgets and caps, due to its critical long-term role in fuels and vegetation management.* However, decadal and centenary budgets should be developed for terrestrial ecosystems, and the progress and rate of prescribed burning should be evaluated for ecosystems at these broader time scales.
4) *Evaluate carbon emission and sequestration trade-offs between prescribed burning and wildfires.* Carbon sequestration is one of many ecosystem services that can only be measured at decadal and centenary time scales. Only in the long-term does prescribed burning have significant potential to reduce total carbon emissions and increase carbon storage associated with forest burning. Managing more wildfires in remote areas for ecological objectives should also be encouraged.
5) *Wildfire suppression should be used as a risk-mitigation strategy in specific critical locations, not as a remedy for curbing carbon emissions.* Wildfire suppression and prevention will always be a strategy in areas where it is critical to mitigate risk to human populations and where frequent, human-ignited fires have significantly altered an ecosystem where naturally-ignited fires were historically rare. Outside of these areas, wildfire suppression should be phased out as the primary fire management tool, with prescribed burning, well-designed fire surrogates, and carefully managed wildfire utilized to meet long-term carbon objectives and increase ecosystem resiliency.