Ecological objectives can be achieved with wood-derived bioenergy

Peer-reviewed letter

Renewable, biomass-based energy options can reduce the climate impacts of fossil fuels. However, calculating the effects of wood-derived bioenergy on greenhouse gases (GHGs), and thus on climate, is complicated (Miner *et al.* 2015). To clarify concerns and options about bioenergy, in November 2014, the US Environmental Protection Agency (EPA) produced a second draft of its Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources (http://1.usa.gov/1dikgHq), which considers the latest scientific information and input from stakeholders. The EPA is expected to make decisions soon about the use of woody biomass under the Clean Power Plan, which sets targets for carbon pollution from power plants.

In a March 11, 2015, letter to US EPA Administrator Gina McCarthy (http://bit.ly/1HsSaWf), the Ecological Society of America objected to EPA's proposal that sustainably harvested woody biomass could reduce carbon emissions. Citing a November 2014 EPA memorandum (known as the McCabe memo; http://1.usa.gov/1zMeZf2), the Ecological Society letter argued that the EPA's stance would undermine federal efforts to "deter rapid deforestation, lower carbon emissions, and mitigate the effects of global climate change". We believe that the Ecological Society letter reflects an incomplete understanding of EPA's position, of the factors affecting deforestation, and of the mitigation benefits of wood-derived energy. In actuality, the EPA McCabe memo (1) emphasizes that "carbon neutrality is not an appropriate a priori assumption" for biomass energy; (2) describes many complex issues that need to be considered when assessing effects on biogenic carbon cycles; (3) states that, for net emissions to be low, several conditions, beginning with sustainable forest management, must be met; and (4) confirms EPA support for forest conservation goals.

The Ecological Society's suggestion that increased demand for wood will cause deforestation is misguided, especially in the US, where most wood-producing land is privately held. As demand for wood increases, net forest area typically expands (Miner *et al.* 2014). Indeed, forest area and carbon stocks in the US have increased along with rising wood demand since the 1950s (Zhang *et al.* 2015). Even on intensively managed, industry-owned timberland, carbon stocks are essentially stable (Heath *et al.* 2010). While a spike in demand for forest biomass could briefly increase harvesting rates, evidence to date indicates that harvest surges are temporary and are followed by expanding forest area (Lubowski *et al.* 2008; Galik and Abt 2015). There is, of course, a need for diligence to ensure that other forest values, such as water quality, biodiversity, and scenic and recreational values, are maintained (Evans *et al.* 2013), which is why sustainable forest management is emphasized in the EPA draft framework. Furthermore, forests require attentive monitoring and interventions (eg periodic harvesting or controlled burns) to avoid or minimize impacts from disturbance such as catastrophic fires, insects, and pathogens. Managed forests provide benefits to neighboring landscapes by limiting the intrusion of these disturbances and thereby enhancing other ecosystem services (Malmsheimer *et al.* 2011).

As discussed in the McCabe memo, selection of a reference system is a critical choice that relates to the goals and circumstances of each analysis (Dale *et al.* 2015). The Ecological Society letter specifically objects to the EPA using current forest stocks as a baseline to calculate future carbon changes. Yet baselines that rely instead on future projections (business-as-usual or otherwise) are not necessarily better or more environmentally protective than the simpler and easier to verify reference point proposed by the EPA (Buchholz *et al.* 2014).

A major omission in the Ecological Society letter is the issue of timing. A robust body of research confirms that forests that are sustainably managed for wood products and energy are associated with long-term reductions in atmospheric carbon dioxide (CO_2) emissions (Miner *et al.* 2014; Ter-Mikaelian *et al.* 2015). The primary debate about the use of sustainably produced biomass for energy revolves around the timing of mitigation benefits, not whether they exist (Helin *et al.* 2013; Marland *et al.* 2013; Buchholz *et al.* 2014). Timing is related to many factors, including the response of landowners to increased demand for wood, forest growth and mortality rates, combustion efficiencies, and fate of the carbon in unused biomass. Currently, in places without bioenergy markets, much wood is disposed of by burning or is left to decompose, releasing GHGs and thereby affecting climate without providing energy benefits (Figure 1). Under these and many other conditions, net benefits from the use of wood for energy can begin accruing immediately or within a few decades of harvest, especially in scenarios with fast-growing trees and where there is a strong response from landowners (eg increased planting and more investment in active management via monitoring, thinning, and removal of residues following harvest; Miner *et al.* 2014; Ter-Mikaelian *et al.* 2015). On the other hand, where landowner investment response is lacking or omitted from the analysis, or where large or slow-growing trees are involved, additional time may be required to achieve net benefits (Ter-Mikaelian *et al.* 2015).

Because the benefits of bioenergy vary with time, analysts and policy makers need to be clear about the time horizon for analysis. The selected temporal window is largely a policy issue that should be informed by the particular context and an understanding of the dynamic warming effects of GHGs such as CO_2.

The Intergovernmental Panel on Climate Change concluded that, for CO_2, long-term cumulative emissions are likely to drive peak global temperatures, not short-term emissions trajectories (IPCC 2013). While there are uncertainties about "tipping points", the social value of limiting long-term cumulative CO_2 emissions is widely acknowledged, as are the benefits of more intensive management to accelerate sequestration and to increase the amount of wood available to substitute for fossil fuels and for other materials (eg framing and floors for buildings) that require large quantities of fossil fuel to produce.

The Ecological Society's critique of the proposed EPA framework for assessing biogenic CO_2 emissions is not supported by scientific evidence. The EPA proposal is not final, but it recognizes the complexity and importance of considerations about system boundaries (in time and space) and the reference scenario. To conserve and enhance US forest ecosystems, every opportunity should be seized to support continual improvement in forest management. Forest biomass for bioenergy can provide an important contribution toward mitigating climate change (Cowie *et al.* 2013) and increasing the land area sustainably managed as forest. Objecting to EPA's approach without considering historical and scientific evidence is counterproductive to the objectives and mission of the Ecological Society of America.

Virginia H Dale[1*], Keith L Kline[1], Gregg Marland[2], and Reid A Miner[3]

[1]*Center for BioEnergy Sustainability, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN* [*]*(dalevh@ornl.gov);* [2]*Research Institute for Environment, Energy and Economics, Appalachian State University, Boone, NC;* [3]*National Council for Air and Stream Improvement, Inc, Research Triangle Park, NC*

Acknowledgements

This response was supported by the US Department of Energy (DOE) under the Bioenergy Technologies Office. Oak Ridge National Laboratory is managed by the UT-Battelle, LLC, for DOE under contract DE-AC05-00OR22725. We thank S Sokhansanj for comments on an earlier draft.

Figure 1. *The abundance of wood available for bioenergy from forests in the southeastern US is illustrated by the large amount of wood remaining on the ground after a clear-cut harvest at the Oak Ridge Forest (University of Tennessee – Forest Resources AgResearch and Education Center). Most of the private timberland in the southeastern US (80–90%, depending on the location) is held by small, non-corporate, private landowners (FIA 2012). Hence the summation of many activities, such as those depicted, constitutes a major source of woody biomass available for energy use.*

Buchholz T, Prisley S, Marland G, *et al.* 2014. Uncertainty in projecting GHG emissions from bioenergy. *Nat Climate Change* **4**: 1045–47.

Cowie A, Berndes G, and Smith T. 2013. On the timing of greenhouse gas mitigation benefits of forest based bioenergy. IEA Bioenergy ExCo: 2013:04. www.ieabioenergy.com/publications/on-the-timing-of-greenhouse-gas-mitigation-benefits-of-forest-based-bioenergy. Viewed 31 May 2015.

Dale VH, Efroymson RA, Kline KL, and Davitt M. 2015. A framework for selecting indicators of bioenergy sustainability. *Biofuels Bioprod Bioref*; doi:10.1002/bbb.1562.

Evans JM, Perschel RT, and Kittler BA. 2013. Overview of forest biomass harvesting guidelines. *J Sustain For* **32**: 89–107.

FIA (Forest Inventory Analysis). 2012. Forest resources of the United States, 2012. A technical document supporting the 2015 update of the RPA assessment. www.srs.fs.usda.gov/pubs/47322. Viewed 23 Jun 2015.

Galik CS and Abt RC. 2015. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States. *GCB Bioenergy*; doi:10.1111/gcbb.12273.

Heath L, Maltby V, Miner R, *et al.* 2010. Greenhouse gas and carbon profile of the US forest products industry value chain. *Environ Sci Technol* **44**: 3999–4005.

Helin T, Sokka L, Soimakallio S, *et al.* 2013. Approaches for inclusion of forest carbon in life cycle assessment – a review. *GCB Bioenergy* **5**: 475–86.

IPCC (Intergovernmental Panel on Climate Change). 2013. Climate change 2013: the physical science basis. Contributions of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY: Cambridge University Press.

Lubowski RN, Plantinga AJ, and Stavins RN. 2008. What drives land-use change in the United States? A national analysis of landowner decisions. *Land Econ* **84**: 529–50.

Malmsheimer RW, Bowyer JL, Fried JS, *et al.* 2011. Managing forests because carbon matters: integrating energy, products, and land management policy. *J Forest* **109**: S7–S48.

Marland G, Buchholz T, and Kowalczyk T. 2013. Accounting for carbon dioxide emissions. *J Ind Ecol* **17**: 340–42.

Miner RA, Abt RC, Bowyer JL, *et al.* 2014. Forest carbon accounting considera-

tions in US bioenergy policy. *J Forest* **112**: 591–606.
Ter-Mikaelian MT, Colombo SJ, and Chen JX. 2015. The burning question: does forest bioenergy reduce carbon emissions? A review of common misconceptions about forest carbon accounting. *J Forest* **113**: 57–68.
Zhang FM, Chen JM, Pan YD, *et al.* 2015. Impacts of inadequate historical disturbance data in the early twentieth century on modeling recent carbon dynamics (1951–2010) in conterminous US forests. *J Geophys Res–Biogeo* **120**: 549–69.

doi:10.1890/15.WB.011

Reply to Dale *et al.* letter invited by ESA

Dale *et al.* raise some important points about the complexity of the ecological issues underlying the effects of wood-derived bioenergy on energy yield, forest cover, and greenhouse-gas emissions and on how these effects should be assessed over different timescales. These are complex issues that require careful ecological analysis and assessment, using the best available science and common sense. These issues will need to be resolved before decisions are made that may have long-term and widespread implications for land use and atmospheric chemistry.

First, a matter of background: David Inouye's letter to the EPA (11 Mar 2015; http://bit.ly/1HsSaWf) on behalf of the ESA – referred to as the "Ecological Society letter" by Dale and colleagues – followed an earlier letter (9 Feb 2015; http://bit.ly/1DhNyQ0) from the Natural Resources Defense Council (NRDC), which I signed along with numerous other members of the ESA, including several members of the National Academy of Sciences. Both the ESA and NRDC letters contribute similar arguments (some of which are challenged by Dale *et al.*) to the EPA's deliberations as it revises its framework to evaluate the use of biomass energy to mitigate climate change.

Let me reiterate and clarify those arguments here:

(1) Wood has a lower energy content than coal. You need to burn more wood relative to coal to generate the same amount of energy; thus, wood burning is associated with greater initial carbon dioxide (CO_2) emissions. The CO_2 from the combustion of fuel (wood or coal) is released almost instantly, whereas the growth and regrowth of wood takes decades.

(2) Not all biomass is the same. Burning grasses such as *Miscanthus* and young trees – such as slash pine (*Pinus elliottii*), which are then replanted – is probably helpful in reducing anthropogenic emissions of CO_2 to the atmosphere. Burning mature and old-growth trees is not. The difference stems from the time it takes to regain the carbon storage on the landscape – ie pay off the "carbon debt". It is true that the issue of timing is a political and not a science question, but at the moment the US is committed to reducing its carbon emissions within a couple of decades. Many believe that is all the time we have, if we are to avoid the most serious consequences of climate change.

(3) Not all forests are the same. Increases of forest coverage at the expense of agricultural land and replantings of forests on harvested land are more likely to consist of plantations, with lower habitat value and biodiversity. When these young forests replace forests with larger, older trees, the demand for saw-timber for construction is shifted overseas, resulting in deforestation elsewhere – often called "leakage".

(4) Accurate and dynamic baselines against which to measure carbon inventory are critical if monetary credits are to be allocated. As a taxpayer, I would not be happy rewarding a landowner or a corporation for carbon accumulations that would have occurred in the absence of specific management. The key to solving the CO_2 emissions problem through the use of biomass energy or sequestration of carbon in soils must focus on "additionality" – a reward for something that would not occur anyway.

The ESA and the NRDC hope that the EPA keeps these facts in mind as it completes its deliberations.

William H Schlesinger
President, Emeritus, Cary Institute of Ecosystem Studies, Millbrook, NY; Member, Board of Trustees, Natural Resources Defense Council, New York, NY
(schlesingerw@caryinstitute.org)

doi:10.1890/15.WB.012

South China Sea conflict could harm marine environment

China's claims to large chunks of South China Sea waters – which are potentially rich in natural resources, including petroleum and natural gas – are already causing well-documented diplomatic tensions; less explored, however, are the environmental implications of this territorial dispute.

Paradoxically, overlapping claims to territorial waters may have a positive impact on the protection of marine biodiversity (Machlis and Hanson 2008). Fishing bans imposed by China and the Philippines as part of their contested territorial claims could help the recovery of fish stocks (Fratticcioli 2013), for instance. Similarly, key habitats and biodiversity hotspots in disputed regions may also indirectly gain protection from immediate economic exploitation (Peh 2010). The tensions in the South China Sea might even reduce the illegal harvesting of protected wildlife; largely because of its desire to assert sovereignty, the Philippines is enforcing its environmental regulations more actively. However, such temporary and accidental advantages may no longer apply to the South China Sea, as the confrontation is now about land grabs.

The area's relatively pristine environment is at risk from the current race to develop and populate disputed but previously uninhabited

