Natural Resource Economics

1430 Willamette St., # 553
Eugene, Oregon USA 97401-4049
Phone • (541) 937-3644 | Cell • (541) 505-2704
www.nreconomics.com
ernie.niemi@nreconomics.com

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TO: **Mary Scurlock, Oregon Stream Protection Coalition**
FROM: **Ernie Niemi**[1]
SUBJECT: **POTENTIAL CARBON VALUES IN RIPARIAN ZONES**

You asked me to estimate the potential economic value of carbon that could be stored in expanded riparian buffers on private forestlands in western Oregon. By allowing trees to grow, rather than be logged, expanded buffers would create an economic benefit by increasing the amount of carbon dioxide the trees remove from the atmosphere, and reducing the damage that anticipated changes in climate will impose on Oregonians and others. The assumptions and data described below suggest that this benefit likely would be about $100,000–$300,000 per acre. Incorporating different assumptions or data into the analysis would change the analytical findings somewhat, but there are significant reasons to anticipate that the actual benefit per acre will be larger.

A. Background

The Intergovernmental Panel on Climate Change (IPCC) has concluded that human-caused emissions of carbon dioxide and other greenhouses gases (GHGs), which have "increased to levels unprecedented in at least the last 800,000 years," likely underlie observed changes in average surface temperature of about 0.85^{O}C since the beginning of the 20th century.[2] This increase in temperatures has been accompanied by changes in precipitation levels and patterns, increases in extreme weather events, rising sea level, acidification of oceans, and changes in ecosystems. These changes in climate, in turn, are associated with increases in undesirable events, such as mortality and morbidity from heat waves and storms, reduced agricultural production from droughts, and property damage from floods and sea-level rise.

Carbon dioxide emissions impose real costs on real Oregonians. If emissions continue their current trends, average surface temperature is expected to increase another 4^{O}C, potentially triggering run-away changes in climate with catastrophic effects felt in Oregon and around the world. Six years ago, I directed a team of more than 20 economists that prepared the first-ever assessment of the economic costs that climate change will impose on the families, businesses, and local governments in Oregon.[3] Using the data available at the time, it concluded that,

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[1] My CV is available at http://www.nreconomics.com/cv.html.

[2] IPCC. 2013. "Summary for Policymakers." In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[3] Niemi, E., and members of the Program on Economics' Steering Committee. 2009. *An Overview of Potential Economic Costs to Oregon of a Business-As-Usual Approach to Climate Change.* Climate Leadership Initiative, Institute for a Sustainable Environment, University of Oregon. February 17.

absent meaningful actions to reduce the emissions of greenhouse gases, the average annual cost would total about $2,000 per household by 2020. Subsequent research suggests the actual costs likely will be several times larger.

When Oregon's forests remove carbon dioxide from the atmosphere and store the carbon, they reduce the risks of climate change. This reduction in climate-related risks constitutes an economic benefit to Oregonians and others exposed to these risks. Conversely, when forests are logged, much of the stored carbon is released to the atmosphere, increasing the risks, and imposing costs on individuals, families, businesses, and communities in Oregon and around the world.

B. The Potential Carbon Value of Riparian Forests

Calculation of the potential climate-related benefits from allowing forest to grow in expanded riparian buffers is a straightforward, three-part process. The first entails obtaining a credible, quantitative estimate of the additional forest carbon stored each year in the expanded riparian buffers. The second entails obtaining a credible estimate of the per-unit value of the stored carbon. The third entails multiplying the two estimates to yield an estimate of the potential economic harm per year.

Rasmussen et al. (2012) reports that private forestlands in western Oregon add about 120 cu. ft. of wood per acre per year.[4] This amount is equivalent to about 1.7 metric tons of forest carbon per acre per year.[5] This number suggests that, if an acre of riparian forest had trees about 50 years old, it would hold aboveground forest carbon equivalent to about 85 metric tons of carbon. If that acre were logged, about 70 percent of that carbon, 59 metric tons, would be released into the atmosphere before the end of the century.[6] In addition, logging, slash burning, and other forest-management activities would emit another metric ton of carbon,[7] for a total of about 60 metric tons per acre. If, instead, that acre continued growing, the forest would hold that carbon out of the atmosphere and produce economic benefits by preventing the economic damages that would occur if the carbon were emitted into the atmosphere.

An extensive review of the professional literature available through 2012 estimated the present value of the damage per ton of CO_2 emitted into the atmosphere.[8] [The present value is a single number that represents what the damage would be if the future stream of damage were to occur, instead, entirely in 2012.] The effort considered several scenarios. The core scenario indicates that each ton of forest carbon emitted into the atmosphere over the remainder of this

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[4] Rasmussen, M., R. Lord, B. Vickery, C. McKetta, D. Green, M. Gren, T. Potiowsky, D. Adams, G. Latta,R. Anderson, B. Mitchell, and D. Mark. 2012.*The 2012 Forest Report: An Economic Assessment of Oregon's Forest and Wood Products Manufacturing Sector.* Oregon Forest Resources Institute. p. 16

[5] Conversion algorithm from: BLM. 2015. "Carbon Storage in Live Trees." *Draft Resource Management Plan, Environmental Impact Statement: Western Oregon.* Appendix G – Climate Change. p. 1103

[6] Calculation using the formula reported in BLM. 2015. *Draft Resource Management Plan/Environmental Impact Statement: Western Oregon.* p. 1104.

[7] Sonne, Edie. 2006. "Greenhouse Gas Emissions from Forestry Operations: A Life Cycle Assessment." Journal of Environmental Quality. 35:1439-1450.

[8] Interagency Working Group on Social Cost of Carbon, United States Government. 2013. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866.* May.

century would result in economic damage of about $280 (2012 dollars).[9] Another scenario recognized that the damage could be as high as $870 per ton.

Multiplying the tons of stored forest carbon times the core estimate of the value per ton indicates that the carbon-related benefit of not logging an acre of riparian forest would be about [60 tons times $280 per ton =] $17,000. Multiplying by the upper estimate of the per-ton value indicates the benefit would be $52,000 per acre.

These numbers do not tell the full story. In particular, they understate the true benefits of standing forests. The estimate of the per-ton value of stored carbon is based on the literature through 2012, which omits several major costs of climate change. One recent study filled one portion of the gap by looking beyond the initial damage from climate-related droughts, storms, etc. and quantifying the long-run impacts on global economic growth. Incorporating this finding into the numbers above increases the economic benefit from not logging a 50-year-old riparian stand by a factor of six, to about $100,000-$300,000 per acre.[10]

These numbers provide a ballpark estimate of the economic importance of carbon that could ultimately be stored in expanded riparian buffers, once trees are permitted to grow there. Further research that accounts for other types of damage omitted from the 2012 professional literature likely will push these values even higher. Other factors might push them lower. New technologies might increase the amount of carbon in long-lived wood products, for example, reducing somewhat the net benefit of not logging the trees. On balance, though, I anticipate that factors pushing the value of forest carbon higher than these numbers probably will outweigh those that might push it down.

In sum, policy actions that would prevent the logging of Oregon's riparian forests would, on average, yield an economic benefit of at least $100,000–$300,000 per acre by preventing the economic damage that would result if logging were to convert forest carbon to atmospheric carbon dioxide.

[9] BLM (2015 p. 483).

[10] Frances, C., and Delavane B. Diaz. 2015. "Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy." *Nature Climate Change.* 12 January. http://www.nature.com/nclimate/journal/v5/n2/full/nclimate2481.html. p. 2.