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To: Climate Action Reserve
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RE: Forest Protocol White Papers

Weyerhaeuser Company (Weyerhaeuser) appreciates the opportunity to provide comments on the CAR Forest Project Protocol white papers, *Accounting for Carbon in Soils, Carbon Accounting and Management of Lying Dead Wood, Carbon Dynamics Associated with Even-Aged Management, and Sustainable Forest Management Certification.* Weyerhaeuser has participated as an advisor in California's early efforts to establish forest protocols, participating in the Commission's May 2004 workshop. Since then, we have responded to multiple requests for comments on various versions of the Forest Sector Protocol (including Version 2.0 in September 2007, Version 3.0 in January 2009, and version 3.1 in May 2009).

Weyerhaeuser is one of the world's largest forest products companies and is principally engaged in the growing and harvesting of timber; the manufacture, distribution and sale of forest products; and real estate construction and development. The company was incorporated in 1900 and is headquartered in Federal Way, Washington. In 2010, total sales revenue was $6.6 billion. Weyerhaeuser maintains operations in several areas in California, principally through its wholly owned subsidiary, Pardee homes, a major real estate developer, as well as through the distribution of a wide variety of forest products, including cellulose fiber and structural building materials. In the U.S., Weyerhaeuser owns or manages over 6 million acres of forestland, and it is in this context that we comment on these white papers.

Weyerhaeuser has a long history of silvicultural research and is committed to the use of good science as the guiding principal to managing forest ecosystems sustainably. Weyerhaeuser's research program includes expertise in regeneration, tree improvement, silviculture and environmental sciences. These efforts are focused in the Pacific Northwest and southeastern U.S. but projects also have been established the last decade in South America. Many of our research projects, essentially all of the environmental projects, are conducted in collaboration with university, federal or ENGO research organizations. As such, we applaud an effort to collect scientific information as it relates to down woody debris, soil carbon, and even-age management. In addition, One hundred percent of Weyerhaeuser's lands in the U.S. have been certified to the Sustainable Forestry Initiative® (SFI) since 2002.

Below we have some specific comments and corrections related to the Even-Aged Management white paper and some overall comments related to the Soil Carbon white paper and Certification white paper.

Please contact me 253-924-3292 or edie.sonnehall@weyerhaeuser.com with any questions you may have regarding these comments.

Very truly yours,

Edie Sonne Hall
Manager, Sustainable Forests and Products
Weyerhaeuser Company

Carbon Dynamics Associated with Even-Age Forest Management White Paper

General Comments

The white paper does a good job of explaining the different silvicultural treatments and uses in different parts of the country and reinforces our conviction that there is not one universal way to practice forestry. The authors state throughout the report that there are many considerations in comparing carbon implications of different management techniques, including the impact of leakage (dispersing harvest to other lands) and product substitution (accounting for avoided GHG emissions from using wood products as opposed to more energy intensive materials)[1] (see Introduction, heading 4, pg 4-6). It is clear that this white paper does not support one "optimal" way to manage for maximal carbon storage. Moreover, in the offset context, having an optimal way is somewhat irrelevant since the landowner can only sell the additional carbon that has been quantified in the project. It is the choice of the landowner how much or how little of an increase they choose produce, and it will depend on many other factors, including economic considerations and other values for the land. So if the purpose of the white paper was general education into different kinds of forestry practices, we think it succeeded. It does not, however, provide the basis for making specific protocol changes unless it is to remove the arbitrary 40-acre clearcut limitation.

Furthermore, throughout the paper there are multiple conclusions that are not supported by the actual data modeled or reviewed in the report. See specific comments for needed revisions.

Specific Comments

Heading 1 – *The carbon storage potential based on the pre-treatment land use and productivity has a significant influence on carbon.* In the next sentence the authors state "Any harvesting treatment will reduce carbon in stocked land versus not harvesting even accounting for in-use forest products pool due to conversion inefficiencies, with this effect particularly pronounced in forests with high initial stocking." This sentence is grossly misleading as it is true only in a limited temporal sense. Throughout the report all modeling is done over a 100-year time frame, which is appropriate since that is the time frame of the project crediting period. However, this time frame does not necessarily yield the same result as a 200-year or longer time frame. In fact, managing at or below the culmination of mean annual increment is seen as a widely accepted strategy for sequestering more carbon over the long term.[2] Figure 1 illustrates the carbon dynamics of managing Loblolly pine on a 30-year rotation (around the culmination of mean annual increment) versus never harvesting. The no-harvest scenario reaches a stable state while the harvest scenario shows the continuous maintenance of a lower average carbon stock in the forest, but a continuous build-up of wood product carbon storage. In this scenario, it overtakes the no-harvest regime after about 130 years. The cross-over mark will be much longer in forest species that have longer growth periods (e.g., Douglas-fir) and much shorter if the system boundary

[1] In addition the authors should have also stated that carbon implications also depend on the time-frame. We will discuss this further in the comments.

[2] IPCC. 2007. *Working Group III. Mitigation of Climate Change: Section 9.4.2.4. Increasing off-site carbon stocks in wood products and enhancing product and fuel substitution.* "Wood products derived from sustainably managed forests address the issue of saturation of forest carbon stocks. The annual harvest can be set equal to or below the annual forest increment, thus allowing forest carbon stocks to be maintained or to increase while providing an annual carbon flow to meet society's needs of fibre, timber and energy"

expanded to include landfill carbon, avoided emissions from product substitution and bioenergy.

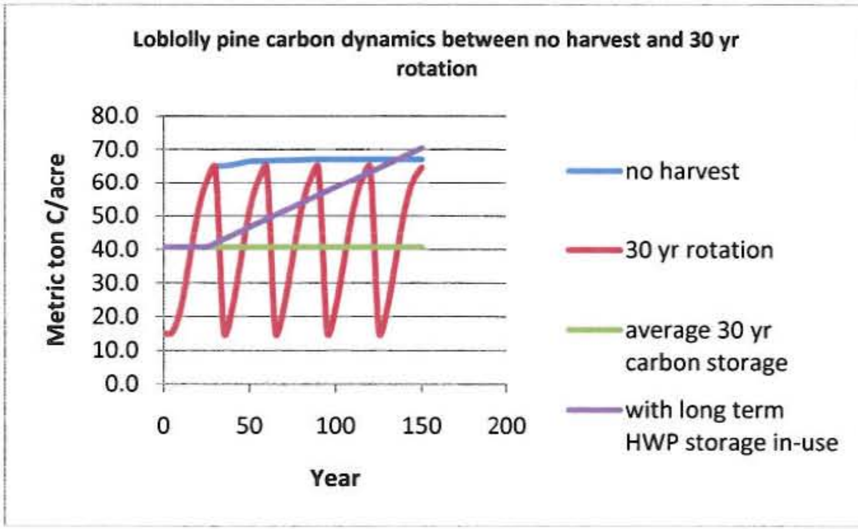

Figure 1: Loblolly pine carbon dynamics between no harvest and 30 yr rotation (using USFS FIA Carbon Inventory and wood product storage published in 1605b) tables)[3]

Please re-characterize the sentence in quotations above to reflect the limited temporal context of the statement.

Heading 2 – *The quantity of live tree retention significantly determines forest carbon.* The results of the studies described in this paragraph do not support this general finding. In fact, it appears that this was true in only the intermediate to shade tolerant angiosperm forests as described in Nunery and Keeton (2010) in a northern hardwood forest type. Not surprisingly, this result supports the time-tested silvicultural practice that currently is used in these types of forests (partial retention). The authors even state the "modeling results of intermediate to intolerant (shade) Douglas-fir showed no impact of silvicultural retention treatment with only rotation period providing a significant difference"[4]. Again, not surprisingly, this result supports the general practice of even-age management in shade intolerant forest ecosystems, such as Douglas-fir and Loblolly pine. The only other study mentioned in this part of the white paper is the DEMO study, which does not have a clear-cut option. Figure 2 is a graph that demonstrates the vastly superior regeneration growth of Douglas-fir (and to a lesser extent Red Cedar, Grand Fir and Hemlock) under a clearcut scenario than any other form of retention.[5]

[3] Department of Energy. 2006. *Appendix 1 of Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program: Chapter 1, Emission Inventories: Part I Appendix: Forestry*: March 2006.

[4] Foster, B., Robards, T., Keeton, W. 2010. *Carbon Dynamics Associated with Even-Aged Forest Management.* Written for Climate Action Reserve. P. 3.

[5] Oregon Forest Resources Institute. 1999. *Harvest and Regeneration in Oregon's Commercial Forests: silvilcultural options and outcomes in forests managed for wood production.* A background paper commissioned by the Oregon Forest Resources Institute.

Fourth-year data combined from two experiments showing how western Oregon conifers grow under various light conditions. (Growth is in cubic centimeters per tree.) *Source: Mike Newton, Oregon State University.*

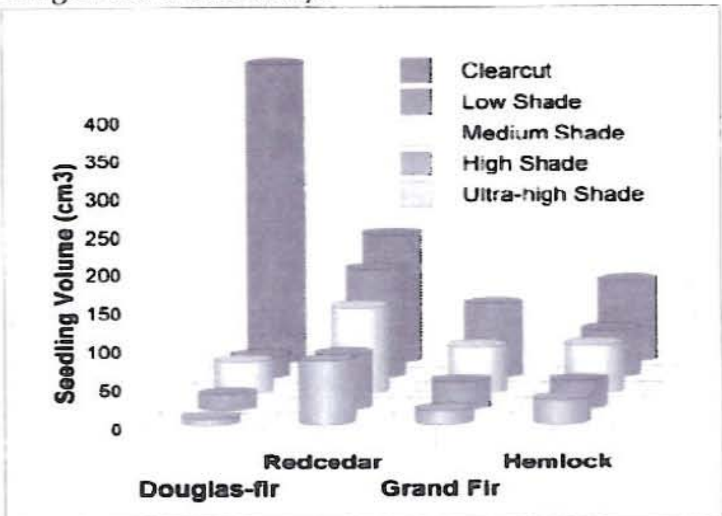

Figure 2. Western Oregon conifers grown under various light conditions.

Figure 2 also supports the early growth findings consistent with the DEMO study that Douglas-fir seedlings appear to grow slightly faster under medium shade than low shade. This finding does not support a linear relationship between live-tree retention and forest carbon, as the heading suggests. More importantly, however, it shows that any form of retention vastly reduces seedling growth relative to clearcut, a finding DEMO could not know because there was no clearcut option included in the study.

Figure 3 pulls together studies that demonstrate reduction in Douglas-fir stand productivity can be larger than the percentage of residual trees remaining.

Please clarify the general description of heading to put in the context of intermediate to shade tolerant angiosperm forests or clarify that it is not a direction relationship (i.e., in shade-intolerant species the quantity of live tree retention can have a negative impact on forest carbon by reducing stand productivity).

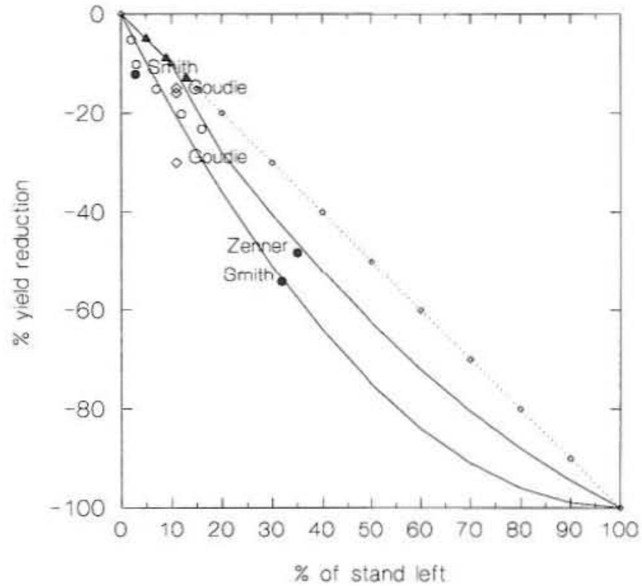

Figure 3. Notional yield adjustments for dispersed and variable retention systems. Note yield reduction is a composite of area reduction for area removed (percent retained in variable retention) and yield reduction of new crop. Data in Figure 2-1b are from ORGANON (Birch and Johnson 1992, Table 2); Goudie: simulations using TASS (Mitchell 1975) for a group retention, strip shelterwood and uniform shelterwood (increasing reduction in that order) using an approximate 11% retention level; Zenner (Zenner 1995) was calculated as -100 x [1-(1-0.35)(1-0.26)] = a -52% reduction comprised of a 26% reduction in mean annual increment in the understory under an average 35% in volume residual tree overstory; Smith data are from Appendix I: the data were split into two subsets: for less than 15% residual trees, the reduction was 12%, i.e., -100 x [1-(1-0.028)(1-0.092)] = -12% comprising a 9.2% yield reduction in the understory and 2.8% residual overstory volume, and for greater than 15% residual, volume the reduction was 54%, i.e., -100 x [1-(1-0.319)(1-0.323)] = -54% comprised of a 32.3% understory yield reduction under a 31.9% residual overstory volume (**NOTE:** these data use the surrogate stand and not the estimated fully stocked stand volume as a comparison base [see Appendix I].) The text above explains how a portion of the area occupied impact is already accounted for in the timber supply framework and how this is incorporated.[6]

Heading 3 – *The length of the rotation length (even-aged) or entry period (uneven-aged) also significantly determines forest carbon.* In the last sentence the authors state, "our modeling suggests that rotation ages linked to annual growth culmination may maximize live tree carbon stocks." Weyerhaeuser agrees with this statement and would like to point out that the culmination of mean annual increment (cMAI) varies significantly by tree species, site index, and silviculture treatment. For example, the biological cMAI in Loblolly pine can vary from 24 to 31 years depending on site index, stand planting density, and site treatment (e.g., fertilization, bedding, herbaceous weed control).[7] cMAI of Douglas-fir, on the other hand, is closer to 70-90 years depending on site index[8], though silvicultural

[6] Smith. N. 1999. Effects of alternative silviculture on yield: coastal BC Forests. Weyerhaeuser BC Coastal Group Nanaimo Woodlands. Available on request.

[7] Guo, Z. Grebner, D., Sun, C., Grado, S. XXXX. Biofuel Product Impacts on the Management of Southern Pine Plantations in Mississippi. Approved for publication as Journal Article No. FO 346 of the Forest and Wildlife Research Center, Mississippi State University; Guo, Z., D.L. Grebner, C. Sun, S.C. Grado. 2010. Evaluation of loblolly pine management regimes in Mississippi for biomass supplies: A simulation approach. Southern Journal of Applied Forestry 34(2):65-71.

[8] McArdle, R.E.; Meyer, W.H.; Bruce, D, 1961. The yield of Douglas-fir in the Pacific Northwest. Tech. Bull. 201. [Washington, DC]: U.S. Department of Agriculture. 72 p.:; Curtis, R. O. 1992. Technical Commentary: A new look at an old question- Douglas-fir culmination age. *Western Journal of Applied Forestry.* Volume 7: 4 (97-99).

treatments such as thinning can extend this period[9] and others such as fertilization can reduce this period.

Though cMAI is useful for understanding biological capacity it is not useful for determining practical management regimes for a particular stand. In the case of loblolly pine, the financial optimal rotation is often longer than the biological optimal rotation, as lengthening rotations allows more growth of more sawtimber, which commands a higher price than smaller diameter wood. Conversely, the financial optimal rotation for Douglas-fir is considerably shorter than the biological cMAI because such a long rotation age carries with it huge carrying costs.

Heading 4 – *The quantified effects of silvicultural treatments on total net sequestration or emissions of carbon will depend significantly on how carbon accounting boundaries are drawn, i.e. which carbon pool and downstream effects are included in the analysis.* Weyerhaeuser agrees with this statement and believes that the temporal component should also be added as an explicit parameter per justification above related to Heading 1. Weyerhaeuser also believes that the rest of the case studies compiled in the white paper should begin with the explicit context in which the study was conducted.

Pg 5. Forest Product Accounting – The authors should clarify that Harmon's study was referring to the roundwood and not the entire live tree. This is interpreted by reading Harmon's (2009) paper, which refers to assuming percentages of the "harvest would be converted to a mix of various long-term products…" [10] and from checking the definition of harvest in STANDCARB Version 2.0 manual, which states that "only sapwood and heartwood (i.e., boles) either alive or dead can be removed from the simulated forest."[11] If the assumption is correct that the utilization rates refer to percentage of roundwood (e.g., harvested material) and not the live tree (i.e., including branches, etc.) then the high utilization assumption is quite realistic for Douglas-fir forests. In fact, the Department of Energy Voluntary GHG Reporting 1605b) wood product calculation tables state that 74% of PNW roundwood becomes a product and that the decay rate is only 0.6% (0.3% if include landfill carbon as well as in-use).[12]

Pg. 5-6 Leakage – In the section on leakage the authors suggest that the wood product leakage effect between partial harvest stands and clearcut stands could be mitigated by harvesting more acres. In order for this to work, these would have to be acres that weren't previously being harvested, in which case there would be potentially another leakage between the unharvested and newly harvested stands unless there is an assumption that there is a market response to increase productivity somewhere. Such as scenario is plausible but needs to be specifically stated in the sentence. Otherwise the sentence should be removed.

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[9] Curtis, Robert O. 1995. Extended rotations and culmination age of coast Douglas-fir: old studies speak to current issues. Res. Pap. PNW-RP-485. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 49 p

[10] Harmon, M.E., Moreno, A. and Domingo, J.B. 2009. Effects of partial harvest on the carbon stores in the Douglas-fir/western hemlock forests: A simulation study. *Ecosystems* 12: 777-791.

[11] Harmon, M.E., Domingo, J.B. 2001. A Users Guide to STANDCARB version 2.0: A model to simulate the carbon stores in forest stands. (http://andrewsforest.oregonstate.edu/pubs/webdocs/models/standcarb2.htm).

[12] Department of Energy. 2006. *Appendix 1 of Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program: Chapter 1, Emission Inventories: Part I Appendix: Forestry*: March 2006.

Case study on variable retention component of natural disturbance based silviculture: DEMO – Since the DEMO study did not include a zero retention option (i.e., to simulate even-aged management) it is misleading to have a title that concludes "Dispersed retention patterns provided greatest tree growth benefits, but studies vary on appropriate level of retention for Douglas-fir to provide sufficient light."[13] As shown in Figure 2, Douglas-fir seedlings have a dramatic reduction in growth with any form of retention relative to clearcut, a finding DEMO could not know because there was no clearcut option included in the study.

(C) Effect of even-aged management and uneven-aged management on lying dead wood, litter and duff, and soil carbon.
Pg. 26 soil carbon -- The USFS North American Long-Term Soil Productivity Experiment found similar results to those described in Slesak et al, 2009. Specifically, the study found that that removing all surface organic matter had no impact on C or N levels in the upper soil profiles after 10 years across the studied geographies (five from the Sierra Nevadas and seven from the Southeastern Coastal Plain)[14]. Ares et al.[15] found similar results on a long-term research study site in Washington State (at a separate site than the Slesak study with similar treatments but different soil types). Incidentally, these studies also found that post-harvest C increased at all depths across all studies (regardless of whether or not surface organic matter had been removed). Powers et al. conclude that "soil inputs following disturbance depend less on decomposition of surface residues and more on the decay of fine roots that remained from the previously harvested stand."[16]

(D) A Case Study of the Carbon Stocks in Various Management Regimes in a Coastal Pacific Northwest Douglas-fir Forest Type – In the method section (pg. 29) the authors state that they assumed a 12x12 foot replanting density, which produced 304 trees per acre. This planting density is much lower than a typical Douglas-fir planting regime. It would be useful to rerun the model with a sensitivity analysis of different planting densities as it would appear that the chosen planting density would result in a bias against shorter rotations because there would be less carbon accumulated in the early years of the rotation.

Wood product accounting – It is unclear what accounting method was used for harvested wood product accounting (i.e., whether the CAR Forest Protocol Version 3.1 accounting method or another one). Please clarify. In addition, on page 35 the authors state that "the in-use wood product pool ranged from between 15% and 24%, but was not all countable towards reductions." Please clarify why some of the in-use product carbon wasn't countable towards reductions. Finally, it would be helpful to separate out the live carbon pools from the wood product carbon pools in the results tables.

[13] Foster et al. p. 15

[14] Powers, Robert F., Felipe G. Sanchez, D. Andrew Scott, and Deborah Page-Dumroese. 2004. The North American Long-Term Soil Productivity Experiment: Coast-to-Coast Findings from the First Decade. US Department of Agriculture Forest Service Proceedings RMRS-P-34.

[15] Ares, Adrian, Thomas Terry, Constance Harrington, Warren Devine, David Peter, and John Bailey. 2007. Biomass removal, soil compaction, and vegetation control effect on five-year growth of Douglas-fir in Coastal Washington. *Forest Science.* 53(5): 600-610

[16] Powers et al, 2004.

Accounting for Carbon in Soils White Paper

Weyerhaeuser appreciates the thoughtful background paper on soil carbon and supports the conclusion that soil carbon gains and losses are highly variable and depend on many factors. As such, Weyerhaeuser supports including soil carbon as an optional pool for measurement. Weyerhaeuser also has two points of clarification.

Fertilization- (pg 35, pg 16-17) – The authors convey that many studies show that fertilization can increase soil carbon but references that currently the Forest Project Protocol, version 3.1, does not allow fertilization. Weyerhaeuser finds this ban on fertilization to be completely arbitrary and unfounded. In addition to the studies mentioned in this white paper, there are numerous other studies that support the finding that increased N-availability actually causes more litter deposition and larger forest floor accumulations[17]. Forest floors have been found to decompose proportionally at the same rate, whether big or small[18], so if one does activities such as fertilization, then over multiple rotations there should be more soil organic matter built up in the ecosystem, which results in increased productivity resulting in a beneficial positive feedback. Although it is out of the scope of this white paper, Weyerhaeuser encourages the Climate Action Reserve to revisit the requirement to ban fertilization, taking into account the numerous benefits to soil carbon as highlighted in this white paper.[19]

Furthermore, Weyerhaeuser would like to clarify the authors' statement that there is a general lack of multiple studies testing the effects of fertilization and competing vegetation on soil carbon. Several of the Forest Productivity Cooperative trials have study these questions in southeastern United Stated and have published numerous peer-reviewed journal articles on this topic[20].

Harvest activity (p. 21, 36) – The authors state that "whole tree harvesting has a significant negative effect on soil carbon" and cites the Johnson and Curtis (2001) article as the source for this finding. Johnson and Curtis actually found that whole-tree harvest creates a slight decrease on average (~5% according to Figure 2 of the white paper). The authors state the results accurately in the statement below the figure but mischaracterize the conclusions of Johnson and Curtis in the conclusion paragraph on p. 22. In fact Johnson and Curtis concluded that there is very little effect of harvesting on soil C and N and nowhere do they mention that residues should be kept on site in the way that is portrayed in this white paper. Furthermore, the results of the Long Term Research Productivity study also do not support such a strong conclusion. These studies also found that post-harvest C increased at all depths across all studies (regardless of whether or not surface organic matter had been removed). The authors conclude that "soil

[17] Phelan, J and H.L. Allen. 2008. Have repeated applications of nitrogen and phosphorus to a loblolly pine (*Pinus taeda* L.) plantation changed stand productivity and soil nutrient supply? *Canadian Journal of Forest Research.* 38: 637-644; Leggett, Z.H. and D.L. Kelting. 2006. Fertilization effects on carbon pools in loblolly pine plantations on two upland sites. *Soil Science Society of America Journal* 70:279-286.

[18] Zerpa, J.L., Allen, H.L. Campbell, R.G. Phelan, J., Duzan, H. 2010. Influence of variable organic matter retention on nutrient availability in a 10-year-Old loblolly pine plantation. *Forest Ecology and Management.* 259: 1480-1489; Liu, L. King, J.S., Booker, F.L, Giardina, C.P., Allen, H.L. 2008 Enhanced litter input rather than chances in litter chemistry drive soil carbon and nitrogen cycles under elevated CO2: a microcosm study. *Global Change Biology* 15: 441-453.

[19] See Albaugh, J., Allen, H.L., Fox, T.R. 2007. Historical patterns of forest fertilization in the Southeastern United States from 1969 to 2004. *Southern Journal of Applied Forestry.* 31(3):129-137, for an overview of the biological and economic benefits of fertilization in Southeastern forests.

[20] Eisenbies, M.H., Burger, J.A., Aust, W.M. Patterson, S.C., Fox, T.R. 2006. Assessing change in soil-site productivity of intensively management loblolly pine plantations. *Soil Science Society of America Journal* 70:130-140; see Forest Productivity Cooperative web site for a list of publications. http://forestnutrition.org/publications.htm

inputs following disturbance depend less on decomposition of surface residues and more on the decay of fine roots that remained from the previously harvested stand."[21]

Examining Carbon Accounting and Sustainable Forestry Certification White Paper

Weyerhaeuser agrees with the conclusions in the report that current approach in the Forest Project Protocol meets the needs of the CAR program. Weyerhaeuser further agrees with the authors that adding any more requirements beyond the sustainability requirements and requirements in 3.9.2 of the Protocol will only increase project costs with little added benefit.

[21] Powers et al, 2004.