



Dept of Environmental Science, Policy, and Management
 130 Mulford Hall #3114
 Berkeley, CA 94720-3114
billstewart@berkeley.edu
 (510) 643-3130
 June 21, 2016

Dear BOF Chair Gilles,

At the June 15, 2016 meeting of the Board of Forestry, Glenn Christensen from the USFS PNW Forest Inventory and Analysis (FIA) program came down. He gave a presentation on the increased collaboration between the BOF and the FIA program with respect to ensuring that the BOF provides guidance regarding the added public goal of the ‘sequestration of carbon dioxide’ that came with the passage of AB 1504.

(PRC 4551 (b) (1)) The board shall ensure that its rules and regulations that govern the harvesting of commercial tree species, where applicable, consider the capacity of forest resources, including above ground and below ground biomass and soil, to sequester carbon dioxide emissions sufficient to meet or exceed the state’s greenhouse gas reduction requirements for the forestry sector, consistent with the scoping plan adopted by the State Air Resources Board pursuant to the California Global Warming Solutions Act of 2006 (Division 25.5 (commencing with Section 38500) of the Health and Safety Code).

You requested that I put in writing some of the ideas I expressed in strong support of the increased collaboration between the BOF and the FIA program. I have worked closely with the FIA analysts over the past few years with respect to this issue and want to affirm the basic insight that FIA has much to offer to California both in terms of understanding 1) the factors controlling the recent baseline rates of carbon sequestration as well as 2) greater insights into what new approaches and innovations could increase the already significant level of carbon sequestration benefits provided by California’s forest sector. A key principle is that to have an effective statewide policy to increase carbon sequestration related to forests and forest products, it is necessary to use a statistically valid data set that captures the opportunities and risks in a manner that also allows differentiating ownership classes and forest types.

An example of the power of the FIA data and analysis can be shown in their plot based analysis of the components of annual carbon sequestration rates by land owner/manager in the latest FIA report ((Kuegler 2016) in (Christensen et al. 2016)). Large differences among different owners and management approaches are very evident.

Table 1: In-forest sequestration rates in live trees on Conifer Forests of California

mmtCO ₂ /yr	~2000 - 2010						
million acres ->	7.492	4.057	3.435	9.14	3.271	12.41	19.903
	All Private timberlands	Private - Corp.	Private - Family	Federal - NFS timberlands	Federal - other timberland, other NFS	All Federal Forest	All Forests
Growth	23.5	13.3	10.0	22.4	7.3	29.6	53.2
Mortality	5.3	2.6	2.7	16.0	9.2	25.1	30.4
Removals	12.0	9.5	2.5	1.1	0.1	1.2	13.2
Net Change	6.3	1.2	4.8	5.3	-2.0	3.3	9.6
Net Growth & Yield/Gross Growth	78%	81%	73%	29%	-26%	15%	43%

While the BOF and many other state entities have reviewed many different individual projects and have heard about many different policies, the summary FIA data illustrates key statistically valid patterns that vary greatly by ownership and the types of management they practice. Many observers will note that the baseline rate of in-forest carbon sequestration in live trees is estimated at 9.6 mmt CO₂/yr even though some forestlands (such as the federal non-timberlands where there is no vegetation management) actually have negative carbon sequestration rates. This is greater than the 5 mmt CO₂/yr estimate based on a few pilot sites from some earlier California Energy Commission (CEC) funded projects. However, those earlier estimates are not compliant with the most recent IPCC good guidance practices (IPCC 2014) that also requires countries (or states such as California that want to be global leaders) to account for carbon sequestration related to products if they collect official data on products.

There are many ways to account for carbon sequestration related to products. One way to summarize the different methods is to compare them based on the 100 year sum of how much carbon is stored long term in products. This is sometimes referred to as a ‘pickling rate’ (e.g. how many fresh cucumbers can be stored long term as pickles) (van Kooten and Johnston 2016, van Kooten et al. 1995). ARB’s Forest Carbon Offset Protocol has many coefficients that consider how much of the harvested tree ends up in products and landfills. Since they ignore all wood used for bioenergy (even though such wood is classified as meeting the Renewable Portfolio Standard (RPS) used by most non-ARB entities in California), their calculations result in a relatively low ‘pickling rate’ of 0.3. Based on field work in Northern California where much of the logging residue was taken to bioenergy plants when there was robust demand for their electricity (Stewart and Nakamura 2012), our follow-up analysis of the full carbon sequestration benefits of managed forests on private lands (Stewart and Sharma 2015) essentially has a ‘pickling rate’ of 1.0. Improvements in the utilization of wood products, more efficient landfill operations, and greater use of wood residue could significantly increase the pickling rate. For our purpose, using a broad range of pickling rates provides insight into how forest products can affect the overall 2014 IPCC compliant good guidance estimate of total forest and forest product carbon sequestration (the last column in Table 2).

Table 2: Long term carbon storage in products in mmt CO₂/yr by owner class with different pickling rates

van Kooten Pickling Rate	All pvt	Corp	Family	NFS	Other Fed	All Fed	All CA forests	Total new C sequestration in forests and forest products
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6
0.3	3.6	2.8	0.8	0.3	0.0	0.4	4.0	13.5
0.5	6.0	4.7	1.3	0.6	0.0	0.6	6.6	16.2
0.8	9.6	7.6	2.0	0.9	0.1	1.0	10.5	20.1
1	12.0	9.5	2.5	1.1	0.1	1.2	13.2	22.8
1.25	15.0	11.8	3.2	1.4	0.1	1.5	16.5	26.1
1.5	18.0	14.2	3.8	1.7	0.1	1.8	19.8	29.4

The major take home message is that regardless of the chosen pickling rate, private forests provide far more carbon sequestration benefits per acre of forest land than federal forests because harvested products (referred to as ‘removals’ when focusing on the in-forest measurements) are efficiently used in California. A testable hypothesis is that increased production of products can complement strategies to reduce mortality to wildfires and other sources of mortality.

Equally or perhaps more important than providing a solid baseline number for forest related carbon sequestration is the potential of combining the wall to wall FIA plot data with models that project how the carbon sequestration rates across all carbon pools may change over time due to changes in climate as well as changes in management. For this we can use insights taken from the current differences in forest management approaches by owner classes and test out improvements with forest growth and fire models that are designed to use the detailed data from FIA live tree lists, dead and down trees, surface fuel characteristics, and data on other carbon pools.

When we look at the growth, removal, and mortality (GRM) components of the carbon sequestration rates by owner in table 1, there are significant differences that help define opportunities where the combination of new investments and proper technologies can generate increased climate benefits.

- 1) higher growth rates (ie by ensuring successful regeneration of burned areas, full site utilization by trees)
- 2) removals that are used efficiently for energy and products
- 3) lower mortality rates through better fuels management'; increased stand level resiliency to beetles, mistletoe, and other mortality vectors; and efficient identification and utilization of dead trees before their product value is zero.

Building on years of research work by researchers at PNW, we just turned in a major analysis of how to reduce fire hazards (a major cause of loss of live tree carbon sequestration) in California's forest based on an integrated model that use FIA plot data, USFS forest growth models, USFS fire hazard models, and harvested product allocation models (Fried et al. 2016). The report is still in review at the CEC, but provides valuable evidence of how FIA data can be used to design even more effective forest management strategies relevant to forests of California.

Another example is our ongoing project to combine FIA data with the most recent Canadian forest carbon model that also tracks carbon as it moves from live tree pools through the various dead carbon and soil carbon pools (Schmitz et al. 2014, Shaw et al. 2014, Smyth and Kurz 2013, Smyth et al. 2014). This can provide a more comprehensive understanding of the full carbon cycles in the forest and in products as required by AB 1504.

In sum, I believe the increasing collaboration between the FIA program and the BOF will be advantageous to everyone in the state and is essential to improving our understanding of the full system of forest and forest product related carbon sequestration. As the recent trends in catastrophic wildfires and drought related mortality are showing, just because our forests are mainly green now, they may not always stay green and healthy.

Please do not hesitate to contact me if you want any further information.

Sincerely,



William Stewart

Forestry Specialist

billstewart@berkeley.edu

Co-Director Center for Forestry <http://ucanr.edu/sites/cff/>

Co-Director Center for Fire Research and Outreach <http://ucanr.edu/sites/cfro/>

cc. Glenn Christensen, USFS PNW FIA program

References

Christensen G, Waddell K, Stanton S, Kuegler O. 2016. California's Forest Resources: Forest Inventory and Analysis, 2001-2010. PNW-GTR-913. Portland, OR: U.S. Forest Service, Pacific Northwest Research Station.

Fried JS, Loreno S, Sharma B, Starrs C, Stewart WC. 2016. Inventory based landscape-scale simulation to assess effectiveness and feasibility of reducing fire hazards and improving forest sustainability in California with BioSum: California Energy Commission ARFVT Program, March 2016.

IPCC. 2014. 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol in Takahiko Hiraishi TK, Kiyoto Tanabe, Nalin Srivastava, Baasansuren Jamsranjav, Maya Fukuda and Tiffany Troxler (eds) ed. Kanagawa, Japan.

Kuegler O. 2016. Annual Tree Growth, Removals, and Mortality in California in Christensen G, Waddell K, Stanton S, Kuegler O, eds. California's Forest Resources: Forest Inventory and Analysis, 2001-2010 PNW-GTR-913, vol. PNW-GTR-913. Portland, OR: U.S. Forest Service, Pacific Northwest Research Station.

Schmitz O, Raymond P, Estes J, Kurz W, Holtgrieve G, Ritchie M. 2014. Animating the carbon cycle. *Ecosystems* 17: 344 - 359.

Shaw CH, Hilger AB, Metsaranta J, Kurz WA, Russo G, Eichel F, Stinson G, Smyth C, Filiatrault M. 2014. Evaluation of simulated estimates of forest ecosystem carbon stocks using ground plot data from Canada's National Forest Inventory. *Ecological Modelling* 272: 323-347.

Smyth CE, Kurz WA. 2013. Forest soil decomposition and its contribution to heterotrophic respiration: A case study based on Canada. *Soil Biology and Biochemistry* 67: 155-165.

Smyth CE, Stinson G, Neilson E, Lemprière TC, Hafer M, Rampley GJ, Kurz WA. 2014. Quantifying the biophysical climate change mitigation potential of Canada's forest sector. *Biogeosciences* 11: 3515-3529.

Stewart WC, Nakamura G. 2012. Documenting the full climate benefits of harvested wood products in Northern California: Linking harvests to the U.S. Greenhouse Gas Inventory. *Forest Products Journal* 62: 340-353.

Stewart WC, Sharma BD. 2015. Carbon calculator tracks the climate benefits of managed private forests. *California Agriculture* 69: 21-26.

van Kooten GC, Johnston CMT. 2016. The Economics of Forest Carbon Offsets. *Annual Review of Resource Economics* 8.

van Kooten GC, Binkley CS, Delcourt G. 1995. Effect of Carbon Taxes and Subsidies on Optimal Forest Rotation Age and Supply of Carbon Services. *American Journal of Agricultural Economics* 77: 365-374.